

## **Narrative for Regents' Research in Undergraduate Teaching Award Gail Schiffer, Kennesaw State University**

### Introduction

Life is funny. I can still distinctly remember that one of the questions I was asked at the interview for my job at Kennesaw College (as it was then known) was whether or not I was interested in doing any research on teaching. My answer was a succinct "No". And yet, after 14 years, the hallmark of my career has been just that – the scholarship of teaching and learning.

My attitude changed in the fall of 1992 when I became involved in redesigning our general education science program. I have gone on to become active, not only in science curriculum reform, but also in the development of assessment instruments, laboratory program innovation, assessment of our General Education program and, ultimately, the development and assessment of our first-year learning community program.

### Curriculum Reform

In the fall of 1992, I became an initial member of a committee established to examine our general education science curriculum. At the time, our institution offered a standard menu of choices among biology, chemistry, and physical science. After considering recommendations from both the National Science Teachers' Association (NSTA) and the American Association for the Advancement of Science (AAAS), we decided to design and pilot an integrated science sequence that would examine broad themes that encompass all science disciplines. With help from an NSF grant, three of my colleagues (Ben Golden, Gray Lewis, and Diane Willey) and I led the design and implementation of this sequence.

Designing this new sequence was a major challenge, since there were no models or books to use as a base. We intended two primary innovations for the course – integrating science knowledge into a cohesive whole and shifting the pedagogy from lecture-based to student-centered learning.

The original design was indeed unique. It introduced six broad, general themes that integrated all science disciplines and allowed for the introduction of a wide spectrum of content knowledge. Students were first introduced to the nature and methods of science. Through the use of a series of classroom activities, readings, and discussions that centered on issues of interest (such as dinosaur extinction), students explored such topics as pattern identification, generation and testing of hypotheses, data collection, and organization and manipulation of data. Succeeding units centered around the nature of systems with sections on energy, information storage and transfer, and the control of systems. A section on origins and destinations explored basic concepts in cosmology, geology, and the evolution of life. The course ended with exercises on the limits of science, the differences between science and non-science (pseudoscience) and evaluation of scientific claims.

The methodology used in teaching this science sequence was entirely non-lecture, relying on readings, demonstrations, student research, group activities, and some professor-guided discussions. Each course was taught by an interdisciplinary team of two, both of whom were actively engaged in the classroom throughout the course.

One of my primary responsibilities for this endeavor was coordinating the design of laboratory exercises. The laboratory utilized the open-lab format already in use at our institution. Early exercises focused on introducing students to science process and analysis. As the sequence progressed, students obtained practice in such skills as writing hypotheses and predictions, operationally defining variables, designing experiments and evaluating design validity, and using statistics to analyze data. The lab experiences culminated in an independent project chosen and designed by the student.

The sequence was evaluated in four ways. The first two involved paper-and-pencil tests. To assess science process skills, Diane Willey and I developed and validated a test of science process skills (see SCIPROS, below). Secondly, we selected the Student Attitude Inventory (SAI) developed by Richard Moore to measure changes in attitudes toward and about science. Both instruments were administered to students taking the first science course in discipline-specific non-major sequences (biology and chemistry) and in our interdisciplinary science sequence as well as to students in their first introductory courses for majors (biology, chemistry, and physics). Students in all sequences were given a pre-test, a test at the end of the first course, and a test at the end of the second course. Quantitative analysis of the results clearly indicated that the instruction in our integrated science courses was at least as effective in developing a more positive attitude as that in other non-major courses. Furthermore, it was more effective at providing a greater understanding of science process skills than that in any of the other introductory courses – major or non-major.

The third form of assessment was peer review of the two laboratory manuals. Four faculty members from four very different universities and two different disciplines (biology and chemistry) were asked to complete a form for each manual. The reviews were very positive reviews and the suggestions elicited were useful.

And finally, mid-way through the development and assessment process, a team of two faculty members provided by PKAL (Project Kaleidoscope – a government-funded science education program) did an on-campus review, interviewing students and faculty as well as examining materials and visiting classes. Their review indicated that we were on the right track, but they also made a number of valuable suggestions that we later implemented.

In addition to these, anecdotal evidence indicated that many students completing the sequence were adopting, in larger numbers than usual, the habits of mind we advocated, such as questioning media reports and analyzing what they read.

