Community Partnership Grant Generates Preservice Teacher and Middle School Student Motivation for Authentic Science and Mathematics

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Motorola Inc., research climatologists, preservice teachers taking a science requirement, and students in a Title I middle school explored whether a new major urban lake increases local humidity and decreases quality of life in a community dependent on "dry heat" during summers. Analysis of automated climate data reveals that the urban lake is too small to increase humidity, a conclusion roughly consistent with student-gathered data—keeping in mind the difficulty of students in making reliable scientific measurements. Qualitative survey questions and interviews about the process revealed that elementary education majors learned they could generate excitement for authentic science and mathematics within themselves and within students through research experiences. Furthermore, the interaction introduced low income, minority middle schoolers to the idea that attending college is an option in their future. Thus, synergistic involvement of education majors and children in scientific research to generate excitement in science and mathematics is strongly encouraged..

An important topic in today's educational marketplace is the role of collaborations among private and public stakeholders in the preparation, retention, and recruitment of science, mathematics, and technology teachers. The project described in this article represents just such a collaboration. The project brought together Motorola Inc. (a private corporation), climatologists in a major state university (as a scientific research unit), preservice elementary teachers taking their general studies science course, and students in a suburban Title I middle school with 60% free and reduced lunch and 45% minorities (25% non-White Hispanic; 10% Black; 10% other).

A 2-year grant from the Arizona State University/Motorola Great Communities Grants program partnered Arizona State University (ASU) personnel with local groups to help solve community problems. The scientific issue of interest to the community focused on the extent to which the addition of a 224-acre lake would affect the climate of the adjacent community. In a location where "dry heat" makes the summer bearable for many, any potential development that would increase humidity raised concerns about quality of life. The grant provided weather monitoring equipment and supplies and expenses for student field trips. Since field data transects were a fundamental part of the study, university students assisted middle school students with data collection.

The research problem addressed here is whether grant funds from a corporation can spur a synergistic project promoting (a) preservice teacher interest in science, (b) middle school student interest in applied mathematics, (c) a greater appreciation by all parties for basic science research, and (d) contributions to scientific knowledge on urban ecological issues, such as the climatological effects of a public water project.

Context

The context of this project is the nationwide agenda of "accountability" in K-12 education. Arizona's educational reforms in standards and accountability testing, measured by standardized testing in the skill arenas of language arts and mathematics only, preceded President Bush's new education bill. The impact of accountability had been realized by Arizona school administrators well before President Bush's agenda:

> Accountability is the buzzword in education. As schools are put under the microscope to get students to pass standardized tests [in math and language arts], the responsibility ultimately rests on the shoulders of the superintendent....administrators will increasingly see their pay linked to student performance. We're probably getting into a time where there'll be more and more performance pay contracts. (Go, 2001, p. B-9)

A statewide proposition, 301, even ties funds and administrative careers directly to mathematics and language arts test scores. The net result amounts to a reduction in emphasis of content-rich areas such as science education and not only in Arizona: "'His schools', Parker says, 'are sacrificing important lessons in science, social studies and foreign languages to focus on concepts that will be tested'" (Cole, 2001, p. 61). John Parker is Assistant Superintendent for Roanoke Rapids District, North Carolina.

In no uncertain terms, science education is under siege, albeit in an unintended war in Arizona and, perhaps, in the future, nationally, through these accountability measures. In the Arizona environment of accountability, we decided to see if this science-mathematics partnership could function under the umbrella of a mathematics class, in which the mathematics teacher-partner focused the student's performance on mathematic standards of number sense and measurement.

In presenting the findings, prevalent issues in the larger literature governing our project are first discussed, then the methodological approach applied to different components of this partnership is described, results are summarized, and broader implications of our findings are discussed.

Theoretical Framework

A number of larger issues in the science education literature helped to focus this study. First, the greater literature emphasizes the potential for combining mathematics and science education (Beaton et al., 1996; Hurd, 2000; Kelly & Lesh, 2000; National Center for Education Statistics [NCES], 1997). The Technology in Context project, involving teachers, their school districts, urban universities, the Mathematics and Science Education Center of St. Louis, and McDonnell Douglas Corp, infused curriculum into the classroom (Markovits & Mitchener, 1992). Thus, we developed the science research project within the context of a standards-based mathematics curriculum.

