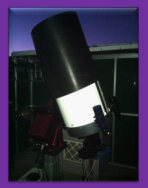

# Introducing Astronomy into High School Physics Curriculum Through the Use of the University of North Dakota Observatory

**Caitlin Nolby, Advisor: Paul Hardersen**
Space Studies Department, University of North Dakota

## Introduction

This project involved the development of astronomy curriculum to be used at the secondary level throughout North Dakota. This poster describes the participation of nineteen advanced physics students at Grand Forks Central High School over the course of two weeks. Along with course instruction and in-class activities, students visited the University of North Dakota Observatory and John D. Odegard School of Aerospace Sciences. Students were given in-class assessments including a pre-test and post-test on astronomy topics and daily exit surveys to determine best practices for future installments of the curriculum.

## Objectives

- Use feedback from students' in-class assessments to develop a lesson plan to be made available to educators across North Dakota as astronomy education is currently not a focus in local high school curriculum.
- Allow students open access to the University of North Dakota Observatory to complete remote observing projects as the UND Observatory is the only research capable observatory in the state.
- By making astronomy education an option for secondary students in schools across North Dakota, the hope is that this project will better prepare students for college astronomy courses and spark an interest in space sciences.

Clockwise from top left: Bird's eye view of UND Observatory before new office trailer was installed showing facility's 3 internet-controllable observatories, Observatory #1 (16" S-C Telescope on Paramount), UND Observatory's current office trailer installed in 2010

## UND Observatory

The University of North Dakota Observatory is located 10 miles west of Grand Forks, ND. Current equipment includes:

- Three Internet Controllable Schmidt-Cassegrain Telescopes: Two 16-inch, one 10-inch; All controllable with ACP Observatory Control Software
- On-site Office Trailer
- Solar H-Alpha Patrol Camera/Filter
- Visible Wavelength Stellar Spectrograph
- All-Sky Camera and Virtual Weather Station
- CCD Cameras (Charge-Coupled Devices)

Research-capabilities at the facility includes:

- Photometry
- Astrometry
- Stellar Spectroscopy
- Solar Imaging
- CCD Color Imaging

## Methodology

1. Develop astronomy curriculum to be taught to high school physics students over the course of two weeks using multiple online resources, textbooks, and content from two undergraduate courses:
   - Space Studies 425 – Observational Astronomy
   - Astronomy 1001 – Exploring Our Universe (course at the University of Minnesota - Twin Cities)

2. Plan in-class activities and create worksheets to reinforce understanding of classroom topics

3. Deliver course material to two advanced physics classes at Grand Forks Central High School over ten class periods from April 16, 2012 through April 27, 2012.

4. Administer course pre-test and post-test to gauge students' conceptual understanding of the material, as well as daily exit surveys to determine the student point-of-view of the course.

5. Analyze daily exit-surveys and pre-tests and post-tests to determine best instructional practices for future class periods. This knowledge will also be applied to future installments of the course across the state.

## In-Class Assessments

The students were given a pre-test and post-test at the start of instruction and at the beginning of the last class period to assess any student gains in understanding of the material. The following questions were included:

1.When you hear the word "astronomy" what comes to mind?
2.What processes provide energy for the Sun and other stars?
3.How do astronomers conduct research? What equipment do they use?
4.Pictured below is the Sun. If the following were a size and distance scale of the solar system, where would Earth be? Where would Jupiter be? Where would the nearest star (Proxima Centauri) be? (Please draw in the planets and star, or explain where they should be.) [There was a picture of a semicircle at the edge of the page representing the Sun, 7 cm in diameter.]
5.How do telescopes work?
6.List and describe solar system objects.
7.If you were going to observe an asteroid for the night, what types of things would you need to know before planning your observing run? How would you get this information?
8.Below, describe what causes moon phases using words or diagrams or both.