In 1998, the integrated science sequence was adopted as the primary general education science offering at KSU. While many factors went into this decision,

these assessment results were instrumental in convincing the faculty of the value of the sequence. I was subsequently appointed to be the General Education Science Coordinator.

The attached vita lists a few of the 18 presentations our team made on this sequence.

### SCIPROS

One of the goals we had for the first sequence was that students have the basics needed for evaluating a scientific claim. A search of the literature revealed no existing instruments for testing the skills we required. Diane Willey and I created and validated SCIPROS, a test of science process skills that has two versions that can be used for pre- and post-testing. For a description of the test and for validation data, please see Appendix A.

The development and validation process was lengthy. Once questions were created, they were submitted to students to establish clarity and difficulty levels and were then revised appropriately. After arranging the questions into two parallel forms, each version was edited to avoid gender and ethnic bias in language and content. Editing was also used to adjust the reading level of both versions to 11.6 on the Bormuth scale.

Content validity and answer agreement was assessed by submitting each version to faculty members who represented five different institutions and two different science disciplines (biology and psychology). Concurrent validity was established by comparing student scores on each of the SCIPROS versions with their scores on the Test of Integrated Process Skills (TIPS), a similar but less extensive instrument. The equivalence of the two versions was established by administering both forms of the test to students during single class sessions and comparing the scores.

A paper on the development and validation of SCIPROS is in process and our work was the topic of six presentations plus a published vignette on its use in testing the integrated science sequence. We have had a number of inquiries on the tests and several faculty members at various institutions have used it.

### Curriculum Reform Revisited

As anyone who has developed curricula knows, the transition from the “laboratory” to a full-fledged offering is fraught with difficulties. In our case, we were translating a set of courses designed for small classes and for use of student-centered learning into a set with large classes taught by faculty who were not comfortable with the pedagogy. As a result of difficulties encountered along with a shift in the department’s general education goals, I coordinated a revision of the sequence that gave it an environmental theme.

Since we intended to teach the sequence in a distance-learning format, Matt Laposata and John Pratte, who are more technologically savvy than I am, joined me to form a general education science team. In 2001, our team received an NSF grant to develop a new laboratory concept that better serves our new goals,

gives more flexibility to the 90% of our students who are commuters, and is more readily adapted for distance-learning courses. With some input from me, Matt and John have developed four technology-enhanced, textbook-independent, multi-week modules that synthesize traditional wet-lab exercises with computer simulations and with online data collection and analysis. The modules explore local and global environmental issues, making them relevant to student concerns and personalizing the issues by helping students understand their own contributions to environmental problems. For example, one exercise provides a calculator where students compare the amount of carbon dioxide their automobiles emit with that of other models, including hybrid cars. As a result of our course revisions and our new laboratory program, the sequence has been accepted as a developing SENCER program. SENCER (Science Education for New Civic Engagement and Responsibilities) is a joint venture between the National Science Foundation and the AAC&U dedicated to dissemination of programs that encourage civic engagement in science issues.

My primary role in the laboratory design has been to coordinate its implementation and to conduct the assessment. Pre- and post-testing with the Students Attitude Inventory was done for students taking the previous lab program and for those taking the new one. Student surveys were also administered to determine student perceptions of what they learned, of its usefulness, and of their attitudes toward environmental problems. I am in the process of analyzing the SAI data. I have compiled the survey data (see Appendix 2), although I have not yet run tests of statistical significance. Not shown in Appendix 2 is the substantial shift in the significance of the types of changes students are making in response to their laboratory experience. Pre-test responses were vague and general while students taking the newer sequence provided a variety of specific responses.

In addition to student surveys, we have surveyed the faculty teaching the course and we are collecting peer reviews of the laboratory program from four faculty members representing a variety of institutions and two disciplines (biology and chemistry). As with the original sequence, an outside reviewer visited the campus and discussed the laboratory program with both faculty and students. Again, the reviews to date are positive and very helpful suggestions have been provided. Based in part on the positive results to date, a new NSF grant has been approved to expand on the laboratories.