Second, the science education literature emphasizes the importance of cooperative field teaching experiences, revealing that elementary education students' teaching self-efficacy benefits from these experiences (Cannon & Scharmann, 1996). The Practicing Integration in Science Education project combined teachers, academic researchers, and in-service training to improve students' relationship with nature (Riquarts & Hansen, 1998). The University of California at Los Angeles (UCLA) School of Medicine maintains a pre-college outreach partnership in which UCLA faculty and staff work with science teachers and administrators from elementary, middle, and high schools with the goal of promoting teacher professional development and student achievement in urban Los Angeles (Palacio-Cayetano, Kanowith-Klein, & Stevens, 1999). In urban California, collaboration between preservice teachers, teachers, students, and community builds toward accessible science (Hammond, 2001). Furthermore, limited teacher knowledge of how science applies to the environment and everyday experiences tends to focus science instruction on textbook and seatwork activities, avoiding whole-class activities (Lee, 1995). Thus, we wondered if this partnership could provide a model to aid teachers in developing whole-team activities in the middle school context and to help elementary education students visualize the potential for such team-building field research.

Third, the premise of the Motorola community partnership grant is to bring together corporation, university, and public need. Internationally, projects such as UNESCO-SEMEP (Serman, Rudenjak-Lukenda & Perkovic, 2000) establish that student-oriented field research helps students understand real problems of local community significance. The development of a large urban lake in the dry Salt River channel proximate to low-income schools, along with the climate issues raised in the community, presented an opportunity to engage this partnership.

Fourth, in terms of the science specialty of climatology, projects such as Schools of the Pacific Rainfall Climate Experiment (Postawko, Morrissey & Gibson, 1994), the Illinois-School-Children's-Atmospheric-Network (ISCAN; Schmalbeck & Pappler, 1994) and Project Atmosphere (Ginger et al., 1996) reveal that teachers and students gain a greater appreciation of climate by conducting basic research in tandem with scientists. Middle school atmospheric education often involves units on such dramatic topics as threats of global warming and ozone depletions (Rye, Rubba &

Wiesenmayer, 1997); thus, we believed that a local project involving a new public water works project might help kids understand the basics of climatological measurement in a more intuitive way.

Fifth, the literature notes substantive complications in dealing with the student population typical of McKemy Middle School (MMS): heavily Hispanic; urban; low income; and substantively learning disabled. Hispanic middle school students, for example, have difficulty perceiving themselves as future scientists and think they must be geniuses at mathematics to pursue a technical career (Sorge, Newsom, & Hagerty, 2000). The literature recognizes that motivation for science education declines for adolescents with learning disabilities, especially in middle school years (Anderman, 1998). Furthermore, the literature details many difficulties in teaching science in urban, low-income schools, such as MMS (Tobin, Roth & Zimmermann, 2001). Given these issues, we sought to engage this student population in a field-based measurement project.

Science Research Question

The study site surrounds a 224-acre artificial lake, adjacent to downtown Tempe, Arizona, within the formerly dry Salt River channel (Figure 1). Two miles (3.2 km) long, the lake ranges in depth from 7 feet (2.13m) to 19.5 feet (5.94 m), contained by inflatable rubber dams at each end. The naturally perennial Salt River is normally dry due to the construction of numerous flood control and water retention dams upstream within the Salt and Verde River watersheds. During spring snowmelt events, the Salt River channel occasionally floods, and the inflatable dams are designed to be deflated, letting potential floodwaters move harmlessly through Tempe.

The residents of Tempe raised concerns that creating a lake in the middle of the desert would increase humidity and the heat index and possibly alter wind flow and precipitation patterns. City officials wanted to address these concerns with scientific data and analyses.

Figure 1. *Routes of the ASU and MMS student groups as they conducted measurements walking around Tempe Town Lake, shown by white arrows superimposed on this 1999, 4 megapixel digital image from Landiscor Aerial Information, Phoenix, AZ. Lake is 2 miles long.*

In addition, water resources managers needed to know how much water evaporates daily from the lake to calculate their water budget.

