1.2 IMMERSING INSTRUCTION IN INQUIRY – THE I^3 PROJECT: SCIENCE TEACHERS AS RESEARCHERS

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1. INTRODUCTION

The University of Louisiana at Monroe (ULM) hosted a professional development project for elementary and middle school science teachers from northeast Louisiana. The I^3 Project (Immersing Instruction in Inquiry) was funded through the Louisiana Systemic Initiatives Program (LaSIP) and LA GEAR-UP in order to involve teachers in a true scientific research environment.

During the three week summer institute teachers became better equipped to meet the state's science core guidelines by developing critical thinking and analytic skills and acquiring content knowledge, while experiencing the actual science inquiry process. The procedures followed, methods used, and some of the results of the participants' work are highlighted in this paper.

2. SUMMER PROGRAM ELEMENTS

The summer I^3 program at ULM was designed for teachers from low-performing middle schools participating in LA GEAR-UP, a program to improve educational opportunities for middle grade students in order to increase their likelihood of success in college. The twenty-four participants in I^3 were selected from the GEAR-UP schools and their associated elementary "feeder" schools. The selection of teachers was made by the school systems (which also supported the costs, including tuition payments and supplemental stipends).

During the first week of the institute teachers worked with middle school science education specialists learning the basic principles of experimental design and data analysis necessary for developing scientific "habits of mind" including scientific curiosity, investigation, integrity, and open-mindedness. This followed the National Science Education Standards tenet that school science should be real science (National Research Council 1996).

During the second and third weeks teachers were involved in their own self-selected scientific investigations under the guidance of university researchers. Small collaborative groups were formed to conduct research in the areas of chemistry, paleontology, and weather (atmospheric science). The groups involved in paleontology learned to isolate and identify ostrocodes in soil samples from castle moats collected in Wales. The chemistry investigations included an analysis of natural pH indicators and the uses of chromatography. The activities of the three groups working in the atmospheric sciences are described in this paper.

The three weather groups (four teachers each) spent three hours each morning with ULM faculty mentors engaged in projects requiring observation, analysis, and interpretation of data, and application of concepts. Some portion of each morning was also spent in follow-up questions about their projects and about the weather and science topics discussed each day. The intent of the I^3 Project was to provide them both real-time and real-life examples of science integrated within society as well as to illustrate the interdisciplinary nature of atmospheric science in order to see its applications.

The projects incorporated use of various scientific tools and technology (e.g., graphing calculators, web resources). All groups, and all members of each group, then presented the results of their research projects at a "Scientist-in-training" convention attended by school and system administrators and community support persons. The teachers working on weather-related projects focused on the integrative nature of atmospheric science in their studies in order to facilitate student-centered learning.

3. ATMOSPHERIC SCIENCE ACTIVITY

On their first day, three separate teacher groups were provided a simplified introduction to the basic weather map. This overview focused on observation sites, data listed on the map for each site (including temperature, dew point temperature, sky and weather conditions, visibility, wind direction and speed, and pressure), the presence of analytic tools

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and methods on the weather map (isobars, areas of high and low pressure, fronts), and the use of temporal variations of these (day-to-day maps) to assess atmospheric conditions and causation.

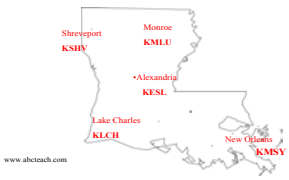
Following this brief introduction, and allowing for a question and answer period, all three groups met in conference to decide the nature and focus of their intended projects. Two groups agreed upon pursuing a synoptic climatology (albeit a limited one) in order to determine whether the analyzed weather patterns were associated with specific variations in actual weather conditions as reported at observation sites in Louisiana. For example, these might include high and low temperatures, rainfall, and other day-to-day "summary" observations. The third group chose to analyze the rainfall patterns across the state as associated with the path/track of tropical cyclones.

For these projects the groups were shown the online Daily Weather Map Series (http://www.hpc.ncep.noaa.gov/dailywxmap/index.html) and asked to review the nature of the resource and its use. After their review, each group had to determine the period of time to cover both in terms of years and months. These were predicated on the fact that a true synoptic climatology typically requires a minimum of ten years of data (preferably thirty) and the fact that they would not be able to produce a climatology for every month of the year in less than two weeks' time.

Thus each group necessarily had to "frame" their research problem, develop a hypothesis, and then determine both a meaningful data set as well as a practical one. Limitations were also quickly realized when discovering that some data and maps might be unavailable. The groups also met to determine how best to represent conditions in Louisiana – in other words, how to illustrate variations across the state without looking at every observation site.

Based on physiographic reasoning, five locations (see map) were selected for study: Shreveport and Monroe in the northern part of the state (but with differing landscapes), Alexandria in the center (transition zone north/south and east/west), and Lake Charles and New Orleans in the southern part of the state (coastal and east/west variations). For each

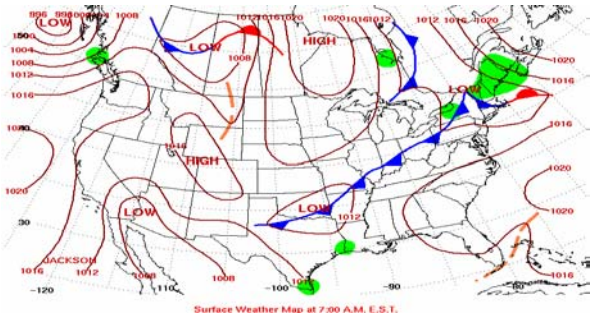
Five Cities Used to Gather Data



location the groups selected variables of interest (storms of interest for the tropical cyclone group) and were then faced with the task of collecting the necessary data.