### General Education Program Assessment

As the General Education Science Coordinator, I belong to the General Education Council on our campus, and it is there that I became involved in program assessment. As a member of the assessment committee, I was part of a team lead by Susan Rouse and Diane Willey that developed assessable General Education goals and assessment tools. A student satisfaction survey was administered to graduating seniors for the first time last spring, and the feedback has been analyzed by a SALT student (a student working as a research assistant to a faculty member – in this case, Dean Mary Lou Frank).

We will be comparing these results with those obtained in the future to monitor changes in the General Education Program. I was also involved in writing the program review for the General Education Program – another form of assessment.

Through my involvement in General Education, I have had the opportunity to work with Rebecca Casey, David King, Susan Rouse, Deans Joanne Fowler and Mary Lou Frank, and others in the KSU Learning Community program – and its assessment - from its inception. During the first two years, the Learning Communities were primarily made up of students who took three classes together (English 1101, Freshman Seminar, and another General Education class). This year, the program was almost doubled in size (from 8 sections to 15 sections) and the format changed to include themes for each Learning Community. In each case, I have been involved in both the teaching and in the assessment – primarily surveys of the students, although we have also done faculty feedback discussions. The results indicate great student satisfaction along with guidance on making the program stronger, and we will be making two presentations this spring, one of which is on how we “close the loop” by using survey results in planning our programs for the next year. In addition, we have worked with the registrar’s office to gather information on GPA and retention. The results indicate that Learning Community students have a slightly higher GPA during the semester than a comparable group of non-Learning Community students, and a larger percent of them continue to take classes the following semester. This assessment effort is on-going. Results have been presented to an international conference on assessment.

### Conclusion

Being nominated for the Regents’ Award for Research in Undergraduate Education is an honor, but it is not mine alone. Very little of what I have done has been my doing alone. All along, I have been fortunate in working with some wonderful colleagues who have guided, encouraged, and collaborated with me. There are too many to name in the space I have left, but they know who they are. In many ways, this nomination is a validation of the efforts of all of us.

## APPENDIX A

### SCIENCE PROCESS SKILLS TEST (SCIPROS Test)

#### Information Sheet

##### Test Description

The SCIPROS Test is a 42-item multiple choice test that does not assume specialized content knowledge and measures seven process skills—identify hypotheses, identify variables, identify measurement of variables, identify appropriate experimental design, interpret graphs, identify assumptions, and identify conclusions. There are six items to measure each skill. The Test has two parallel forms for pre- and post-testing that were equated in terms of item difficulty, item discrimination, reading level, discipline of problem context, and balance of gender and ethnic references. The test was designed for college-level students in general science courses.

##### Content Validity Information

The items were scored and classified by skill by expert raters and revised until a new group of raters achieved consensus on the correct answers and skill groupings.

##### Reliability Information

Tests were administered to classes of students at two universities to obtain reliability estimates.

Table 1. Internal Consistency Reliability Estimate ( $\alpha$ )

Test	N	Mean (raw score)	Mean (%)	SD (rs)	r ( $\alpha$ )
SCIPROS-A	97	24.56	58.5	5.84	.76
SCIPROS-B	106	24.03	57.2	6.24	.80

Table 2. Alternate Forms Reliability Estimate

Test	N	Mean (rs)	Mean (%)	SE <sub>mean</sub> (rs)	SD (rs)	r <sub>A-B</sub>
SCIPROS-A	344	25.95	61.79	.33	6.09	.70
SCIPROS-B	344	25.29	60.21	.33	6.10	

The reliability estimates of the two forms of the test presently are sufficient for making educational decisions about groups of students, but NOT about individuals. Thus, SCIPROS is best used for evaluation of classes, cohorts, or programs.

**APPENDIX B****SCI 1101 Laboratory Evaluation Form Results**

Percent of Students Agreeing or Strongly Agreeing with the Statement

Statements	Previous Lab Program	First Version of Lab Program	Revised Lab Program
1. The instructions for these laboratories were clearly written.	64	39	66
2. The laboratories were challenging, but presented an appropriate level of difficulty for non-science majors.	77	52	69
3. The laboratory exercises were about issues that affect me.	26	49	60
4. The laboratory program helped me to understand the environmental issues	50	52	68
5. Completing the laboratories helped me develop a better understanding of how	66	43	57
6. The laboratory activities were interesting.	46	29	41
7. The laboratory program made me realize that I have a part in solving environmental	43	37	58
8. Participating in this laboratory program has caused me to change the way I do some	17	18	29

These are the percents of the total number of students who answered the question.