Since climatologists know that water bodies alter the temperature and moisture characteristics of the overlying air, the following were primary research questions:

1. How far do temperature and moisture effects of Tempe Town Lake extend?
2. What is the spatial pattern of temperature and moisture effects?
3. What is the magnitude of temperature and moisture changes on local air temperatures and dew point temperatures?
4. How quickly do temperature and moisture effects decrease with increasing distance from the lake?

Methodology

Linking ASU/Motorola With Prospective Teachers

The course, Introduction to Physical Geography, meets the laboratory science requirement for all ASU students. Elementary education majors frequent this class, and thus they were recruited during two semesters to partake in fieldwork with MMS students. During these semesters, 28 preservice elementary (K-8 certificate) education majors participated in the project, with the reward of (a) interacting with middle school students; (b) obtaining photographs of the experience useful for portfolio building; and most importantly to them, (c) earning extra credit in the university class.

Linking to Middle School Teachers

The McKemy teacher volunteering as a partner teaches eighth-grade mathematics. Students involved in the field science experience took pre-algebra and honors algebra. The teacher organized the class to match each field experience with measurement and number sense performance objectives. Table 1 summarizes the student tasks organized by the partner teacher.

In the first field experiment, 150 MMS students were divided into 12 groups. The second field trip was reduced to 110 MMS students divided into 12 groups. A third trip included about 80 MMS students divided into 12 groups. ASU student volunteers accompanied each of these groups.

Data Acquisition and Analysis

In addition to the elementary education majors, a number of non-education ASU students volunteered for the field project. Interviews with 30% of these volunteer students generated results discussed later. ASU and MMS student participant interviews took place immediately after each field trip. ASU student interviews took the form of an e-mail response, with a 100% response rate (due to extra credit rules) within 2 weeks of the field trip completion. ASU students responded to the following questions:

- What grade(s) (if any) do you anticipate teaching? Did this trip influence your answer?
- Did you talk about college with the middle school students? If so, what did you talk about?
- Do you think there is potential in linking science

Table 1
Tasks for Each Student Group at Each Site Along the Lake

Measurement	Equipment	Task Required of Students
Time	Watch	Coordinate reading at three types of surfaces in a short period of time.
Surface Temperature	Infrared Thermometer	At three types of surfaces per site (lakeside, levee, back of levee), students noted whether surface was concrete, asphalt, grass, or gravel/dirt.
Wind Speed	Kestrel hand-held impeller anemometer	Hold anemometer at shoulder height into the wind and read the digital output.
Dry and Wet Bulb Temperatures	Sling psychrometer	Swing sling psychrometer and read the liquid-in-glass thermometer.
Sun Angle	Protractor, string and weight	Sight along the protractor edge to the sun (while not looking at the sun) and then read the angle with a string and weight.
Temperature and Humidity	Automated HOBO sensors by Onset Computer Corp.	Carry the HOBO.

and mathematics education through making real-world measurements? Did this field trip experience have anything to do with this opinion?
- Did you like science before taking this class? Did this field trip show you any ideas about bringing science into your future classrooms?
- Would you run a similar field trip when you are teaching? What would you do differently? Similar?
- What other observations do you have about the trip?
- Was the time worth the 50 [extra credit] points?
- Do you want any future contacts with MMS teachers for your future observations/student teaching?

The large number of ASU student responses were placed in three "bins" for each interview question: positive, negative, and ambiguous. Selected quotes derive from the bin with the largest number of responses. Thus, our selection represents an attempt to present the "mode" or most typical response. Interview responses in minority bins contained abundant extraneous comments, for example: "It's amazing how much respect you can gain from [middle school] kids by treating them like adults and having fun with them." Another ASU student responded,

> There was a lot of paper work involved on this trip, and I think that the children could have had more fun by spreading the trip out. Keep the same worksheets and all, but when there was that much to do in one day, some got tired out, bored, and didn't even do their work.

