

A Grand Experiment in e-Education

Offering Adult Students an Online Apprenticeship in Weather Forecasting

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During our combined 35 years at The Pennsylvania State University (PSU), we have received many inquiries from adults seeking an educational outlet to nourish their passion for weather and forecasting. Almost all of these adults held jobs unrelated to the field of meteorology. Moreover, they were in a position that prevented them from simply pulling up stakes and becoming full-time students (family obligations, etc.). The oldest of us, having taught mathematics in Atlanta in the 1970s while secretly aspiring to be a meteorologist, also struggled with the notion of quitting his job and going back to school for an advanced degree in atmospheric science. So we empathized with their plight. But we did not have any sound alternatives to suggest to these adults until we took the professional plunge into online education in 2001.

From the outset, we started to see possibilities that we never realized before. Was it possible that this relatively new electronic format could afford us the opportunity to teach these adults, most of whom had no formal training or education in meteorology, to competently forecast the weather? Coming from Penn State, where legendary football coach Joe Paterno began his “Grand Experiment” in the 1960s (to field a team of scholar–athletes), we suddenly were inspired to conduct our own grand experiment.

In the spring semester of 2002, we kicked off the grand experiment by offering a single, online

course that focused on the basic principles of weather forecasting. “Meteo 101: Understanding Weather Forecasting” gained national attention in 2003, when the University Continuing Education Association recognized the course with its Meritorious Course Award. Meteo 101 also received rave reviews from many returning adult students, and we quickly realized that these students wanted more. Responding to perceived demand, we began to write and construct the online program that confers a Certificate of Achievement in Weather Forecasting, with Lee Greci authoring the courses, David Babb providing media and instructional design, and Steve Seman assuming a lion’s share of the teaching load while construction was underway.

When the dust settled, the certificate program consisted of four online courses designed to afford students the flexibility to engage the course material and complete their assignments within a specified block of time (typically one to three weeks):

- Meteo 101: Understanding Weather Forecasting
- Meteo 241: Fundamentals of Tropical Forecasting
- Meteo 361: Fundamentals of Mesoscale Weather Forecasting
- Meteo 410: Advanced Topics in Weather Forecasting

We emphasize here that Penn State’s online program does not translate to *certification* of any kind. Rather, the certificate distinctively acknowledges each student’s academic success and commitment to lifelong learning. For more information about Penn State’s online certificate program, please visit www.worldcampus.psu.edu/WeatherForecastingCertificate.shtml.

For all practical purposes, we launched the program in the fall of 2005 by offering Meteo 241 (needless to say, tropical forecasting was intense that semester), and our first class graduated in the fall of 2006 (Fig. 1).

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DOI:10.1175/2008BAMS2550.1

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FIG. 1. The first graduating class from Penn State's online certificate program poses by the Nittany Lion on 4 Nov 2006.

Among the pictured graduates, there is an Olympic skier from Canada, a farmer, a legal administrator, a business consultant, a nurse, and an undergraduate student majoring in communications.

Meteo 410, the program's capstone course (Meteo 101, Meteo 241, and Meteo 361 are prerequisites for Meteo 410), focuses on advanced forecasting techniques, such as ensemble forecasting. For this course, we require our students to participate in WxChallenge, a national collegiate forecasting contest run by the University of Oklahoma. Contestants in WxChallenge match forecasting wits with other undergraduate students, graduate students, and professors at universities all across the country. Essentially, students learn by doing. In our opinion, the results of the forecasting contest would ultimately be the litmus test for judging the success of our grand experiment.

Our certificate students far exceeded our expectations. Competing against over 1,250 forecasters from 53 universities across the nation, our Canadian Olympic skier finished 27th in the nation. Nationally, our top six certificate students finished in the upper 10%, and the entire class finished in the top quarter (see Fig. 2 for national rankings).