Previous Lab Program is the lab program in place for environmental sequence in spring and summer, 2000. N = 140

First Version is the original design of modular lab program implemented in fall, 2000. N = 224

Revised Lab Program is the revised version of the modular lab program implemented in spring, 2002. N = 208

## GAIL B. SCHIFFER

### EDUCATION

Ph. D., Biology, Washington University, 1973  
B.A., Biology, Macalester College, 1966 (cum laude)

### TEACHING EXPERIENCE

PROFESSOR (Assistant, Associate, and Full), Kennesaw State University, Department of Biological and Physical Sciences, August, 1989 – present.  
INSTRUCTOR, part-time, Kennesaw State College, Department of Biology, 1984 - 1989

### SELECTED RECENT SERVICE ACTIVITIES

#### University-Level Service

General Education Committee/Council	1997- present
Assessment Subcommittee, 1997- present	
General Education Executive Committee	2002 - present
Learning Community Committee	Spring, 2000 – present
Faculty Development and Awards Committee	August, 2000 – May, 2002
Institutional Review Board	August, 2000 – present
Leadership Team Coordinator for Scholarship of Teaching and Learning (CETL program)	2001-2002
CETL Faculty Fellowship Committee	Spring, 2002
Search Committee for Undergrad/Gen Ed Dean, secretary	Fall, 2000 – April, 2001
Intellectual Property Policy Committee/Senate Task Force	Spring, 1998 - 2000

#### Department-Level Service

Biology Curriculum Assessment Committee	1996- 2001
General Education Science Coordinator	1997- present
Committee for On-Line General Education Science Sequence	1999-2000
Biology/Physics General Education Committee - Chair	1997- 2001
General Education Science Design Committee – Chair	1999
Science Core Lab Design Committee – Chair	1998

### SAMPLE PRESENTATIONS

#### SCIPROS

Schiffer, Gail, Ben Golden, Diane Willey, and Gary Lewis, “A Pair of Tests for Assessing Science Process Skills”. Invited presentation made to a joint session of the National Science Education Leadership Association, the National Teachers Association, and the Georgia Science Supervisors Association, October 30, 1996

Willey, Diane and Gail Schiffer, “Using a Science Process Skills Test to Evaluate the Success of General Science Courses”. Georgia Conference on College and University Teaching, April, 1998.

#### Curriculum Reform

Golden, Ben, Gary Lewis, Gail Schiffer, and Diane Willey, “An Analysis of the Impact of Student Centered Instruction on Science Process Skills,” Georgia Science Teachers Association Annual Conference, February, 1996.

Golden, Ben, Gail Schiffer, Gary Lewis, and Diane Willey, “Connecting With Science:



An Integrated Science Sequence for the General College Student," Society of College Science Teachers at the National Science Teachers Association National Conference, March, 1996.

Golden, Ben and Gail Schiffer, "Integrating Student-Centered Instructional Methodologies Into Non-major Science Courses." National Science Teachers Association Regional Conference, November 1, 1996.

Golden, Ben and Gail Schiffer, "Developing Alternate Assessments of Student Ability to Use Scientific Processes." National Science Teachers Association Regional Conference November 1, 1996.

Golden, Ben and Gail Schiffer, "Making the Leap into Integrated Science Courses." Presented three times: Georgia Science Teachers' Association Annual Conference, January, 1998; Society for College Science Teachers at the annual conference of the National Science Teachers' Association, April, 1998; Association of General and Liberal Studies, October, 1998.

Schiffer, Gail, Invited presentation - "Taking the Leap into Integrated Science: Lessons Learned in Curriculum Reform", Board of Regents' P-16 Network meeting on Teaching and Learning in Science and Mathematics in the Core, October, 2002

#### Laboratory Innovations

Rhyne, Pam, Ben Golden, Gail Schiffer, and Don Davis, "Designing Take-Home Laboratories." Georgia Science Teachers' Association Annual Conference, January, 1998, and to the Society for College Science Teachers at the annual conference of the National Science Teachers' Association, April, 1998.

Davis, Don, Pam Rhyne, Gail Schiffer and Ben Golden, "Authentic Situations in the Science Laboratory Program". Society for College Science Teachers at the annual conference of the National Science Teachers' Association, March, 1999.