Thus, our selection attempts to portray the typical response, even though the larger range of comments represents a valuable data set unto itself.

MMS student participant interviews took place in an open-ended format, whereby the middle school teacher solicited open-ended comments surrounding student interest in science, mathematics and college, in relation to the trip. The end interview form is called "taking stock" and is available from the authors upon request. MMS student comments were placed in two data bins initially: relevant to research question and irrelevant to research question. For those relevant to the research question, comments were then placed in subsequent bins related to the research questions with representative responses selected for presentation. In contrast to the purposeful portrayal of representative survey responses, we did not select "representative" scientific data. Figures 2-4 in the paper present the full student data collected from student data collection sheets.

The MMS teacher interviews after each field trip were similarly open-ended. The results presented represent a mix of post-trip thoughts and retrospective opinions derived from the reading of MMS student responses.

Linking to Science Research Project

To measure climate effects, we installed small, archiving temperature/humidity sensors around the lake, at various locations throughout Tempe, and along the main street of downtown Tempe, every half block, south of the lake. These sensors are called "HOBOs"—to the delight and humor of middle school students. We also had an 18-year record of data from the National Weather Service Cooperative Observer Station on the ASU campus in Tempe, and a 1-year record from an automated station at the Office of Climatology, just north of the lake. An additional automated weather station was installed at MMS, about 2 miles (3.2 km) south of the lake in a residential neighborhood. The city installed a complete energy balance weather station and evaporation pan at the downstream dam of the lake. Measurements at all these sites, except the Cooperative Observer station, were made every 5 minutes to measure both diurnal and microclimate effects.

The MMS student field trips were planned to take measurements of air temperature, moisture, wind speed, and surface temperature at selected sites adjacent to the water, 10 to 20 feet back from the water on an artificial levee, and 50 to 60 feet back from the water. The measurements were taken over various surface materials, including grass, asphalt, concrete, and dirt/gravel. The transects were designed to provide simultaneous measurements at varying distances from the water.

Results

Qualitative Results from Preservice Elementary Education Majors

Interviews with the ASU preservice elementary education majors revealed three salient qualitative findings in order of interviewee emphasis, aside from the delight in obtaining extra credit related to their career goals.

First, elementary education majors (and non-education majors also participating in the field experience) found great reward in discussing the college experience with lower income middle school students. For example, "They asked what class this was for, talked about wanting to go to college, ASU, and some of them talked about sports they would play in college. I advised them to stick with school." Honest, heartfelt discussions created linkages between college students, who admitted that they never thought about college when they were middle schoolers. Accordingly, some of the middle schoolers realized — many for the first time — that they, too, could attend the nearby state university.

> The girls in my group told me that they never thought about going to college. Now they are thinking about it. They got talking about the cute guys that are not losers and about how they can pick to study what they are interested in.... I told them about scholarship opportunities.

Second, preservice elementary education majors saw the importance of real-world science experiences in making measurements relevant to mathematical education: "The field trip showed me the importance of creating real situations where the students actively implement the concepts that are being taught." In their own elementary education experiences, measurement was limited to classroom activities using meter-sticks and made-up tasks such as counting pennies to represent the first 100 days of school. One elementary education major said, "I would definitely try this type of field trip with students. The teachers were all very organized and I felt like the work that the students had to do was appropriate." The education majors asked about the cost of obtaining basic climatological equipment and spoke about the potential to set up basic measurements to monitor weather on their future elementary grounds. Another elementary education major said,

> Before I took geography I never thought about all the different measurements, recordings, and problems needed to figure out the weather. Now when I watch the news I see the weather report in a whole different light. The lab and this field trip did shift more attention to how important math and science are needed.

Third, the preservice elementary education majors freely admitted their almost-universal distaste for science, as in the following quote:

> Personally, I have a hard time with both math and science, so it is very hard for me to get excited about either of them. But using math and science in the real world makes it more interesting. The field trip was fun and I think that the students learned some things without realizing it.

