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

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TUES Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics
Course, Curriculum, and Laboratory Improvement (CCLI)

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.

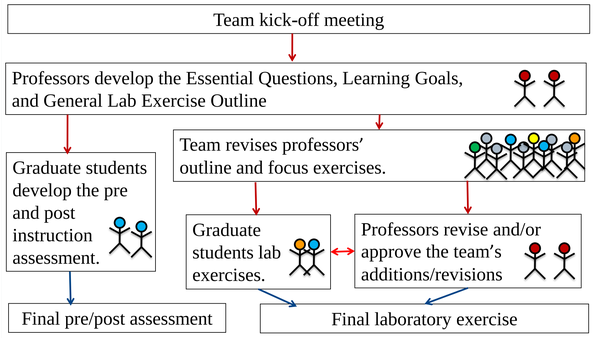
❖Evaluate curriculum using pre- and post-questionnaires.

❖Integrate curriculum into undergraduate weather and atmosphere course sequence.

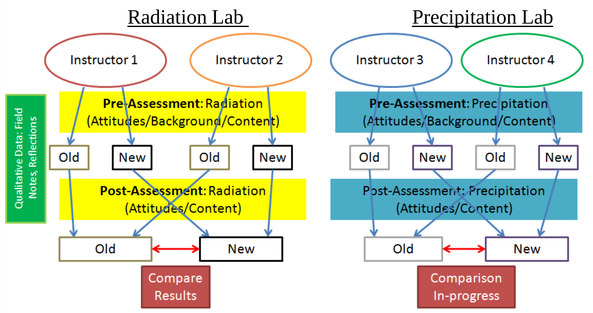
Methodology

Four Phases of Curriculum Development:

1. Development Phase (Nov. 09 – Mar. 10)



2. Pilot Phase (Mar. 10 – Apr. 10)



❖ Piloted "new" laboratory exercises in 4 lab sections and compared with 4 "old" traditional labs.

3. Revision Phase (Apr. 10 – Aug. 10)

❖ Team revised new labs based on instructor s' feedback .

❖ Overhauled ATOC 1070 syllabus to accommodate new curriculum.

❖ Piloted 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

Ceilometer

❖Incorporates guided inquiry and local radiation measurement instruments, and Skywatch Observatory data.

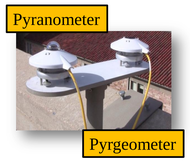
❖Part 1: Instructor demonstrates impacts of radiation sources on pyranometer and pyrgeometer. Students experiment with instruments in classroom and infer the wavelengths that each instrument measures.

❖Part 2: Students examine pyranometer, pyrgeometer, ceilometer, and video archive data corresponding with various weather. Students determine the impact of time of day and clouds on radiation.

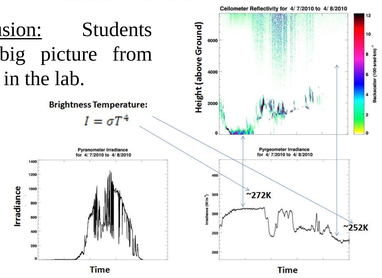
❖Part 3: Students calculate the emissive temperature of the atmosphere and effective emission altitude.

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

Pyranometer



Pyrgeometer



Radiation Lab Objectives Comparison	
New	**Traditional**
Radiation in the Atmosphere	**Infrared Radiation and the Greenhouse Effect**
Essential Questions:	Demonstrate the following:
1. How do the magnitudes of solar and infrared radiation compare during the day and night?	1. Properties of emission and absorption of radiation in the atmosphere.
2. What factors control the amount of solar and infrared radiation reaching the ground?	2. How the Earth's atmospheric and surface temperatures may be determined by measurements from a weather satellite.
3. How does the greenhouse effect work?	3. How temperature of the troposphere depends on the amount of carbon dioxide, water vapor, and other absorbing gases.

