Javametrics 101:

Introducing Nonscience Majors to the Chemistry Laboratory

Coffee Experiments that Stimulate Interest in Science

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A novel way to introduce nonscience majors to the chemistry laboratory using hands-on experiments can be done with one of college students' favorite beverages—coffee. The course described in this article, Javametrics 101, integrates the art, literature, history, and music of coffee with experiments that emphasize the scientific method.

JCST has published several articles in the last few years emphasizing an interdisciplinary approach to teaching science (Duchovic 1998) and elaborating on specific methods to make nonscience majors more receptive to organic chemistry (Labianca 1998). These articles recommend infusing interdisciplinary stories and examples into the teaching process as a way to make science more meaningful to nonmajors.

One novel way to introduce nonscience majors to the chemistry laboratory using hands-on experiments can be done with a favorite beverage of college students—coffee. The growth in the number of coffeehouses, coffee bars, and coffee shops around college campuses, major urban centers, and popular retail bookstores attests to the drink's popularity. With this kind of evidence, I thought it appropriate to interest my students in science by offering a mini-course called Javametrics 101 at our college.

Many liberal arts institutions have a two-week period between first and second semesters during which students may enroll in mini-term courses. At Huntingdon College in Montgomery, AL, this time period is referred to as January Term. Many of these courses are related to faculty members' hobbies and interests, such as fly-fishing, bagpipe playing, Hollywood movies, or medical vocabulary.

Historically, during the January Term, the chemistry department offers specialized courses, such as FT (Fourier-Transform)-Infrared Spectroscopy, which attract only undergraduate chemistry majors and an occasional nonscience major. I find that we can attract more students to the chemistry department by offering January Term courses on topical subjects that interest the nonscience major and that place the students, often for the first time, into the chemical laboratory to perform discovery-based experiments.

For our most recent January Term, I designed a course entitled Javametrics 101: Mastering the Art and Science of Good Coffee. The course lasts two weeks and meets daily from nine to noon. Students need no prior laboratory experience to take the course. Enrollment in these term courses is limited to 20 students in order to provide individual attention and to maximize student interaction with the professor.

The first year of the course, 18 of the 20 enrolled students were nonscience majors who declared art, accounting, economics, Christian education, mathematics, philosophy, education, business, communication studies, or history as their majors. These students were delighted with the course and some of them have subsequently enrolled in chemistry classes to fulfill the college core requirement of six semester hours of physical, natural, or biological science.

Javametrics 101 introduces students to the art, history, literature, science, and music associated with coffee. One of the major goals of the course is to acquaint nonmajors with the scientific method. Secondary goals of the course are to provide a positive and challenging hands-on experience for students who have never taken a laboratory science in college and to pique interest in the many connections between the history and science of coffee.

I also use the course as a public relations tool to demonstrate to nonscience majors that contrary to popular belief, chemistry professors, in general, do not: 1) constantly blow things up, 2) synthesize illegal drugs, or 3) behave any stranger than other professors found at most undergraduate institutions.

A Typical Javametrics 101 Class

The course begins with a 45-minute lecture in the morning. On the first day, I explain the history of coffee in the world, beginning with the origins of

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For more about the history of chemistry, NSTA members can log in to JCST's web site at *www.nsta.org/pubs/jcst.*

coffee as a social beverage in medieval Middle East (Stella 1997). Subsequent discussion topics are listed in Figure 1.

A 15-minute coffee break, held in the lecture room, follows the lecture. During the break, students sample various blends and roasts of coffee donated by local coffee shops, mail-order coffee companies, and local grocery stores. After the break, students don laboratory goggles, receive a laboratory notebook with instructions and background of each experiment, and spend two hours in the laboratory doing instructor-guided experiments with coffee. Each experiment emphasizes the scientific method, requiring students to start by developing a hypothesis, then conduct experiments, evaluate data and results, and, finally, reach a conclusion about their hypotheses.

As this is the first laboratory experience for most of the students enrolled in Javametrics 101, I spend the opening laboratory session introducing students to the laboratory, the scientific method, safety procedures, laboratory glassware, the use of spreadsheets and computer graphing programs, and calibration of the coffeemaker. Then each student receives a coffeemaker and a laboratory drawer stocked with necessary equipment.

Students use their coffeemaker for many of the experiments during the two-week period. For safety precautions, we strictly forbid food and drink in our chemistry laboratories, and we instruct students not to taste, sample, or eat any of the coffee products that they use in the laboratory.

During the first laboratory period, the students use flexible digital temperature probes and measure the maximum temperature of the water and coffee at various locations on the coffeemaker. They learn that most commercial coffeemakers used for the home heat the water just below the boiling point to a temperature between 90 and 96 degrees Celsius, and that the actual temperature of the coffee as it filters into the glass canister is between 81 and 85 degrees Celsius.