As a product of linking the class with K-12 students, these majors uniformly felt a stronger connection with science. In other words, elementary education majors recognized linkages of relevance between their interests in elementary education and potential science lessons, as exemplified in the following:

> I am not a big fan of science. It is not a concept that I can grasp easily no matter how hard I study, and I am having a very hard time with this GPH 111 class. However, I feel that this field trip showed me how hands-on experience can really help kids learn, and I think that it definitely helped to convince me to bring science into my classroom, in a form other than just simply lectures.

Several majors then inquired about "extra credit" for the development of lessons—based on a class topic, or even "substituting" lessons for the lowest examination grade. This option was granted, but with detailed instructions to ensure quality control on lessons. Each elementary education major was required to follow the template imposed by the NASA Mission Geography lessons (see http://missiongeography.org).

Impression of Middle School Teacher Partner

The first impression of the teacher partner was the enormous amount of work involved in organizing and conducting the field trips. Anybody who has conducted fieldwork with 150 middle school students wandering around a 5-mile perimeter lake, taking scientific measurements along the way, would recognize the work required in coordinating the students, with the ASU student supervisors enforcing continued performance.

The most important outcome for the teacher partner was the team building that took place among the students. The perceived rigor of the long walk in hot temperatures (90° F-plus) generated a sense of achievement by the students. The students themselves thought the field trip to be a fun break from the daily rigors of in-room mathematics instruction. After the students learned instrumentation at school prior to the field trip, taking measurements, interpolating measurements from analog thermometers, and writing data in tables was an intuitive and natural consequence of the overall process.

The interactions with the college students enhanced the experience for the MMS students:

> I really liked having an ASU student in our group. She made the trip more fun. She encouraged us to take good measurements and to take turns with the equipment. We talked about going to college and what she did to get into ASU. I found out that if I keep getting grades like I have now that I could probably get into ASU too!

Some of the MMS kids had a boost to their self-esteem, as they were able to teach the college kids something: "The ASU students were kind of fun. Some of them didn't know how to use the equipment. It was cool to get to show them how and to teach them to say 'sling psychrometer!'"

Student performance did improve by 2% overall in Stanford 9 eighth-grade mathematics testing. Although student performance on measurement and number sense in state-required, high stakes testing slightly improved above years when the field trip was not run, this increase in scores could have been due to factors other than the field trip. In other words, although the teacher partner intuitively felt that the fieldwork improved student understanding of measurement, and although test scores increased over years when the field trip was not run, causality cannot be proven.

General ASU Student Views

The elementary education majors, with prior training and a focus on primary grade learning, had a different focus than the run-of-the-mill ASU student out for a few extra credit points. Here, the ASU-MMS interaction was less sophisticated and more casual than with the elementary education majors.

Two general positive observations stood out in interviews with general ASU students. The most positive interaction related to discussions with the middle school students about the accessibility of ASU for students who had previously never thought that college was in their future. The greatest connections were made by the ASU students who lacked self-confidence in their own science abilities, emphasizing the attitude of, "if I can do this, then you can do this," to the middle school students. A second positive interaction revolved around discussions over the importance of mathematics and science. ASU students felt that they were able to communicate to the middle school students the importance for future high school and university studies of staying focused on mathematics and science learning.

One negative result occurred. Inappropriate language and behavior by ASU students did take place, checked by peers, middle school students and teachers — reinforcing the need for training university student participants.

Examination of the Student Data

The quality of student data ranged greatly from poor to good. Some students took responsibility for making high quality measurements on the required tasks, and these data may be reliable. Most student data, however, were not gathered carefully. Problems ranged from neglecting to record time of measurements to recording the measurement in the wrong column to inadvertently changing the mode of the digital instruments to a different unit. For example, the first 10 wind speed measurements were all between 1.2 and 3.5 mph. The next four were around 35. Since the students were careful in their placement of decimal points, the error was most likely caused by inadvertently switching the instrument from wind, in mph, to temperature, in Celsius.

The number sense lesson for students rests in whether values being recorded made sense. Presumably some of the more careful students would have wondered why the instrument was recording such a high value for a slight breeze. This type of mistake is widespread in field data, and this is an ideal way to impress on students the importance of knowing where the data came from, how data were collected, and what units and precision were used. In most cases, gross errors can be corrected. By looking at the entire data sheet and comparing values between groups, we were able to identify data collection problems and identify whether the errors were human or instrumental in origin. The automated sensors (HOBOs) were helpful in correcting data problems only when the students recorded the times of their observations.