During the spring semester of 2007, three more certificate students enrolled in Meteo 410 and finished in the top 10% in WxChallenge. For the record, the professions of the second graduating class included a computer software designer, an emergency medical technician, and an air-quality forecaster.

The success of these returning adult students was not limited to their high standings in WxChal-

lenge. For example, during the summer of 2006, after she completed Meteo 361, Marie (the nurse) decided to chase storms over the Midwest (an organized tour run by professional meteorologists). On one morning, the tour guides asked her to give a weather briefing that formulated a chase plan for the day. She pinpointed southwestern Nebraska, but the professionals decided to drive into Colorado instead. After they arrived, they realized that conditions were not favorable for severe weather, so they drove back to southwest Nebraska, where they encountered a couple of supercells, just as Marie had predicted.

Why are our students so successful? First and foremost, we cannot overstate the importance of having returning adult students who dedicate themselves to becoming lifelong learners. Second, the framework of Penn State's online certificate program provides a unique environment for students to thrive as learners and forecasters.

Elaborating on the second point, we believe that each of our online courses has four primary components that help to cultivate this unique learning environment. First, each course includes

Forecaster	National Rank (1258 Forecasters)
Olympic Skier	27
Business Consultant	37
Legal Administrator	58
Weather Solutions Meteorologist	80
Farmer	97
Communications Major	100
NWS Intern	325
Nurse	348

FIG. 2. The final cumulative national rankings of Meteo 410 students who competed in WxChallenge during the fall semester of 2006.

a dynamic online text that encourages our students to critically think about atmospheric science and weather forecasting. By "dynamic" we mean that the courses are rife with videos and interactive animations that allow our students to explore important scientific concepts.

For example, we included two images (Figs. 3 and 4) from an interactive animation that allows students to interactively explore the concept of

resolution as it relates to satellite imagery (please visit https://courseware.e-education.psu.edu/public/meteo/sat_sim.swf to access this interactive tool; we include a companion animation at <https://courseware.e-education.psu.edu/public/meteo/resolution.swf> so readers can manipulate the resolution of real satellite imagery). It is well accepted that there is a tactile component to learning, and interactive animations help our students to better grasp complex concepts. Compared to the traditional approach of reading text and studying static images, the tactile component is an invaluable learning tool.

We note that there are no math prerequisites for our online program (students with a sound background in high school physics can be successful). Although higher mathematics provides the underpinning for resident courses taught by the Department of Meteorology at Penn State, we present most of our online material in a conceptually rigorous way. Still, we sprinkle calculus and some basic mathematics throughout our courses to enhance the learning experience of our more quantitatively oriented students. For students with little or no background in mathematics, we encourage our students to treat the quantitative content as if it were a food buffet. We do not require students to consume all of our mathematical explanations, but we strongly recommend that they partake in an overall “balanced meal” of atmospheric science.

The second component of the program’s unique e-learning environment has its roots in peer-to-peer interactions on a special forecasting forum specifically tailored to each course. In the three upper-level courses, these asynchronous forecasting forums simulate an operational forecasting environment. Here’s how it works: Each week, we assign at least one student to be a

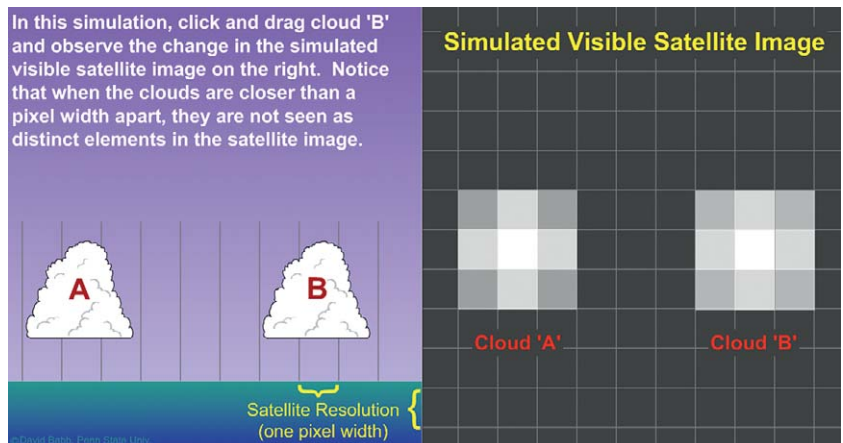


FIG. 3. A screen capture of an interactive animation that allows Penn State certificate students to interactively explore the concept of satellite resolution (as it relates to imagery).