Subsequent laboratory experiments during the two-week period (see figure 2) include determining the density of various roasts of coffee beans, the percentage of coffee extracted from dry coffee, the changes in pH (or acidity) and the temperature of coffee as it remains on the heating plate over time. We also carry out a carbon dioxide analysis of roasted coffee beans and flame tests of coffee beans at various degrees of roasting, extract caffeine from instant coffee bags (Nimitz 1991; Pavia, Lampman, and Krisz 1988), and compare the rate of cooling hot coffee in styrofoam, plastic, or ceramic coffee containers.

To receive a passing grade in the course (January Term courses are graded on a pass or no credit basis), each student must conduct an original research project on coffee (see "Select Titles"). I assist students with the design and selection of their research projects, and devote the last two laboratory sessions to student research.

The projects culminate in poster-format presentations at an evening JavaFest, scheduled at a nearby coffee shop located in a large retail bookstore. A local bookstore's monthly newsletter advertises the JavaFest so that other coffee aficionados can also attend.

Results

Including nonscience majors in a laboratory-based science course can make an instructor nervous and uncertain about the possible outcomes, especially when one of the course requirements is a student research project. To my surprise, I have found the coffee research projects in Javametrics 101 to be creative, quantitative, and of high quality. In addition, I have found that the students really enjoy giving presentations complete with graphs and data about their research project in the coffee shop setting.

Students enrolled in Javametrics 101 complete course and teaching evaluations at the end of the two-week course. Based upon the anonymous evaluations, 88 percent of the students responded that they had learned a significant amount from the short course, 55 percent responded that they would be interested in taking a regular chemistry course offered at Huntingdon College in the future, and 75 percent indicated that they would like

Select Titles of Student Research Projects

- The Relationship Between the Density of Coffee Beans and the Degree of Roasting
- Is Your Coffee Cup Keeping Your Coffee Warm?
- Decaffeinated Coffee and pH
- A Comparison of Caffeine Content in Instant vs. Brewed Coffee
- Percent of Caffeine Extracted in Various Coffees
- Design of a Seven Course Meal Using Coffee in Each Course
- A Directory of Internet Sites Related to Coffee
- The Effect of Particle Size and Grinding Time on the Extraction of Caffeine from Coffee Brewed from Coffee Beans
- The Economics of Caffeine: Do You Get What You Pay For?
- The Search for the Perfect Cup of Joe (cartoon strip)

Figure 1. ***Lecture Topics Covered in Javametrics 101***

Day	Topic	References
1	Introduction: The History of Coffee in the World	Berstein; Blixen; Perry; Jobin
2	The Chemistry of Coffee	Strong-Aufhauser; Clifford & Wilson
3	Coffee and Power: Revolution and the Rise of Democracy in Central America	Stella; Perry
4	Art and Coffee: Depiction of Coffeehouses Around the World	Stella; Heise
5	Coffee and the Relationship Between the Sexes in England	Stella
6	Music and Coffee: Some Selections from the Past and Now	www.amazon.com
7	Caffeine and Your Health: What Does the Research Tell Us?	Edwards
8	Coffee Plantations Around the World: Environmental Effects	Stella; Jobin; De Graaff
9	The Rise in the Number of Coffee Shops in America: 1988-1998	Heise; Stella

to take a second, more advanced course on mastering the art and science of coffee during a future January Term.

Conclusion

Javametrics 101 is a unique way to integrate various subjects for nonscience majors. An integral component of the course is a two-hour daily lab that features coffee and the scientific method in each experiment. The level of student learning and performance is high, as indicated by the quality of the student research projects and as measured in an end-of-course evaluation.

An added perk of the course is that the instructor can learn new information, as I did about coffee, such as the fact that some coffee beans are packaged in vented foil containers to aid in the release of carbon dioxide gas given off by the roasted beans.

Finally, developing a curriculum for a two-week course to attract nonscience majors to science need not be overwhelming. In fact, because of the shortened length of the course, developing such a curriculum can be easier. In my case, by carefully selecting a topic of current interest to students and weaving that topic through laboratory experiences, my nonmajors learned about the scientific method, laboratory glassware and procedures, the use of technology in science, and data collection. Results have been well worth the effort as seen by two new January Term courses (Perfume-Making and Isolation of Medicines from Native Plants) Huntingdon College has developed for students.

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Figure 2. ***Laboratory Experiments for Javametrics 101***

Day	Topic
1	Introduction, Check-In, Safety, Temperature Calibration of Coffeemaker, Use of Spreadsheets and Graphing
2	Determination of the Density of Various Coffee Beans
3	Determination of the Percentage Coffee Extracted During Brewing
4	Isolation and Purification of Caffeine from Instant Coffee Bags
5	Carbon Dioxide Analyses of Roasted Coffee Beans
6	Air Oxidation and Brewed Coffee: Measuring pH
7	Temperature Effects and Coffee; Flame Tests of Coffee Beans
8	Thermal Effects on the Rate of Coffee Cooling in Various Coffee Containers
9	Students work on research projects