Climate Effects of the Lake

The students found little difference between air temperatures recorded adjacent to the lake and those recorded 40 to 60 feet away from the lake (Figure 2). Air temperatures varied by about 10°F, regardless of proximity to the water. Atmospheric moisture, as measured by the wet bulb temperature, also showed no discernible decrease with distance from the water (Figure 3). However, the wet bulb temperature variation was around 15°F at all distances. The dew point temperature, calculated from the data shown in Figures 2 and 3, similarly did not reveal an effect of the lake on the microclimate of the surrounding shore (Figure 4). The calculated dew points had a range of 25°F at all distances, with a few outliers. The graphs show the April 2000 field trip results and are representative of all the field trip data.

Discussion

The large range of wet bulb and dew point temperatures were primarily due to a lack of patience on the part of the middle schoolers. The wet bulb thermometer requires that the wick be thoroughly wetted before the sling psychrometer is swung. Then, the instrument swings in the air long enough to maximize evaporative cooling of the thermometer. The student must take at least two consecutive readings where the wet bulb temperature remains constant. If the student stops the process too soon, the wet bulb temperature will be higher than the actual value. Failure to completely wet the wick also results in an erroneously high wet bulb reading. The net effect of improper measurement is to simulate higher humidity values and higher dew points

Figure 2. *Dry bulb (air) temperatures April 26, 2000, at three distances from the water: a few feet from the lake; 10 to 20 feet back from the water on an artificial levee; and 50 to 60 feet back from the water.*

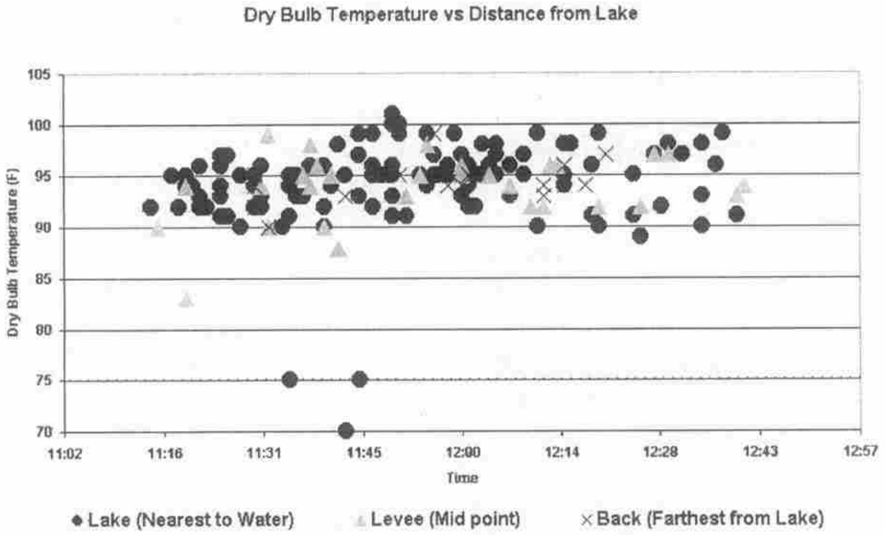
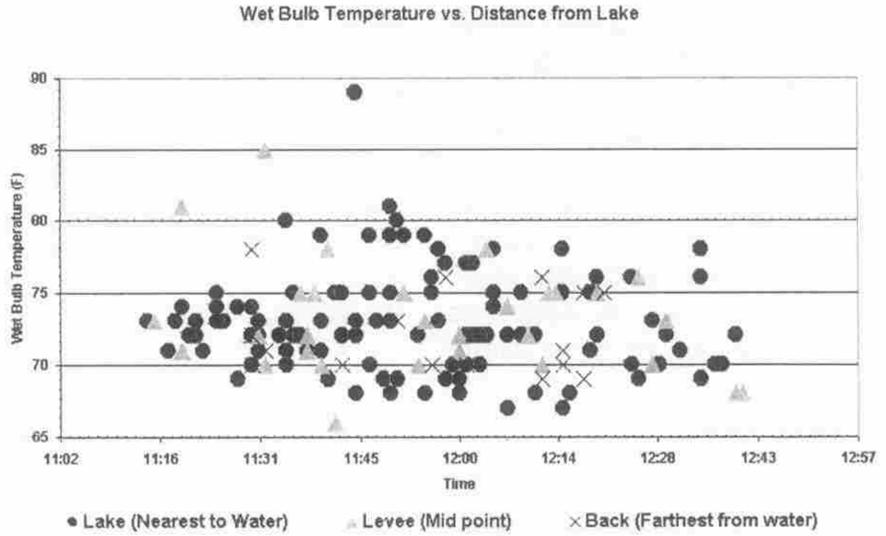


