TJ3.5 EXPERIENTIAL LEARNING ON HYDROMETEOROLOGY THROUGH A UNIVERSITY STUDY ABROAD PROGRAM

Curtis N. James*
Embry-Riddle Aeronautical University, Prescott, Arizona

1. INTRODUCTION

Disparity often exists between teaching and learning in the atmospheric sciences, especially at the undergraduate level (e.g. Roebber 2005). It has been shown that students generally learn best through sensory learning or active learning styles, unlike their professors who are accustomed to more traditional lecture-based or deductive teaching techniques. As a result, the Boyer Foundation (1998) recommends dramatic changes in undergraduate education, including more inquiry-based learning rather than mere knowledge transmission.

Recent studies have documented efforts to transform atmospheric science curricula towards hands-on research and inquiry-based learning in an attempt to enhance undergraduate education. For example, Yarger et al. (2003) explored the effectiveness of using simulations in undergraduate education, while Richardson et al. (2008) created an undergraduate field experiment using the Doppler on Wheels to integrate classroom learning with field research.

2. MOTIVATION

Embry-Riddle Aeronautical University (ERAU) is a leader in this effort to respond to the changing educational needs of undergraduate students and has adopted a Quality Enhancement Plan (Clevenger and George 2012). The focus of this plan is to transform teaching by encouraging inquiry learning and student innovation both in and out of the classroom. One way that the Meteorology Department at ERAU's Prescott, Arizona, campus has contributed to this initiative is through the implementation of research-focused study abroad programs.

The study abroad programs are offered every summer, and are focused on field research related to topics in hydrometeorology. On alternating years, study abroad programs are conducted on the topics of Mountain Meteorology in southern Switzerland and tropical meteorology/climate in the Amazon rainforest. These programs provide an opportunity for students to experience very interesting and unique climates first-hand.

* *Corresponding author address:* Curtis N. James, Embry-Riddle Aeronautical Univ., Dept. of Meteorology, Prescott, AZ 86301-3720; e-mail: Curtis.James@erau.edu.

3. SWISS ALPS

Stemming from participation in the international 1999 Mesoscale Alpine Programme (MAP; Bougeault et al. 2001), the author is fortunate to maintain a fruitful research collaboration with scientists at MeteoSwiss. Our research has focused primarily on the unusually heavy precipitation in the region surrounding Locarno, Switzerland. This small city is located on a river delta where the very flood-prone Maggia River empties into the Lago Maggiore, a large lake on the Swiss-Italian border. The Maggia catchment is one of the wettest locations in Europe, and intense floods in this region are usually associated with quasi-stationary lines of training convective cells developing and propagating over the local area (Panziera et al. 2014).

ERAU's Swiss study abroad program is therefore focused on investigating the mechanisms leading to heavy orographic precipitation in Locarno, Switzerland. The students also benefit from the availability of a dense weather observation network in Switzerland and engaging interaction with MeteoSwiss scientists. The students take classes in mountain meteorology, particle physics, and the language and history of the region. They also have the opportunity to tour a meteoSwiss weather radar (see Fig. 1), visit the CERN particle accelerator in Geneva, explore local castles and historic sites, and take breathtaking hikes in the Alps.

The most noteworthy learning activity for the meteorology students is a hands-on field research project conducted during their one-month stay in the Alps. They form research groups, each consisting of about three students, and select interesting topics related to the meteorology around Locarno. Over the past two summers, they have investigated unique

Figure 1. A tour through the radar data acquisition site at Monte Lema, Switzerland.

orographic cloud formations, precipitation mechanisms, and mountain-valley circulations. They have been encouraged to utilize all available observational data (soundings, surface observations, remote sensing imagery) as well as mesoscale model guidance provided by MeteoSwiss on the Internet. In addition, the students are given access to portable weather instruments: rain gauges, hand-held sensors mounted on poles, and digital cameras for high-resolution time-lapse cloud imagery.

