5.5

INTEGRATION OF LECTURE, LABORATORY AND HANDS-ON ACTIVITIES IN AN INTRODUCTORY SEVERE WEATHER COURSE FOR NON-MAJORS

Lourdes B. Avilés*
Judd Gregg Meteorology Institute, Plymouth State University, Plymouth, New Hampshire

1. MOTIVATION

Traditionally, introductory science courses consist of separate lecture and laboratory sessions. The use of in-class activities to promote active learning in lecture settings has become more prevalent in recent years. However, lectures and laboratories are still treated as separate entities, where students either attend a lecture or perform a laboratory activity. During the implementation of a new General Education program at Plymouth State University (PSU), the opportunity arose to develop a completely integrated introductory severe weather course for non-majors fulfilling the Scientific Inquiry requirement of the new program.

2. SCIENTIFIC INQUIRY REQUIREMENT

PSU/s new general education program went into effect during the Fall 2005 semester. Among other features, the program requires so called *Direction* courses, which loosely align with the traditional four category system of Natural Sciences, Humanities, Social Sciences and Creative Arts. The four Directions are *Scientific Inquiry*, *Self and Society*, *Past and Present* and *Creative Thought*.

Courses that fulfill the scientific inquiry direction are meant to emphasize the skills of critical thinking, writing, conducting research, quantitative reasoning, working with information technology and collaborating with others, while working in a framework of scientific methodology and maintaining awareness of the social, cultural, political and ethical context of the specific discipline. Given the significant impacts of severe weather on society, an introductory course on the science of common or infamous severe weather types and their associated effects, is especially suited to fill these requirements.

For more information about the PSU's new general education program, see http://www.plymouth.edu/undergrad/GenEd/index.html.

3. COURSE DESCRIPTION

The Severe and Hazardous Weather course (MTDI 1500) explores the science behind various severe weather phenomena and their impact on society. The course begins with a brief introduction to the atmosphere and basic weather processes. It then focuses on specific severe weather topics such as hurricanes and tornadoes.

Lecture-type elements and laboratory-type elements are integrated throughout the course, rather than having separate lecture and lab sessions. Each class starts with a discussion of the current weather, focusing on any severe weather elements present at the time. The lecture pieces, which are normally no more than 10 or 15 minutes long, revolve around PowerPoint presentations that include diagrams, animations, videos, website links and any other resources needed to illustrate the concept being discussed. Each topic is accompanied by one or more exercises, which are done immediately after specific aspects of the topic have been discussed.

The course is taught in a laboratory-style classroom with large tables, large projection screen, instructor computer with internet access and wireless capabilities for laptops. Fifteen laptops and four desktop computers are available in the classroom for student use. Students are also encouraged to bring their own computers. Normally one or two students work on one computer. A print version of the class notes, as well as links to websites and other materials needed to complete the exercises are posted online and accessed by the students during class.

* *Corresponding author address:* Lourdes Avilés, MSC #48, Judd Gregg Meteorology Institute, Plymouth State University, Plymouth, NH 03264; e-mail: lourdes.aviles@plymouth.edu

3.1 Topics

A high quality severe weather textbook by Rauber et al. (2005) is used as the foundation for this course. This book can be adapted to different levels and once some introductory material has been covered, it is very well suited for modularity.

For this course, the material has been clustered into six different general topics (sometimes spanning various chapters of the textbook):

- Atmospheric Basics
- Weather Basics
- Tropical Cyclones
- Thunderstorms and Their Hazards
  Including
  - Tornadoes
  - Lightning
  - Hail
  - Downbursts
  - Floods
- Winter and Cold Weather
  Including
  - Winter Precipitation
  - Blizzards
  - Nor'easters
  - Lake Effect Snow
  - Mountain Snow
  - Cold Waves
- Summer and Hot Weather
  Including
  - Drought
  - Heat Waves
  - Wildfires

The order in which the topics are covered depends on the term in which the course is being offered. During the Fall semester, tropical cyclones are the first severe weather topic covered, and winter weather is covered last. During the Spring semester, winter weather is covered first, followed by thunderstorms, with summer weather covered last. If the class is offered during the summer, summer and hot weather topics are covered first, and tropical cyclones are covered last. This modularity permits a stronger sense of relevance for the students, most of whom are not science majors.

Besides the basic science behind each of the phenomena, other aspects that are emphasized are historical events and their impacts, and safety measures appropriate for each type of weather. An effort is also made to discuss the societal impacts (economical, political, cultural, etc.) of each type of weather.

3.2 Exercises

There are currently a total of 101 exercises done throughout the course. They cover a wide spectrum that spans from short questions or tasks that can be worked on in a couple of minutes to period-length laboratory-type activities.

Short exercises include historical events research, simple calculations, map analyses, drawings/schematics, observations, comparisons between phenomena, identification of phenomena, concept interpretation and various combinations of these. Examples include temperature conversions, a calculation of the frequency of blizzards for a region based on a map with total number of blizzards, explanation of concepts such as the formation of a downburst, and many others.

