Weather & Ecosystem Monitoring, Assessment, & Prediction for Integration & Training

[Kean University: WE MAP IT! – KU EMPOWERS ME!]

Many forms of learning tend to be better cultivated when interactive opportunities are presented, particularly when those opportunities are connected directly to the local or personal environment of the learner. These cases support greater motivation to learn and apply science and scientific principles given the relevance of the 'personalized situated learning' opportunity provided to the student. In essence, if a student is allowed to serve as an investigator of their local environment he/she is much more apt to learn key content and to be able to apply that information to problem-finding and problem-solving. These stepping stones to critical thinking and synthesis require both a structured curricular plan that allows for self-guided inquiry and an ability to integrate lessons across disciplines.

As a means to embody these basic principles, three key components are needed: (1) A program of education and research using real-time campus ecosystem observations from a single portal; (2) Use of weather and climate products derived from research activities; and (3) Integration of media components and alerts with regard to weather and environmental conditions & hazards. The "Kean University: Weather and Ecosystem Monitoring, Assessment, and Prediction for Integration and Training" (KU: WE MAP IT) program is designed to provide a real-time campus based ecosystem weather monitoring portal through the Department of Geology & Meteorology website (http://hurri.kean.edu). When delivered through the activities of "Kean University's Environmental Management by Portal Outreach for Weather Education and Research by Students with Media Experiences (EMPOWERS ME!)" the program offers cross, inter, and trans disciplinary learning for students through experiential activities.

To ensure a personalized learning situation, the strategy is to provide for measurement of the local environment, excluding human biases, while at the same time accounting for the varying attributes associated with an urban ecosystem region. This requires a series of field investigations to determine the 'pieces' or 'elements' of the local study area that must be depicted and that are most prominent or most significant depending upon the persons (or economies) affected as well as the relative importance of the 'elemental piece' to ongoing environmental processes for that region as a whole. These are particularly difficult questions that arise often in climatological and other environmental studies. Thus learners must consider not only what is representative for a location, but also when and why that will vary with time, space, variable, and situation. This requires a systems approach to study in a coordinated manner.

If a region of study has been identified, according to its relevance to local populations (people, plants, animals, insects) or economies; then it is incumbent upon the learner to discern the best means of describing (i.e. measuring or quantifying) the elemental pieces of that local system. This requires a consideration of instrumentation, observational strategies, deployment, quality control, and data reduction. These are rendered according to pre-determined (i.e. from the literature or statistically selected by an examination of sample data) threshold values of concern based upon the populations or economies of significance that are affected. In tandem, these describe and enact steps of the scientific method that are endemic to the research process. Therefore, by monitoring the local weather and environmental systems a learner becomes engaged in, and aware of, scientific research methods, analysis, and outcomes.

The use of instrumentation requires consideration by students of several important criteria: instrumental, observational, and network; that are critical to decision strategies. Each of these are grounded in content knowledge of equipment (including technical skills), development of an understanding of how to observe (based on the phenomena being examined as well as the needed frequency and precision to do so), and making decisions as to the appropriate deployment strategy of observations in a network across a region to capture the elemental aspects of the select phenomena effectively. Many of these can be learned through trial and error by use of a preliminary site investigation or field survey. This affords opportunities for students to better learn the use of instrumentation, interpretation of the data collected (and stored), the salient metadata observations, and a codification of the intent of the investigation and the context within which it is to be interpreted.

Data reduction and statistical analysis naturally follow the process above and provides students with opportunities to test their hypotheses and theories on the operation and processes within environmental systems. These promote trial and error, consideration of control groups, and the need for comparative observations or literature. In other words, students must establish the basis for evaluation according to scientific truths as presented in peer reviewed studies appearing in science journals. This requires students to ask many questions and to hone their measurements, and their arguments, according to what they know – and don't know – based on data and the available scientific evidence. Therefore, students are engaged in a proof-of-concept sort of study – or an investigative study – that requires critical thinking and applications to problem finding and problem solving. These provide important insights into the limitations or constraints imposed by the system being studied as well as those imposed by the methods used by students.

While gathering and analyzing data collected, students gain an appreciation of process-oriented systems and thus how the elemental pieces act in unison (or discord). This information is crucial to diagnosing system behavior, characterizing its distributional properties and its attributes; and the investigator's ability to predict these so as to avoid, mitigate, or prevent impacts (or in the contrary situation how to maintain or amplify the same). Each of these requires consideration of space and time variations, replications, and design of the intended end-product for the user community (i.e. affected populations or economies). This must include consideration of the data needed to support decision-making and a means to collect it routinely in the future. The data intensive emphasis is critical to quantitative judgments that can be used to render qualitative assessments and actions. These require conceptual and physical models to be applied to multiple variations of the given system being examined and are a step towards numeric simulation.

The delivery of each of the aspects described above requires an expansive and adaptable web-based platform that may serve as a content source, provide real-time data, and allow for archival information to be collected and assessed. This is accomplished through the Kean University Weather and Climate Portal which is designed for various levels of users (i.e. from novice to expert). While the site is available for independent use, specific recommendations are provided in terms of data application and pedagogical approaches (as discussed above) that may be applied to a wide variety of coursework – both science and non-science based. In fact, the site is much more effective when multiple perspectives are considered in a decision-making process. To aid these, information is provided on the development of faculty and student teams, a student-based observational manual, and lesson planning guidelines.

This approach to "Weather & Ecosystem Monitoring, Assessment, & Prediction for Integration & Training" includes application and calculation of comfort and stress indices (i.e. as applied to people, plants, animals), measures of normalcy, the temporal and spatial display, analysis, and interpretation of elemental data and specific phenomena; and applied operational assessments of the environment that students may incorporate into their studies. Each of these affords student opportunities to learn and work with content in very specific contexts so that they may better discern and use the information in a constructivist manner. In addition, various types of media are employed to aid in understanding and interpretation. These are accomplished through the development of "Keancast" products and services which include Kean University television and radio station forecasts and statements, safety tips and training documentation, and a campus alert system. Similar resources are available online and via podcasting.

When all of the features above are considered in concert with one another and the offering of workshops, training, and symposia in a coordinated manner – it provides the stakeholder community of students and faculty an opportunity to improve student engagement – and thus performance – in science. The production of more cognizant and capable students equates with a future in which citizen scientists are able to be involved in decision-making in their community and on local, regional, and global scales. This approach has been used successfully in specific courses at Kean University including Observing the Earth, Introduction to Meteorology, and Research and Technology. In each course students – science and non-science majors – have been responsible for using hand-held sensors to observe and monitor outside conditions of the local environment and atmosphere (and in some cases the local hydrosphere and lithosphere) in order to depict conditions on campus.

The intent has been to aid student understanding of quantitative versus qualitative measures, develop an appreciation for the complexities of measuring the outside environment, assist their learning of the nature of and need for metadata, examine how data may be analyzed in time and/or space, and assess the relevance and need for comparisons between varying observation sites and instruments. These are crucial not only in a network sense, but also when monitoring and assessing the local environment, particularly in an urban ecosystem setting. The pedagogy (e.g., multiple learning levels, styles, and learner types) and the logistics behind this endeavor, and how these relate to course and student outcomes, are integrally tied together and must be planned in advance. The experiences are also useful in modeling the responses expected during outreach to K-12 audiences using the same fundamental approaches.