Students are required to create proposals that establish research objectives and communicate a planned course of action to achieve these objectives. Once these proposals have been approved by their instructor, the students subsequently conduct their research by collecting and analyzing data, attempting to reach conclusions, and finally reporting their findings orally to the class on the final day of the program.

As a result of this project, students learn to share observational resources and cooperate with other groups so that all may achieve intended results. At times, nature does not provide weather conditions that are ideal for achieving their objectives. Consequently, students are encouraged to develop back-up plans just in case the unexpected happens. It is also necessary for students to monitor weather forecast guidance and plan their courses of action accordingly. Thus, the projects closely simulate the experiences of scientists in actual meteorological field campaigns such as the MAP project.

4. AMAZON RAINFOREST

This year is the first time that ERAU will be offering a study abroad program in the Amazon rainforest, centered at Manaus, Brazil. The program will be offered every other year, and will include a river boat cruise on the Amazon River, followed by expeditions from a jungle lodge. The course is designed so that students witness the anthropogenic impacts on the rainforest and the socioeconomic pressures conducive to deforestation and climate change in the region. They also explore the behavior of tropical convection and how it impacts river stages, which in turn affects the economy of the region.

Two courses will be offered, namely Tropical Meteorology and Climate as well as a course entitled Narratives of Exploration, Discovery and the Environment in the Amazon. The students will be directed to conduct a field research project patterned after the Swiss study abroad program. One potential disadvantage will be that the observational network in the rainforest is rudimentary, and it will be necessary to rely heavily on satellite data and global forecast models to guide field operations. Nevertheless, as in the Alps, students in the Amazon program will have access to portable weather sensors, camera equipment and occasional Internet access to online data sources.

5. SUMMARY

These research-oriented study abroad programs have proven to be an excellent learning opportunity because they incorporate proven pedagogical strategies of inquiry-based learning and problem solving. They also give students experience conducting field research. These programs offer learning experiences designed to help the students synthesize their meteorological theories and apply them towards solving real research problems in exciting and unique climatological settings. The students have been able to achieve worthwhile research results and at the same time gain critical thinking skills. Moreover, these programs create educational memories that can last a lifetime.

Meteorology students from all universities are invited to apply for acceptance into one of these research-oriented adventures offered by ERAU, and are encouraged to direct their inquiries to the author.

6. REFERENCES

Bougeault, P., and Coauthors, 2001: The MAP Special Observing Period. *Bull. Amer. Meteor. Soc.,* **82,** 433–462.

Boyer Commission on Educating Undergraduates in the Research University, 1998. *Reinventing Undergraduate Education: A Blueprint for America's Research Universities.* Stony Brook, NY: State University of New York at Stony Brook, 46 pp.

Clevenger, A., and Whealan George, K., 2012. *Ignite.* Publication. Ed. Doug Gutierrez. Revised ed. Daytona Beach: Embry-Riddle Aeronautical University (http://spa.erau.edu/resources/ignite/ignite_document.pdf).

Panziera, L., C. N. James, and U. Germann, 2014: Mesoscale organization and structure of orographic precipitation producing flash floods in the Lago Maggiore region. Accepted to *Q. J. R. Meteorol. Soc.*

Richardson, Y., P. Markowski, J. Verlinde, and J. Wurman, 2008: FIELD EXPERIENCE: Integrating classroom learning and research: The Pennsylvania Area Mobile Radar Experiment (PAMREX). *Bull. Amer. Meteor. Soc.,* **89,** 1097–1101

Roebber, P. J., 2005: Bridging the gap between theory and applications: An inquiry into atmospheric science teaching. *Bull. Amer. Meteor. Soc.,* **86,** 507–517.

Yarger, D. N., R. Thomas, J. P. Boysen, and L. Pease, 2003: EDUCATION: Simulations as learning tools. *Bull. Amer. Meteor. Soc.,* **84,** 1489–1490.