Historical events researched by the students include the Super Tornado Outbreak of 1974, the Great Flood of 1993, the Dust Bowl, the 1998 Ice Storm, the Great Blizzard of 1993, the 1938 New England Hurricane and Hurricane Katrina, among others.

Period-length laboratory activities include the discovery of the naming system for Atlantic hurricanes by using the 2005 hurricane season and the forecasting of general and severe thunderstorm occurrence by using real meteorological data to determine the location of the most favorable conditions for development. The pictures in Figure 1 show students recently working on this activity.

3.3 Other Features

Another interesting feature of this course is a term project where each student creates a product or writes a research paper about a topic related to severe weather (or at least weather in general) and their major. This provides another layer to the integrative nature of the course, in this case, integrating weather with their interests. Each student presents their project or paper at the end of the semester. In some cases, the results have been quite interesting. The following is a selection of term project topics produced for various majors:

- **Criminal Justice** – *The Effects of Weather on Violent Crime*
- **Early Childhood Education** – *Weather-Related Safety Guidelines for Daycare Teachers* (Brochure), The Effects of Severe Weather in School Operation
- **Adventure Education** – *Avalanche Safety*

Figure 1. Students forecasting the location where thunderstorms were most likely to occur by using real meteorological data to determine where conditions were most favorable.

- **English** – *The Origins of Severe Weather Terminology*
- **Business/Marketing** – *Effects of Hurricane Katrina on the Housing Market, How Weather Affects the Advertising Industry.*
- **Music** – *Effects of Weather on Instruments, Weather-Focused Analysis of Vivaldi's Four Seasons.*
- **Psychology** – *The Social and Psychological Effects of Hurricane Katrina on Victims*

Students have produced paintings, maps, brochures, songs as well as numerous papers.

4. IMPLEMENTATION DETAILS

The call for new courses fulfilling the general education requirements provided an opportunity to design from scratch a new course that fit the requirements and took advantage of the available technology. The first offering of the course (Fall 2005), followed a more traditional model with two lectures and one laboratory session per week. With advancement money obtained from donations to the university, we were able to purchase fifteen laptops, which are also used for other meteorology courses. This provided the necessary resources to implement a truly integrated course starting during the second offering of the course (Spring 2006). Ideally, we would like to have a laptop for each student, but the available funds were not sufficient. However, enough students bring their own laptops and only a handful of them end up sharing computers. At this time there is no plan in place to allow for computer replacement in a few years.

The first offering served 42 students (originally capped at 40) that split into two smaller laboratory sections. All subsequent offerings have been capped at 25, in order to be able to use the laboratory-style classroom and the computers. It seems that a problem with the integrated offering is the inability to serve more students because of the resource intensive nature of the course.

5. EVALUATIONS AND OUTCOMES

The course has become extremely popular with students. As an example, the only section offered for next semester (Spring 2007) was completely full within a couple of hours during the first day of registration.

Student evaluations have been very positive. The following are examples from student evaluations at the end of the Spring 2006 semester:

"This course was very interesting. It was fun to learn about all the different types of severe weather that can occur around the world. I am happy I decided to take this class."

"It was a well structured and fun class."

"I feel that I have learned so much. Everything was well organized and tied together nicely."

There were only a couple of negative comments having to do with tough grading and questioning the need for a textbook.

Based on final course grades, we can evaluate the course outcome and the differences between the more traditional offering (Fall 2005) and the first integrated offering (Spring 2006).

For Fall 2005, the mean class grade was 80.19 (B–) and the standard deviation was 13.04 for a total of 42 students. For Spring 2006, the mean grade was 83.7 (B) and the standard deviation was 8.01 for a total of 25 students. The results show a small improvement and more consistent grades during the integrated offering.

Further analyzing the final grades, we find that for the Fall 2005, 59.5% obtained grades above 80 (B– and above), 14.3% above 90 (A– and above), 14.3% were below 70 (D+ and below) and 7.1% below 60 (F). For the Spring 2006, 60% obtained grades above 80, 24% above 90, 8% below 70, and none below 60. The percentage of students with the lowest grades dropped significantly and the percentage of students with the best grades increased significantly. It appears that the immediate reinforcement of concepts as well as the depth of understanding resulting from the numerous exercises and the one-on-one interaction with the instructor, allows higher achievement by the students.

Evaluations and grade data for Fall 2006 should be available for the time of the presentation.

6. ACKNOLEDGEMENTS

Various individual activities done in this course were inspired or directly adapted from activities developed by one or more of the authors of the Severe and Hazardous Weather textbook with whom the author had the pleasure of working during her years at the University of Illinois.

The author also wishes to acknowledge Plymouth State University and the Judd Gregg Meteorology Institute for completely supporting her development and implementation of this course.

7. REFERENCES

Rauber, R. M., J. E. Walsh and D. J. Charlevoix, 2005: *Severe and Hazardous Weather: An Introduction to High Impact Meteorology*, Kendall/Hunt Publishing Company, U.S.A., 580 pp.