10.4 NEW APPLIED CLIMATOLOGY AND METEOROLOGY COURSE AT THE UNIVERSITY OF OKLAHOMA

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1. INTRODUCTION

Spurred by Stan Changnon's statement that "teaching of applied climatology is still too limited, and often not done at many colleges and universities" (Changnon 2005), I decided to develop a new course on applied climatology and applied meteorology for the School of Meteorology at the University of Oklahoma. This paper describes how I developed the course and some of the results of the work. I hope that this discussion encourages others to develop similar courses at their university or college.

2. BACKGROUND

Although graduates of OU's School of Meteorology (SoM) traditionally were hired during past decades by government institutions (e.g., the National Weather Service) or advanced to graduate school, recent graduates were being employed primarily by private companies. These employers included not only private weather firms but also software development, air quality assessment, and financial organizations. To become more marketable in this new environment, SoM students indicated that they desired coursework that focused on solving real-world problems.

Prior to 2008, an applied climatology course had not been taught at the University of Oklahoma (OU) since Fall 1990. During the past two decades, however, the applied research and services of the Oklahoma Climatological Survey at OU, especially those related to its operation of the Oklahoma Mesonet (McPherson et al. 2007), provided a solid basis for real examples to be discussed in an applied climatology and meteorology.

During the spring semester of 2008 (January – May), I taught "Applied Climatology and Meteorology" as senior-level course METR 4803 and graduate-level course METR 5803 at the OU School of Meteorology. Ten seniors (five male, five female) and five masters-level graduate students (all female) completed the three-credit course. Classes were held from 1:00 – 2:15 PM on Tuesdays and Thursdays.

3. COURSE CONTENT

The purpose of METR 4803/5803 was "to broaden the perspective of students to the use of weather and climate information in agriculture, transportation, public safety, public health, and other areas of society." Prerequisites included "Thermodynamics" and "Radiation & Climate" (Physical Meteorology I and III) as well as "Technical Writing." It was advertised that "students should have a basic understanding of the structure and thermodynamics of the atmosphere, physical processes associated with radiative transfer in the atmosphere, energy balance at the earth's surface, the general circulation of the atmosphere, the mean climate of the earth, climate variations in space and time, and climate change."

Because many applied problems and their solutions involve not only climate information but current weather data and products, the topics melded both applied climatology and applied meteorology, as needed. Table 1 summarizes the overall topical content of the class.

No textbook was used for the course; rather several journal articles or other reading materials were assigned based the subject material for the following week.

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WEEK	TOPIC
1	Introduction, Review of Climatology, and "Gallery Walk" on Applied Climatology; *Homework #1: Write questions to ask next week's guest speaker*
2	Modernizing a National Weather Service: Case Study of the Republic of Croatia; Guest Speaker: Ivan Čačić, Director of Državni hidrometeorološki zavod
3	Data and Their Quality: The Cooperative Observer Network and the Oklahoma Mesonet; Guest Speaker: Dr. Chris Fiebrich, Manager of the Oklahoma Mesonet; *Homework #2: Analyze differences in annual rainfall measured at two climate observing stations*
4	Climate Statistics and Products
5	Systems Engineering; Writing Surveys; *Homework #3 (METR 5803 students only): Develop a survey to assess the needs of the Meteorological and Hydrological Services of the Republic of Croatia*
6	Health; Homework #4 (in-class): Mountain cedar pollen forecasting using HY-SPLIT
7	Emergency Management
8	Review of Climate Regimes; Group Project #1 (in-class): Risk and vulnerability analysis using a geographical information system (GIS) tool
9	Examples of Working with Customers on Weather and Climate-Related Problems; Guest Speakers: Dr. Eve Gruntfest, Professor of Geography at the University of Colorado–Colorado Springs and Dr. Dave Robinson, State Climatologist of New Jersey and Professor of Geography at Rutgers University
10	**Spring Break**
11	Discussion of Group Project #2: Summarize a portion of the Intergovernmental Panel on Climate Change (IPCC) Technical Summaries for Working Groups 1 and 2; Discussion of Group Project #3: Find a customer with a weather- or climate-related need and provide a solution; Mid-Term Exam
12	Transportation
13	Vegetation and Agriculture
14	Group Project #2 Presentations
15	Drought Monitoring; Guest Speaker: Dr. Mark Shafer, Director of Climate Services at the Oklahoma Climatological Survey; Work on Group Project #3 (in-class)
16	Intellectual Property; Career Discussion
FINALS	Group Project #3 Presentations with customers in attendance

