The 2001 AMATYC Outer Banks Summer Institute "Teaching in Context"

Small groups climbed the 125 foot tower collecting data on temperature, humidity, barometric pressure and wind velocity as they ascended.

The Outer Banks of North Carolina was home to the second annual "Teaching in Context" AMATYC Summer Institute held June 10 - 15, 2001 at the Army Field Research Facility (FRF) in Duck, NC. The Outer Banks of North Carolina is a thin strip of land that runs the full length of the state and connects to the mainland in Virginia. It varies in width from 100 feet to a few miles. The seemingly constant wind attracted the Wright brothers from Dayton, Ohio to see if their attempt at building a flying machine might work. The Summer Institute attracted 25 math and science teachers from ten states to see if they could learn more about teaching mathematics in context. The Institute is a cooperative effort between the College Teachers Teaching with Technology (T^3) Short Course Program <www.math.ohio-state.edu/~shortcourse/> based at The Ohio State University, the American Mathematical Association of Two-Year Colleges <www.amatyc.org> (AMATYC), and the Army Field Research Facility <http://www.frf.usace.army.mil> in Duck, NC. Further, the Case Studies Project funded by NSF and run by Susan Forman <susan.forman@att.net> and Lynn Steen <steen@stolaf.edu> offered full paid expenses for participants agreeing to bring a non-mathematics person from their campus to the institute. AMATYC is the professional association for two-year college mathematics teachers. The College T^3 Program is funded by Texas Instruments.

Teaching in context can be defined as "teaching a mathematical idea or process by using a problem, situation, or data to enhance the teaching and learning process." Or an alternative definition might be "using a problem, situation, or data to motivate a mathematical topic." There may be a common misconception that teaching "applications" is teaching in context. While both use problems, the difference is in timing, in purpose, and in student outcome. Applications are assigned after mathematics is taught and they are used to apply the mathematics already learned. When used in this way, problems and situations do not enhance the initial learning process, nor do they help in the conceptual development of the mathematics. Applications may be used to answer the student question "What's this stuff good for?" Applications allow us to validate what we have taught. Teaching in context also uses problems, situations, or data but they are used at the beginning of a math topic for the purpose of helping students understand the mathematics being taught, or to create a motivating experience of the mathematics that follows. A situation may be used many times and at different mathematical levels depending on the teaching objective. One

Michelle and Yvonne check to see if waves produce a cyclic pattern on their force meter – just trying to find data for a teachable moment.

situation may have many inherent teachable features that can be used to aid in student understanding of mathematics. Using situations, problems, or data that directly relate to the lives of our students often engages them. Once engaged they are better able to make sense of the mathematics and are better able to master conceptual understandings.

Many times the data surrounding a situation is used as the motivation for teaching a topic. Data and the situation in which the data is generated as well as a series of leading discussion questions often provides the teacher with a contextual lesson plan. Below is a sample classroom set-up for a lesson on teaching the concept of a vertical asymptote.

Mathematical Topic:	*Asymptotic behavior- vertical asymptote*
Equipment needed:	CBL 2™, TI calculator, DataMate software app, Vernier pressure sensor.
Information:	The CBL 2™ will collect volume (in cc) and pressure (in ATM or other units) data for the air secured in a 20-cc syringe.
Setup:	Fill syringe with 20-cc of air. Wait a second for the pressure to stabilize and close the valve. Attach the sensor cable to CH 1 on the CBL 2 and run the DataMate app. Since the Pressure Sensor is not auto-ID, select 1 for Setup. With the cursor on CH 1, type ENTER and select Pressure, followed by Pressure Sensor. Select the units of measure (ATM or your choice). Move the cursor to MODE followed by the ENTER key. Select EVENTS WITH ENTRY. Type 1 for OK. At this time, DataMate will display the pressure in the top right corner of the calculator screen. When ready to record data points select 2 (Startup) and follow screen directions. (Note: Enter Value means the volume of the air at the current pressure.)
Mathematics Pre-requisites:	Students should have some experience in developing linear and quadratic models from a data set using their understanding of the connections between function parameters and the resulting function behaviors. There is no need for students to use regression models. This activity is intended to introduce students to their first function that displays vertical asymptotic behavior.

Leading Questions:

?? As you cause the volume to approach zero with your hand, what do your senses tell you about the pressure?

?? Can you change the volume to 0 cc in the syringe? (without damaging the equipment)

?? If you could change the volume to 0 cc, what would happen to the pressure?

?? Describe a trend (pattern) you see in the **change in the pressure** on the sensor as you **change** the volume from 20 to 19 cc, from 19 to 18 cc, from 15 to 14 cc, from 10 to 9 cc, from 6 to 5 cc. (The pressure is continuously displayed by the DataMate software.)

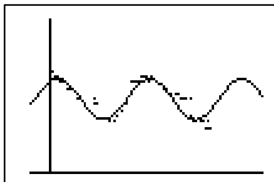
?? As the volume approaches zero, describe the general behavior of the rate of change of the pressure.