lead forecaster. In this role, a lead forecaster’s primary responsibility is to post daily weather briefings that provide the “big picture” (the prevailing background weather pattern) for the rest of the class. Lead forecasters routinely punctuate their discussions by attaching relevant charts and imagery and pointing out features that are keys to the current forecast. Fellow classmates must then respond to the lead forecaster’s weather briefing, adding value to the threaded discussion by supplying a more detailed analysis that they corroborate by attaching timely and relevant images from reliable sources on the World Wide Web. We assess the quality of student participation in our forecasting forums to give all students an incentive to apply course concepts in a real-time environment.

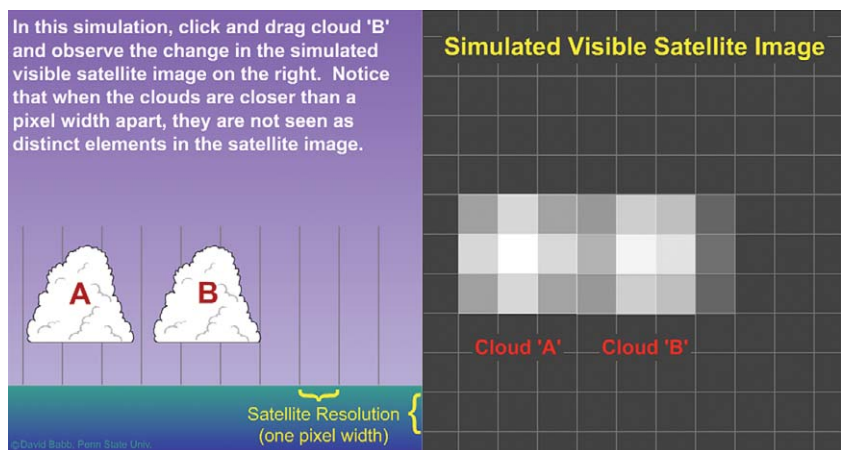


FIG. 4. Certificate students learn that, when the distance between two clouds is less than the width of one pixel, the clouds cannot be resolved as distinct features on the simulated satellite image.

The third component of the certificate program's online leaning environment includes intensive e-mentoring. In each online course, *The Classroom* discussion forum encourages students to ask questions about the course material and to discuss aspects of real-time weather not specifically addressed in the forecasting forums. In addition to providing another outlet for enthusiastic students to talk with each other about the weather, *The Classroom* plays a crucial instructional role. Indeed, the frequent interaction between students and instructors helps students to acquire a deeper understanding of the course material and its applications. Of course, as students interact with their peers and instructors, questions frequently arise, which often lead to tangential threaded discussions that are both interesting and instructional.

Of all the instructional input we have in our online program, none is more pivotal than maintaining our high standard of "customer service." Indeed, we strive to respond to all questions posted by students within a few hours (response times are a bit longer overnight and on the weekends). In our opinion, one of the salient differences between online teaching and resident instruction is the high *frequency* with which we engage our students in the virtual classroom. Most of our returning adult learners require guidance and help, so they greatly appreciate our frequent log-ins to answer their questions.