Table 1. *Topics, homework, projects, and guest speakers for METR 4803/5803, "Applied Climatology and Meteorology," offered for Spring 2008 at the University of Oklahoma.*

Individual homework assignments were assigned during the first third of the semester, followed by group project work for the remaining two-thirds of the year. With the exception of one group project for the METR 5803 (graduate) students only, the instructor assigned both undergraduates and graduate students and both male and female students to each group. For the first group project, each group was led by a graduate student (five groups of three students); for the second project, an undergraduate led each group (five groups of three students); and for the final project, the members of each five-person group could select (or not) a leader themselves.

As expected with most group work, there were times when one student did minimal work or one student completed substantially more work than all others. Although neither of these outcomes was desirable, they did represent team conflict in the "real world." Fortunately, there were no crises that needed intervention, and the group member evaluation forms helped to differentiate the grades received by the stronger and weaker students.

4. LEARNING METHODS

In addition to developing content, I tried to blend different learning methodologies into the class. I openly acknowledge that the easiest method to prepare was the traditional lecture-style class; however, this method was the least desired by students and, in my opinion, the least effective for teaching applied topics.

I made use of the excellent web site entitled "Starting Point: Teaching Entry Level Geoscience" (http://serc.carleton.edu/introgeo/index.html) from Carleton College. Although the site was focused on entry-level teaching, it was quite useful for ideas to teach the seniors and graduate students in this class. In particular, I conducted one Gallery Walk, used "clickers," developed cooperative learning activities, and led a service-learning activity for the final project.

In addition, every week I discussed some user request or practical problem that I was faced with in my job at the Oklahoma Climatological Survey. In that manner, students could see the diversity of the work and discuss the challenges of solving open-ended problems.

4.1. Gallery Walk

Of all of the learning methodologies used, the Gallery Walk received the most positive comments during the semester, probably because only one student had experienced it before. A Gallery Walk (e.g., Kolodner 2004) is similar to how small groups of art students walk from one painting to another and reflect on artist and his/her art. Instead of a painting, the small groups encounter a series of questions that are designed to stimulate discussion.

For my class, I divided the students into five teams of three students and brought them to the large atrium of the National Weather Center building. In five locations, I placed a question and a big writing board for them to write their answers. Each group was instructed that they could not write the same answer as a previous group. Every 10 minutes, I signaled for them to move to a different question station until they visited all five. I walked from station to station to challenge their ideas or help them if they were struggling. At the last station, I gave additional time for the group to summarize all of the responses for that question. Then we returned to the classroom and one member of each group presented their summaries for all to hear.

I conducted the Gallery Walk on Day 2 of class, after providing them the Changnon (2005) paper to read. All of the questions revolved around some aspect of his paper and were designed to demonstrate how much the students already knew about applied topics in our science.

The only disappointment in conducting this activity was that I did not follow up with one or two more gallery walks throughout the semester. Although it requires substantial time, it quickly engages the students and allows them to think on their feet.

4.2. "Clickers"

Electronic Student Response Technology, commonly referred to as "clickers," allows students to use a handheld device to enter answers to multiple choice (or other types) of questions. The advantage of using clickers is to gauge the students understanding of a topic before (or after) teaching. The primary disadvantage is the time it takes to set up, implement, and fix (if something breaks).

I used clickers in the first half of the semester. (During the second half, I was rushing to finish preparations for class and did not have time to prepare and implement clicker questions.) I did not have the students register their individual clicker number, so the responses were anonymous.

In future classes, I will seek to use clickers more fully because the input I received, especially during the first weeks of the semester when the students were shy, allowed me to focus on several misunderstandings that I may have overlooked otherwise.

4.3. Cooperative learning

Cooperative learning provides students an opportunity to work as a team to solve a problem, leaning on the various strengths of individual group members. As one student stated later, "In a team, play to people's strengths and weaknesses."

