Transforming an Atmospheric Science Undergraduate Lab
Integrating Skywatch Observatory into ATOC 1070

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Motivation

Fundamental Idea:
- Introduce atmospheric science instrumentation to students through curriculum that is inspiring and effective in teaching students basic fundamentals of radiation and precipitation.

Project Goals:
- Establish a rooftop observatory to measure and archive radiometric and precipitation quantities: atoc.skywatch.edu
- Provide web-based public access to real-time and archived data.
- Develop local instrument-based curriculum for undergraduate atmospheric science classes.
- Evaluate curriculum using pre- and post-questionnaires.
- Integrate curriculum into undergraduate weather and atmosphere course sequence.

Methodology

Four Phases of Curriculum Development:
1. Development Phase (Nov, 09 – Mar, 10)
   - Team kick-off meeting
     - Professors develop the Essential Questions, Learning Goals, and General Lab Exercise Outline
   - Graduate students develop the pre and post assessment
     - Graduate students lab exercises
     - Professors revise professors’ online and focus exercises.
2. Pilot Phase (Mar, 10 – Apr, 10)
   - Radiation Lab
     - Instructor 1
     - Instructor 2
     - Instructor 3
     - Instructor 4
   - Precipitation Lab
     - Instructor 5
     - Instructor 6
   - Team reviews professors’ online and focus exercises.
   - Graduate students lab exercises
     - Professors revise and/or approve the team’s additions/ revisions.
   - Final pretest assessment
     - Final laboratory exercise
3. Revision Phase (Apr, 10 – Aug, 10)
   - Team revised new labs based on instructor’s feedback
   - Overhauled ATOC 1070 syllabus to accommodate new curriculum.
   - Pilot radiation lab in summer 2010 sections (33 students).
4. Final Implementation (Aug, 10)
   - Incorporated finalized curriculum into fall 2010 syllabus.
   - Taught to 247 students in 14 sections during fall 2010 semester.

Curriculum Examples

Radiation Lab

- Incorporates guided inquiry and local radiation measurement instruments, and Skywatch Observatory data.
- Part 1: Instructor demonstrates impacts of radiation sources on pyranometer and pygermeters.
- Students experiment with instruments in classroom and infer the wavelengths that each instrument measures.
- Part 2: Students examine pyranometers, pygermeters, ceilometer, and video archive data corresponding with various weather.
- Students determine the impact of time of day and clouds on radiation.
- Part 3: Students calculate the emissive temperature of the atmosphere and effective emission altitude.

Lab Conclusion: Students extrapolate the big picture from what they learned in the lab.

Precipitation Lab

- Incorporates disdrometer, radar reflectivity and rainfall data into streamlined laboratory orientation lab.
- Students spray water through disdrometer to analyze drop size and velocity data.
- Student plot radar reflectivity and rainfall rate data in Microsoft Excel, a program they use throughout the lab.

Evaluation Methods

- Assessments developed based on common learning goals between the old and new labs and contain identical content questions.
- Administered pre-assessment 1 week prior to lab.
- Pilot instructors (2) taught “New” (Transformed) Lab to one section and “Old” (Traditional) Lab to second session.
- Administered post-assessment the class period after the lab.
- Compared students who completed both assessments.
- Results include both pilot instructors: new lab - 25 students, old lab - 24 students.

Discussion

- Team successfully developed undergraduate laboratory sessions that incorporated guided inquiry, real data, and actual radiation and precipitation instruments.
- Team used curriculum to partially transform ATOC 1070 – Weather and Atmosphere Laboratory.
- Students’ average assessment scores increased after completing New Radiation Lab, but far from highest possible score.
- New Radiation Lab students’ score increase higher than Old Lab students’, but their pre- and post-assessment averages were lower.
- New Radiation Lab students’ average increase was due to moderate improvements from Low and Medium students. (See orange highlight in below tables.)
- High classification New Radiation Lab students’ scores decreased. (See yellow highlight in below tables.)

Results: Radiation Lab Evaluation

<table>
<thead>
<tr>
<th>Score Change Categories</th>
<th>Moderate Improvement</th>
<th>Small Improvement</th>
<th>Total</th>
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<tbody>
<tr>
<td>Lab</td>
<td>Pre-assessment</td>
<td>Post-assessment</td>
<td>Change</td>
</tr>
<tr>
<td>Old Lab</td>
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<td>7.9</td>
<td>0.7</td>
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<tr>
<td>New Lab</td>
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<td>7.4</td>
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Future Work

- Analyze precipitation assessment data.
- Investigate why radiation assessment scores changed.
- Analyze students’ rating of the Labs.
- Continue to use similar curriculum development techniques and the Skywatch Laboratory to revamp undergraduate curriculum.

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