When a student posts a question in a discussion forum, we do not necessarily divulge the correct answer in our first reply. Rather, most of our initial responses take the form of a leading question meant to guide students or a suggestion meant to refocus their thinking. In this way, we establish a threaded discussion that encourages further dialogue while inviting contributions from other students. Given that program enrollments have steadily grown (from approximately 10 students in 2005 to as many as 30 students per class in 2007), peer-to-peer interactions have become increasingly important in helping us to cultivate a cohesive learning community. In the end, we maintain that the discussion forums allow us to have many more instructional opportunities for interacting with our online students than we ever did while teaching in a traditional classroom setting.

The process of e-mentoring does not end there. Motivated by the medical profession, which routinely teams students with professional mentors, we decided to expand each forum's envelope of instructional opportunities by recruiting highly visible professional forecasters to interact with our students. We

recognized that, for many students of meteorology, opportunities to be mentored are largely limited to summer internships, which are not available for every student. The flexibility of the virtual classroom afforded us a unique opportunity to break away from this traditional model.

Steve Corfidi, a lead forecaster at the Storm Prediction Center (SPC), and Jon Racy, a mesoscale/outlook forecaster at SPC, welcomed our invitation and in their free time have graciously contributed high-quality discussions to our Meteo 361 forums. Here's an example exchange between Steve Corfidi and a certificate student in the immediate aftermath of severe weather near El Reno, Oklahoma, on 24 April 2006:

Student: The tornado that touched down yesterday in El Reno, Oklahoma, just to the west of OKC, was anticyclonic, yet it was not in a left-moving cell—the cell was cyclonic. Dr. Greg Forbes on TWC took the time to explain that the tornado formed on the eastern side of the inflow, rather than the western side, which caused the rotation to turn the opposite way than it normally would. Wish I had a picture . . .

Steve Corfidi (who also provided an accompanying photograph for the student): There were actually two tornadoes in the El Reno area on Monday. The main one was cyclonic; it occurred in the typical fashion in association with a cyclonically turning mesocyclone. This, however, was not the tornado that hit the aircraft hanger. A bit later, a second, shorter-lived tornado occurred not far to the southwest of the original one. The second circulation occurred along the flanking line of convective buildups extending southwest from the main storm that produced the cyclonic tornado; it is this tornado that was shown on most national news programs.

The flanking line is a known area for anticyclonic, non-mesocyclonic tornadoes. Such circulations appear to result when anticyclonic vertical vorticity on the southern edge of the mesocyclone's rear-flank downdraft is stretched by a fortuitously positioned updraft (cumulus tower) on the flanking line.

The insights from these SPC forecasters are invaluable, and students are thrilled to be e-mentored by such highly visible professionals.

The e-portfolio, which is the fourth program component that cultivates a unique environment for students to thrive as lifelong learners, comprises a

lion's share of each student's final grade in the three upper-level courses. For all e-portfolio assignments (Penn State provides free Web space), students select and analyze recent weather events that relate to the current course material (within instructor-specified guidelines). After selecting their case studies, students design a series of Web pages that showcase their research. We strongly believe that e-portfolios give students an important sense of ownership that paves the way for life-long learning. You can see a sample of a student e-portfolio by visiting www.philip-lutzak.com/weather/meteo361/project_3.htm.

We evaluate student e-portfolios by implementing a rubric that has four overarching criteria, which include science, writing, Web page style and technical function, and reflective writing. A reflective piece is an important part of the e-portfolio process, encouraging students to examine how their newly acquired knowledge and experiences have impacted their understanding and attitudes. These are the connections that noted psychologist John Dewey believed were the basis for true learning. Although students quickly discover that reflective writing poses a real challenge, they learn that dedicated practice often yields deep insights in later e-portfolios. Typically, these insights do not directly relate to atmospheric science. Rather, their substance stems from the philosophical and personal nature of wrestling with the uncertainties of weather forecasting.

An unanticipated benefit of student e-portfolios is that they provide opportunities for our students to interact with practicing professionals. On several occasions, our students have shared their research with an operational forecaster. The resulting feedback has led to lasting relationships. For example, Winn (our business consultant) contacted Stacy Stewart, former senior hurricane specialist at the National Hurricane Center (NHC), regarding his e-portfolio writeup of Hurricane Katrina (www.milli-bar.com/wsoldani/Katrina/Katrina1.htm).