In my class, I incorporated cooperative learning with teaching with GIS (geographical information systems) to conduct a risk analysis for a small, U.S. coastal city of their choice. Students were graded on their written analysis, a presentation to the "city council" (i.e., other students), and group interaction. The activity used the Coastal Risk Atlas (http://www.ncddc.noaa.gov/interactivemaps) of NOAA's National Coastal Data Development Center. "Risk assessment of an area is a far more complicated and involved procedure than I had originally envisioned," as one student noted. The activity challenged them because there was no "right answer."

4.4. Service-learning

Service-learning (e.g., Lui et al. 2004) provides students the opportunity for real-world problem solving with the added benefit of serving their local community. Service learning has gained national attention, as college and university presidents sign the Campus Compact (http://www.compact.org/) to promote these activities in their classrooms.

The final project for my class was for the students to seek a "problem" in Norman, Oklahoma or a nearby community, study it, and provide a recommended solution. As I discovered later, this project was the first in the students' coursework that they spoke directly to a customer. (Other SoM classes, most notably "Hydrometeorology," had engaged customers before, but none of these students had taken that class.)

One of the three groups of five students evaluated the drought response plan for the City of Norman. Another group evaluated the weather-related portion of the safety plan for the Gaylord Family Oklahoma Memorial Stadium at the University of Oklahoma. The third group analyzed the needs of the City of Oklahoma City's Public Works Department for new products and services based on data from the Oklahoma City Micronet (to be commissioned later in 2008).

Each group met with their customer at least once in person and interacted via email as they worked on the project. The customers also were provided a written document and a final presentation of the team's recommendations.

5. EVALUATION

Using an online survey tool (http://www.surveymonkey.com) at the end of the semester, 14 of the 15 students provided anonymous input regarding the class. Students indicated that they found the following topics "very interesting" or "moderately interesting": transportation (13 of 14 students), health (13 of 14), emergency management (13 of 14), climate statistics (13 of 14), vegetation and agriculture (12 of 14), and drought monitoring (12 of 14). Systems engineering was deeming "Not too interesting" or "Boring" by four of 14 students.

Thirteen of 14 students noted that they enjoyed working with their classmates on the group projects, although two of the students would have preferred fewer group projects.

Seven of the students indicated that they changed their education or career plans somewhat after taking this class, and 12 noted that the course sparked their interest in a new subject.

6. SUMMARY

Although developing an applied climatology and meteorology class from scratch was time-consuming, it was a rewarding activity to engage with the next generation of scientists. In addition, it provided an excellent opportunity to determine whether or not a particular student would be an excellent addition to my organization in the future.

Comments from the students themselves provided the best encouragement to continue revising and teaching this course. The following are quotes from students regarding what information they deemed most valuable in the course:

"Weather info is useless if not effectively communicated to those using it. I will be more mindful of the end-result of my work (start @ the finish line)."

"It is critical to consider the relationship between meteorology and other disciplines."

"I need to educate users how to use the information that I provide."

"People need to examine all angles and look beyond the boundaries to solve a problem."

"[A needs assessment is] a great opportunity to collaborate, get different opinions, and stay organized to make sure all areas and steps are fully covered in the process."

"Comparing [the two networks] was a great way to show the difference in systems and shows that you need to know where your data is coming from and when you use it."

"I do not have to be pigeon-holed into forecasting. I can use my degree and knowledge in many fields."

"You must do everything with the stakeholders in mind. When running a business, if you are not catering to the consumers' demands, they will find another organization that will."

"You need to be able to communicate meteorology to stakeholders in a way that they can understand."

"When I broadcast the weather, I need to understand the importance of timely warnings and accuracy. I also will put things into perspective for people and explain the toll weather can have on their health."

"Always think of your customers' needs."

"Work with emergency management to help them plan for weather events of the future."

"For future reference, I will know the benefits and limitations of certain datasets/ observation networks.

"Procrastination is not acceptable when it comes to human life. Practicing getting work/ errands done on time will help with the stress level."

"The normal temperature or precipitation measurement doesn't mean it's really "normal" to that area."

"It is imperative to have great 2-way communications with emergency management to get critical weather information out."

"When making a system/product, it is important to communicate with the people who will be using it."

"I have learned the criteria and importance of risk analysis for a weather event. This could help me in my future work with public officials to develop procedures for mitigating such risks."

"Droughts hurt economy and society the worst. If I ever am a state or federal leader dealing with natural disaster mitigation, I will deal with drought first."

7. ACKNOWLEDGEMENTS

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