Figure 3. *Wet bulb (moistened wick surrounding thermometer) temperatures April 26, 2000, at three distances from the water: a few feet from the lake; 10 to 20 feet back from the water on an artificial levee; and 50 to 60 feet back from the water.*

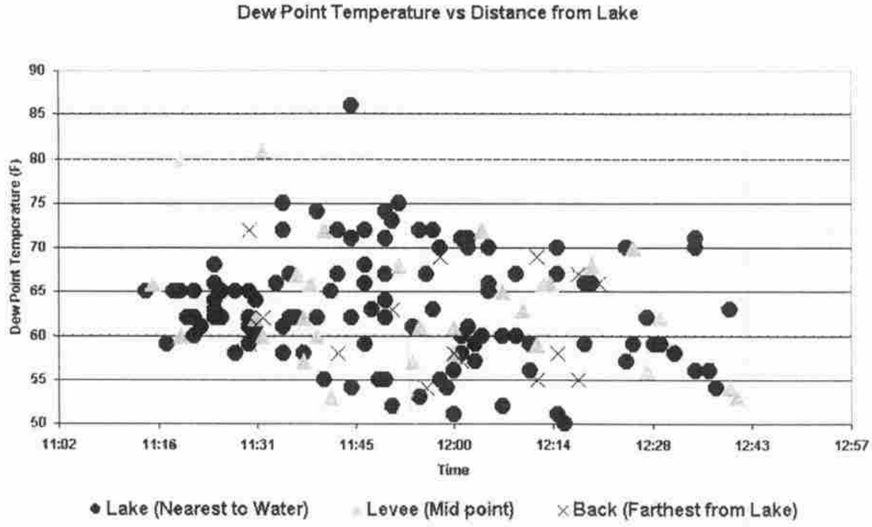


seen in Figures 3 and 4. A stopwatch might have increased the accuracy of student measurements, by forcing students to swing the instrument for a long enough time to lower the wet bulb temperature.

Calculation of dew point temperatures provided several teachable moments in mathematics instruction. First, dew points are calculated using ratios — connecting an important middle school mathematics standard to an important indicator of comfort in Arizona summer heat. Second, students tend to have difficulty understanding graphs that contain multiple pieces of data; a teachable moment rested in student graph construction, leading to better understanding of complicated graphs. Third, graphing the dew point data led to a discussion of data generation and data analysis — revolving around whether the data mirrored their memories of the day.

Graphing surface temperature led to informative student discussions surrounding outliers. Students are

Figure 4. *Dew point temperatures April 26, 2000, calculated from the dry and wet bulb temperature data presented in Figures 2 and 3.*