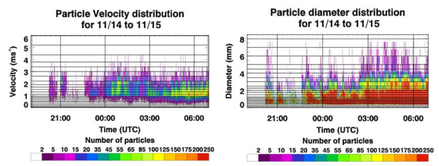
Precipitation Lab

Disdrometer

❖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.



Precipitation Lab Objectives Comparison	
New	**Traditional**
Precipitation Lab	**Cloud Observations and Synoptic Weather Patterns**
Essential Questions:	Objectives:
1. What is the drops size distribution in rain storms and how does it affect rainfall amount and rainfall intensity? How are these measured?	1. Observe, identify, and keep a log of cloud observations.
2. Why do storms with the same rainfall amount have different intensity?	2. Relate cloud observations to regional weather patterns revealed by surface weather maps, upper air maps, satellite images, and radiosonde
3. What is the shape of a raindrop?	

Results: Radiation Lab Evaluation

Evaluation Methods

❖Assessments developed based on common learning goals between the old and new labs and contain identical content questions.

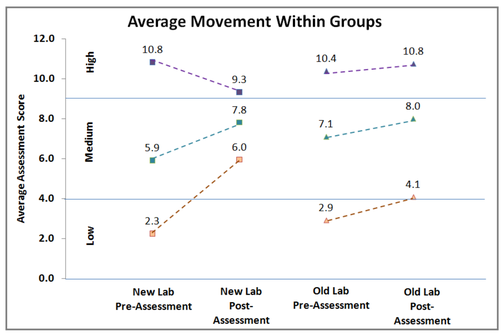
❖Administered pre-assessment 1 week prior to lab.

❖Pilot instructors (2) taught "New" (Transformed) Lab to one section and "Old" (Traditional) Lab to second session.

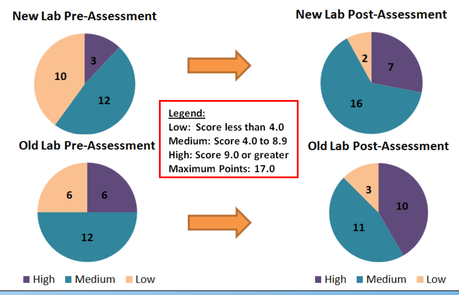
❖Administered post-assessment the class period after the lab.

❖Compared students who completed both assessments.

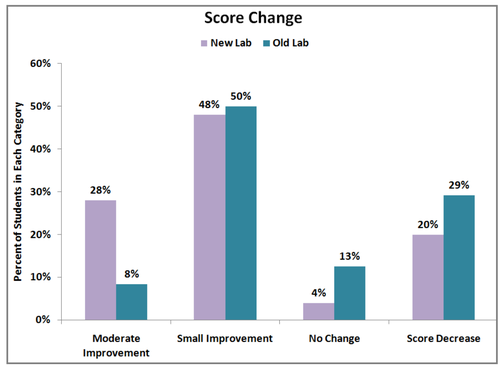
❖Results include both pilot instructors: new lab - 25 students, old lab - 24 students.



Average Scores			
	Pre-assessment	Post-assessment	Change
New Lab	5.0	7.3	2.2
Old Lab	7.1	7.9	0.8



Score Change Legend:
***-Moderate Improvement*: Score increase greater than or equal to 4 points.**
***-Small Improvement*: Score increase greater than 0 but less than 4 points.**
***-No Change*: Pre and Post-assessment scores equal.**
***-Score Decrease*: Post-assessment score is less than pre-assessment score.**



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 ATOC1070 – 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.)

New Lab Classification Chart					
	Moderate Improvement	Same	Score Decrease	Small Improvement	Total
High			3		3
Medium	2	1	2	7	12
Low	5			5	10
Total	7	1	5	12	**25**

Old Lab Classification Chart					
	Moderate Improvement	Same	Score Decrease	Small Improvement	Total
High		2	1	5	8
Medium	1	1	4	4	10
Low	1		2	3	6
Total	2	3	7	12	**24**

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.

Acknowledgements

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