?? Do you think the relationship between volume and pressure linear? That is, for any $?V$ and related $?P$ is the ratio $\frac{?P}{?V}$ the same?

- ?? Might the relationship between volume and pressure be quadratic? Explain.
- ?? Finally, it is the time to collect and store the data points. Perhaps at 20, 18, 15, 13, 10, 8, and 5 cc's. Be sure to let the pressure sensor stabilize at each volume before collecting the data.
- ?? What might the pressure be at 3 cc of volume? 2 cc of volume? (This assumes that most people cannot get the volume to 2 or 3 cc. It may also provide motivation for the need of the symbolic form of the relationship.)
- ?? Graph the data. Does the graph behave as you expected?
- ?? Summarize the behavior of the graph of the relationship as the volume approaches zero.
- ?? Do you notice any pattern developing between the *x* and *y*-coordinates?
- ?? Multiply the *x* and *y*-coordinates together and store the results in L_3.
- ?? Do you notice any pattern developing between the *x* and *y*-coordinates now?
- ?? Make a suggestion for a symbolic model of the data relationship and graph it.
- ?? How does the graph of the model relate to the data points?

Teachers are now ready to analyze the behavior, and functions with this behavior, using a more formal mathematical approach.

While the CBL 2™ and the Vernier pressure sensor <www.vernier.com> as well as many other sensors work well in the classroom or school setting like above, it can be a very interesting and rewarding experience to collect data in the field. The Field Research Facility and Army Pier <www.frf.usace.army.mil/> where the "Teaching in Context" Summer Institute is held, provides ample opportunities for teachers to learn more about teaching in context. The Outer Banks (besides being a resort area) is very fertile for teachers interested in teaching in context. At the Institute, one full day is used to collect data in the field. Below is a listing of data collected this year at the FRF.


Tide height data (with model) collected at the Institute.

Pier (1840 Feet long)

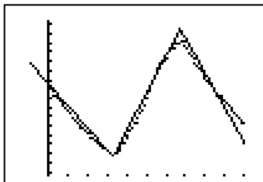
- Time vs. vertical distance from CBR to water (local tide)

Surf and Beach

- Time vs. velocity of the surf
- Time vs. force in wave
- Distance from water vs. beach temperature
- Distance from surface vs. sand temperature

Tower (120 feet tall)

- Height vs. light intensity
- Height vs. relative humidity
- Height vs. temperature
- Height vs. barometric pressure


Surf water velocity data (with model) collected during field day.

LARC (not available in 2001)

- Depth vs. water temperature (same distance from shore)
- Depth vs. water salinity (same distance from shore)
- Depth vs. speed of sound (same distance from shore)
- Distance from shore vs. temperature of water (same depth)
- Distance from shore vs. water density (same depth)

Parked Car

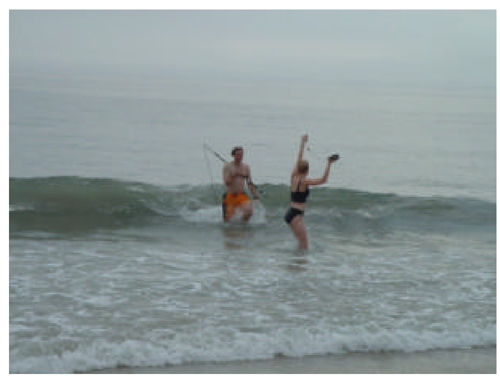
Trudy Streilein’s Car Temperature Data

The morning activities described above were followed by off site field trips to local points of interest where participants performed other data collection experiments and looked for situations and problems that could be used in the mathematics classroom. Sites such as Jockey's Ridge <http://ils.unc.edu/parkproject/jori.html#educ>, Wright Brothers Museum <http://www.nps.gov/wrbr/>, Currituck Light House <http://www.outer-banks.com/lights/ncurrituck.cfm>, and the North Carolina Aquarium <http://www.outer-banks.com/aqua.cfm>. Normal classroom time is devoted to learning to teach in context using problems and situations provided by the instructors.

For the 2001 Institute, twenty-five participants came from ten states (DC, GA, IA, IN, MD, NC, OH, TX, VA, and WI) – 12 from two-year colleges, 7 from four-year colleges, 4 from high schools and 2 from business

Bill Birkemeier, <William.Birkemeier@erdc.usace.army.mil> Director of the FRF, provided ample assistance with talks to the group in the classroom and during the field activities at the FRF. Classroom instruction was provided by Debbie Crocker <www.appstate.edu/~crockerda/> (Appalachian State University) and Institute Director, Ed Laughbaum <www.math.ohio-state.edu/~elaughba/> (The Ohio State University).

For information on the 2002 Summer Institute, please contact Ed Laughbaum <www.math.ohio-state.edu/~elaughba/>, Director of the Institute.



Jack Mika flees a wave and seems to have forgotten that he is in the wave to measure water velocity as it ebbs and flows. Beth Duling keeps the calculator and CBL2 dry.