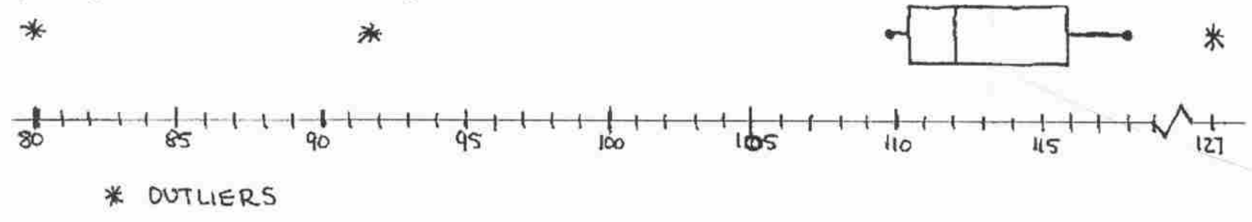
taught in mathematics class to calculate outliers, as a product of learning about box and whisker plots and upper and lower quartiles. The idea of outliers is generally hard for students to understand. However, when plotting actual data, the concept of outliers suddenly crystallized. Consider, for example, Figure 5. Students discussed specific data points — wondering which group and what particular student "messed up" to create such outliers. Such accusations then led to profitable moments about whether such data are good or bad, whether they reflect incorrect readings or some interesting measurement of a shaded place (e.g., 80°F) or particularly hot places (e.g., 127°F).

Our field experience prompted discussions of the importance of taking real measurements. Anecdotal discussions between math and home economics teachers at MMS turned to the recent trend of lower test scores on measurement questions in standardardized tests. Speculation revolves around students spending less time at home with parents involved in measurement related to following cooking recipes. Thus, making such simple measurements as reading an analog thermometer was a new experience for many students living in a digital age. Several students admitted that the field experience was among their first in making actual measurements of temperature.

Although our project finished before the NCES Science Achievement Report Card was released, we found that middle school students did enjoy the integration of earth and physical science in our climate project. The NCES (2002) found, "Eighth-grade students enrolled in a life science course had lower scores than their peers enrolled in earth science, integrated science, physical science, or general science" (p.12). Thus, we recommend this sort of a research project as a way to engage middle school students in integrated science/math education.

We make one final note for university faculty writing similar grants. The middle school teacher volunteer received no monetary compensation from the project. Rather, the grant paid only for supplies, equipment, and field trip expenses. In order to promote an

Figure 5. *Sample box-and-whisker plot by "Mary" (MMS group 4) compiling temperatures measured by infrared thermometers. These data come from April 26, 2000, compiling all measurements of dirt/gravel surfaces from 11:20 am to 12:20 pm.*



ongoing, authentic project of this sort, we recommend providing a month of summer salary for the teacher to plan the trips and prepare for post-trip student analyses.

Conclusion

In conclusion, we asked whether grant funds from a corporation could spur a synergistic project promoting (a) preservice teacher interest in science, (b) middle school student interest in applied mathematics education, (c) a greater appreciation of all parties for basic science research, and (d) scientific knowledge gained from student research on urban ecological issues such as the climatological effects of a public water project. Our answer to all these original questions is a clear "yes," but ordered (a), (c), (b), and (d) in relative degree. Perhaps the greatest benefit of this synergistic project was the enthusiasm created for authentic science and mathematics education within elementary education majors who had a self-proclaimed dislike of science. Both the middle schoolers and the university students gained an appreciation of scientific research and the inherent difficulties in gathering quality data. The middle schoolers took more interest in, and had a better appreciation of, the mathematics lessons using "their" data, as opposed to made-up problems found in other math exercises. Some scientific knowledge of the climate effects of the lake was gained through the partnership effort. As with much scientific research, the initial efforts of this project helped to refine the measurement scales and strategies for the continuing study. One of the most important outcomes of the project was planting the seed of an idea in middle schoolers that they can indeed pursue educational opportunities in their local college.

Continuity remains a key issue when external funds create partnerships that may or may not be self-sustaining. In this case, grant expiration has not reduced the dedication of all participants to continue the field trip experiences. The Introductory Physical Geography course continues to attract education majors, and opportunities for them to actively engage in science projects with K-12 students will enhance both their appreciation of science education and their skills at involving their students in the learning process. The funding necessary for a self-sustaining project involves some type of release time or summer salary for the middle school teacher to handle the middle school logistics and materials, some funds for the middle school student rewards, and bus transport. The partners maintain a renewed faith in the importance of middle school students' understanding the linkages between mathematics and science, particularly in the geosciences. At this age, they could either embrace or reject science as a career opportunity, and it is important that we encourage them to interact with their environment.

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