Not only did Winn receive very positive feedback (which Winn described as "amazing") from Stacy, but their continued correspondence led to a one-on-one meeting at the National Hurricane Center on 26 November 2006. Conversations between Winn and Stacy ranged from the utility of scatterometry to a collaboration on issuing the 5:30 p.m. Tropical Weather Outlook (see Fig. 5).


Although we describe the certificate program as a grand experiment, we admit that there were some strategies we tried that did not exactly work out the



FIG. 5. Winn (a business consultant) collaborated with Stacy Stewart, former senior hurricane specialist at the NHC, to issue the 5:30 p.m. Tropical Weather Outlook at NHC on 26 Nov 2006.

way we thought they would. For example, our low-stakes quizzes (multiple-choice and multiple-select questions) at the end of each lesson require students to critically think about, and then apply, the scientific concepts they learned. We found that some students have never really critically thought about science (a few students were perplexed when they could not find the correct answers in the text). So we decided to allow students two tries per quiz. We also encouraged them to discuss, in *The Classroom*, the underpinning meteorology of any quiz question that posed difficulty. The strategy raised quiz scores, lowered anxiety, and helped to cultivate the sense of a cohesive learning community.

We also altered our approach to the issue of peer-to-peer interactions. In the early days of the certificate program, most students viewed our forecasting forums as places where they could simply fulfill their weekly responsibility of contributing to a threaded discussion focused on the current forecast. Contrary to our somewhat idealistic expectations, many students essentially posted observations, analyses, or forecasts without any regard to interacting with their peers. At one point, we were convinced that some students did not even read the posts of their fellow classmates. So, to cultivate a more meaningful peer-to-peer interaction, we altered our strategy, requiring students to respond to at least two forum posts each week by beginning each reply with the first name of the person whose post they chose to address.



As a result, students started to read the posts of fellow classmates, digest what they wrote, and respond accordingly. The tenor of the forecasting forums changed dramatically to a more personal, interactive conversation that we had intended all along.

There have been other strategies that we had to adjust or completely abandon along our journey, and we are continually refining techniques and implementing new approaches that we hope will better pave the way for our certificate students to become devoted lifelong learners.

July 2008 marks the 100th anniversary of the Chicago-to-Mackinac sailing race, and there has been some preliminary discussion about two of our graduates contributing to the weather forecasting associated with it. In August of 2007, these two graduates forecasted for another major race, the Verve Cup Regatta, sponsored by the Chicago Yacht Club. Their presentation and forecasts were sufficiently impressive to draw the attention of the committee that coordinates the Chicago-to-Mackinac sailing race.

We believe our grand experiment is a success.

FOR FURTHER READING

- Babb, D. M., 2006: Using electronic portfolios to assess adult learners in meteorology. Preprints, *Fourth Int. Conf. on Education and Information Systems, Technologies and Applications (EISTA)*, Orlando, FL, International Institute of Informatics and Systemics, 1–6.
- Chapman, C., L. Ramondt, and G. Smiley, 2005: Strong community, deep learning: Exploring the link. *Innovations Educ. Teach. Int.*, **42**, 217–230.
- Dewey, J., 1933: How we think: A restatement of the relation of reflective thinking to the educative process. *The Later Works of John Dewey*, Vol. 8, Southern Illinois University Press, 105–352.
- Ellis, T. J., 2001: Multimedia enhanced educational products as a tool to promote critical thinking in adult students. *J. Educ. Multimedia Hypermedia*, **10**, 107–123.
- Garrison, D. R., and M. Cleveland-Innes, 2005: Facilitating cognitive presence in online learning: Interaction is not enough. *Amer. J. Distance Educ.*, **19**, 133–148.