While several sources exist online (and elsewhere), most of the observational data were obtained through National Weather Service websites (e.g., www.srh.noaa.gov). Once the groups had matching data sets (i.e., weather maps for a given period of time and observations for five locations in the state) they needed to determine the types of patterns observed through a self-sorting process.

Although somewhat difficult, each group spent time during the first two days of their investigations sorting potential weather patterns (e.g., see daily weather map below). Guidance was purposely minimal in order that they would develop spatial organizational and visual sequencing skills in this process. Upon their first sort, several patterns were identified. These were then resorted when each pattern "bin" was compared with the others. This resorting finalized the patterns to be used (and in some cases simplified them) in their analysis.



Once the groups had their patterns selected, they were then able to correlate their observational data binned according to weather map type. This also provided an opportunity for the teachers to revisit and reframe their primary hypothesis as well as formulate additional related hypotheses that were more specific. In this manner they were able to consider other questions or means of testing that could link their training in the basic principles of experimental design and data analysis necessary for this inquiry project.

During their analyses the teachers encountered a variety of ambiguities; both in the research process as well as in the data they were analyzing, and thus were given real experience in the scientific inquiry process of scientific research. Following their analyses, the teachers then integrated, explained, and illustrated their findings through various technical and technological methods. This

gave them a comprehensive sampling of science and the manner in which it is pursued.

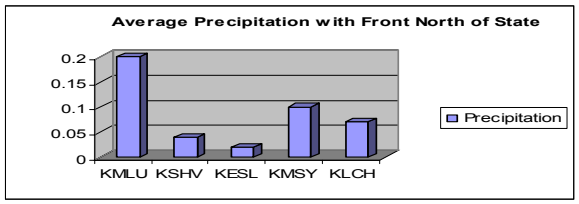
In addition, the teachers were given an opportunity to hear and see work on a research project on wet microbursts. Two undergraduate meteorology majors (Patrick C. Pyle and Scott F. Blair) involved in the COMET Partners Project provided the teachers with a primer on thunderstorms and severe weather. With this background, they explained the nature of the wet microburst phenomenon and detailed the nature of their investigative research project.

4. RESULTS

The three weather groups shared the common theme of synoptic climatology with two focusing on sensible weather and one on tropical systems affecting the state of Louisiana. The first two groups' data were for the month of May and half of June 2003 whereas the last group used data from the five years. Some of their basic findings are summarized here and illustrated.

The first group "Louisiana Weather" considered the variations of weather patterns in terms of their impact on observed temperature, pressure, and precipitation. Their weather types were simplified to include fronts north of the state, moving within the state, and south of the state. Data were analyzed according to maximum and minimum values as well as averages of temperature, pressure, and precipitation for the recurring weather patterns. This allowed summation of the data as well as a view of spatial patterns across the state.

Greatest variations were observed in the precipitation patterns across the state. When fronts were north of the state, eastern and southern sections averaged the most (see figure) whereas when fronts were within the state southern sections had the most on average (and with a larger value). Amounts were lightest statewide for fronts south of the state.



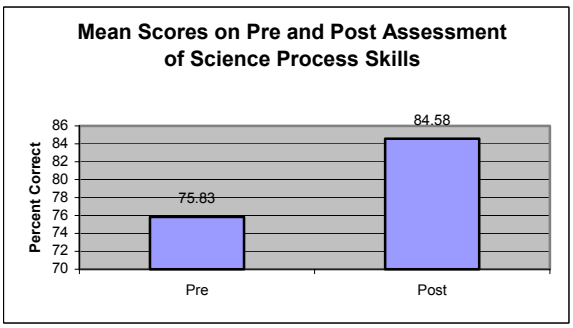
The second group "Patterns of Weather Fronts – Wind, Rain, & Thunder: What Are Our Chances?" examined wind direction and speed, sensible weather types (i.e., fog, thunder, smoke, haze, tornado, fair conditions), and rainfall. This group's weather pattern types included high pressure, front to the south of the state, front to the east, and front within the state.

Average wind speeds varied by weather pattern with directional reversals in some cases. The rainfall patterns also indicated some directional biases with gradients related to the specific weather pattern observed. One significant result was the finding – and very reliable forecast – that fog was observed 23 of 30 times (77%) possible (i.e., for all locations) in all cases in which the weather pattern had a front to the south of the state.

The third group identified eight tropical cyclones affecting Louisiana and considered the direction in which they either passed through or near the state. Half of the storms moved on a northeasterly track with one each to the east, northwest, and southwest. One storm moved in multiple directions. Rainfall for each storm was collected for the period of two days before impact, one day before, the day of, and the next two days afterwards. Those storms with an easterly component (five storms) showed greatest amounts (on average as well as absolute) in the southeastern portion of the state.

5. ASSESSMENTS

To evaluate the attainment of project goals, a pre and post assessment was conducted using Padilla's *Science Process Skills Inventory* (1989). The assessment (see chart that follows) indicated a great diversity in the abilities of participants (range of 45-100 percent). Mean scores rose from 76% to 85% (a mean improvement of 8.75%). The diversity observed in scores clearly indicated the need for this project as well as individualized instruction that was administered during the course of the project. The post assessment indicated improved performance for 75% of the participants with scores ranging from 55 to 100 percent.



REFERENCES

Padilla, M. J., 1989. Assessment of higher-order thinking in science. National Association for Research in Science Teaching, San Francisco.

National Research Council, 1996. National Science Education Standards. National Academy Press. Washington, D.C.

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