*Example of one daily exit survey:*
1.What was the **best part** of class today?
2.Was there any aspect of class today that you would like to see **changed** in the future to improve your learning?
3.Was there any topic introduced today that you **didn't fully understand**?
4.Please feel free to add any **additional comments** about today's class or previous class periods. (Please specify which class periods you are referring to.)

## Course Overview

The students received instruction for a total of ten class periods. On Friday night following the first week of instruction, students were given the option to visit the UND Observatory. One class period took place in the school's computer lab and during another class period, students took a field trip to the University of North Dakota. Each day of instruction was complemented with an in class worksheet or activity. Below is the schedule of the two week course:

**1. Navigating the Night Sky**
- Coordinate Systems, Orbital Precession, Proper Motion, Constellations, Seasons
- *Activity:* Finding Altitude and Azimuth of objects in the classroom

**2. Astronomical Distances**
- Solar System Distance and Size Scale, Stellar Parallax, Doppler Effect
- *Activity:* Calculate 1 Astronomical Unit using radar, Predicting Solar System Distance Scale

**3. Our Moon and Rules of the Solar System**
- Kepler's Laws, Formation of the Moon, Lunar Phases, Planetary Phases
- *Activity:* Moon-Earth Distance, Lunar Phases with flashlight

**4. Telescopes**
- Telescope Types, Telescope Characteristics, Overview of UND Observatory

**5. Asteroids, Comets, and Their "Impacts"**
- Formation of Solar System, Craters, Momentum and Kinetic Energy
- *Activity:* Calculate size of dinosaur-killing asteroid

***Visit to UND Observatory***
- Tour of facilities and equipment including Telescopes, Computers, and CCD cameras

**6. Remote Observing** (Computer Lab)
- Writing Scripts, Using Astronomical Databases for research, ACP Observatory Control Software

**7. Astrometry and its Applications**
- Impacts and Modern Society, Basics of astrometry and CCDs
- *Activity:* Math problem sending a spacecraft to a Near Earth Asteroid

**8. Visit to School of Aerospace Sciences**
- Tour of UND's Spacesuit Lab, Spacecraft Simulators, Lunar Rover, Lunar Habitat
- Aircraft Simulators and High Altitude Chamber

**9. Stars**
- Star Formation, Nuclear Fusion, Stellar Classification, Types of Stars, HR Diagram, Supernovae, Black Holes
- *Activity:* Predicting densities of stars

**10. Life in the Universe**
- Big Bang, Galaxy Formation, Life on Earth, SETI, Kepler Mission and Extrasolar Planets
- *Activity:* Drake Equation: Calculating the possibility of the existence of extraterrestrial life

## Results

Overall, the course was a success. Students enjoyed the in-class activities more than the lecture style instruction. Students found the diagrams and animations to be helpful in promoting their learning, and found videos shown to be interesting. The trips to the UND Observatory and School of Aerospace were also seen as beneficial to student learning as well as fun experiences.

Student performance on pre-tests and post-tests showed general improvement in understanding. The most significant improvement was seen on Question #2 as 100% of the students correctly stated that "nuclear fusion" was responsible for energy production in stars.

It was originally intended that the students complete a group project involving asteroid astrometry through remote observing, but it became apparent that this task in the given timeframe was impractical. Instead students did an in-class activity on the topic. Perhaps in the future with more involvement from teachers and more time in the curriculum set aside for astronomy instruction, students will be able to complete research using equipment at the UND Observatory.

It would be beneficial in the future to stretch this curriculum out over a longer time period. In doing this, more detail could be included on various topics, especially solar system objects and stellar evolution.

## Future Work

- Improve course content and in-class activities to cater to the learning needs of students for future installments of the course.
- Create lesson plan to be made available to teachers throughout North Dakota to use in their classrooms.
- Identify educators willing to participate in astronomy education along with the possibility of student research through remote observing using the UND Observatory.

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## For Further Information

Please contact me via email: *Caitlin.Nolby@gmail.com*
To learn more about the UND Observatory, visit: *observatory.space.edu*

THE UNIVERSITY OF NORTH DAKOTA UND Observatory