Pratte, John, Matthew Laposata and Gail Schiffer, "General Education Environmental Science: An Interdisciplinary Laboratory Program for the 21<sup>st</sup> Century" (poster). Best Practices in General Education and its Assessment. Association of American Colleges and Universities, Atlanta, GA. Feb., 2001.

Pratte, John, Matt Laposata, Gail Schiffer and Marina Koether, "Environmental Science Laboratory", Society for College Science Teachers at the annual conference of the National Science Teachers' Association, March, 2001.

Laposata, Matthew, John Pratte and Gail Schiffer and Marina Koether, "Connecting with the Environment: A Novel Approach to Lab" (poster). SENCER Summer Symposium 2001, Santa Clara University, San Jose, CA, August, 2001.

#### General Education and Learning Communities

Rouse, Susan, Gail Schiffer, Diane Willey and Joanne Fowler, "Assessing the Effects of Learning Communities on Freshman Success and Satisfaction at a Commuter Campus", Caribbean Conference on Higher Education Planning and Assessment, July, 2001.

Frank, Mary Lou, Susan Rouse and Gail Schiffer, "Program Review as a Developmental Tool in General Education". Hawaii Conference on Higher Education Planning and Assessment, May, 2002.

#### Miscellaneous

Schiffer, Gail, D. Don Davis, and Pam Rhyne, "Remembered Biological Concepts and Perceptions: A Comparison between Traditional and Non-traditional Students",

Society for College Science Teachers at the annual conference of the National Science Teachers' Association, March, 2001.

### **SAMPLE PUBLICATIONS**

- Lewis, Gary C., Ben R. Golden, Gail B. Schiffer, Diane L. Willey, "Non-traditional Techniques in teaching Science for General College Students." *Selected Papers from the Seventh National Conference on College Teaching and Learning*, Jacksonville, FL, 1996.
- Schiffer, Gail and Ben Golden. 1997. *An Introduction to Science Process*, September 1997 Edition. The McGraw-Hill Companies, Inc., New York.
- Schiffer, Gail and Pam Rhyne. 1997. *An Introduction to Science Process II*, Second Edition. The McGraw-Hill Companies, Inc., New York.
- Davis, D., B. Golden, P. Rhyne, and G. Schiffer. 1999. "Take Home Laboratories: Flexible Scheduling for the General Education Science Student", *Georgia Journal of Science* Vol. 57, No. 1.
- Davis, D., B. Golden, P. Rhyne, and G. Schiffer. 1999. "Open-scheduled Laboratories: Flexible Scheduling for the General Education Science Student", *Georgia Journal of Science* Vol. 57, No. 1.
- Schiffer, Gail, Ben Golden, Gary Lewis, and Diane Willey. Using Assessment in Curriculum Reform. Vignette in *Pathways: University/College Edition* edited by Eleanor D. Siebert and William J. McIntosh, National Science Teachers' Association, 2001.
- Schiffer, Gail. 2002. "How Do You Know It Works", *The Georgia Science Teacher*, Vol. 42, No.2, pp 8-10.

### **MAJOR FUNDING**

- National Science Foundation Grant (DUE 0088723), "General Education Environmental Science: An Interdisciplinary Laboratory Program for the 21<sup>st</sup> Century", 2001-02. Co-directors: Marina Koether, Matt Laposata, John Pratte, Gail Schiffer. \$74,985
- National Science Foundation Grant (DUE 9651167), , "Instrumentation for Interdisciplinary Open Labs", 1996- 1998. Co-directors: Gary Lewis, Jack Duff, Ben Golden, Pam Rhyne, and Gail Schiffer. \$75,000
- National Science Foundation Grant (DUE 9354798), "Connecting With Science: A Proposal for Engaging the General College Student", 1994-96. Co-directors: Ben Golden, Gary Lewis, Gail Schiffer, and Diane Willey. \$124,903

### **HONORS**

- Distinguished Teaching Award for the College of Science and Mathematics, 1999.
- College Teacher of the Year by Georgia Science Teachers' Association, 2001
- Finalist for Kennesaw State University Distinguished Teaching Award, 2001
- Association of General and Liberal Studies Faculty Award, 2002