Organized to improve science teaching—through research

NARST NEWS

NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

Thaddeus W. Fowler, Editor, University of Cincinnati, OH

Vol. 31 (4) December 1989

PRESIDENT

William G. Holliday
University of Maryland at College Park

Providing Science Teachers with Research-based Knowledge

NARST, AERA and others are presenting and publishing some excellent research that can help experienced teachers improve their science teaching. For example, the latest issue of *Review of Educational Research* (RER) reports research and theoretical advances published by a variety of top scholars including, of course, some members of NARST.

But this exciting work, according to Prawat in his latest RER article, is not affecting the way science is being taught in today's schools, frustrating science education researchers and teachers alike. Perhaps NARST needs to take a more proactive role by working with teacher association, producing products and implementing processes that integrate research-based knowledge with experienced teacher know-how. This can be done at gatherings of preservice and inservice science teacher groups, through sophisticated teacher-oriented publications and by encouraging schools administrators and to provide teachers with school time to read, discuss and make substantiated findings become classroom realities.

In the past, neither NARST nor science teacher associations have taken the initiative to establish linkages between what's happening in research with what's happening in the classroom. As a result, research-based articles of high quality seldom appear in such popular teacher publications and NSTA's *The Science Teacher* or NABT's *American Biology Teacher.*

NARST needs to work with its university colleagues by establishing teacher education programs that provide preservice teachers with both technological *and* intellectual backgrounds in science education. Today, many science methods courses are limited to providing preservice teachers with a bare-bones, first-aid style cur-

continued p. 2 — President

1990 NARST Meeting in Atlanta

The program committee is excited about the upcoming NARST annual meeting to held at the Atlanta Hilton and Towers from April 8 through 11, 1990. The meeting will feature presentations of research studies, symposia, discussion panels, poster sessions, and keynote speakers as well as opportunities for informal meetings and discussions with fellow science education researchers.

The meeting will begin with two professional development workshops on Sunday, April 8 at 2:00 p.m. Ken Tobin and James Gallagher will lead a workshop on qualitative research in science education and Art White will conduct a workshop on the use of personal computers for analyzing research data.

The first general session will be held on Sunday evening followed by a reception for new members. Presentations of papers, posters, symposia, and panels will begin April 9, Monday at 8:00 a.m. The Awards Luncheon will be on Tuesday, April 10.

continued p. II

NARST 1990 CONFERENCE
April 8-11
Atlanta Hilton and Towers

Deadlines	
Roommate Requests Diana Hunn, Indiana University	February 15
Preregistration Glenn Markle, University of Cincinnati	March 10
Hotel Reservations Atlanta Hilton and Towers	March 8
Paper, Final Copy Discussants	March 1
Travel Discounts Delta Air Lines 1-800-221-1212 File Reference Number: D28027	7 days prior

riculum on how to get through the school day—with too little attention focusing on the integration of research-based knowledge with clinical experiences including the reflective and managerial aspects of science teaching. In the future, universities must train teachers to read research, and apply its practical and sustainable findings to classroom contexts.

NARST needs to convince teacher associations to commit substantial resources toward research-based projects such as increasing the editorial staff responsible for working with authors of research-based pieces. This action can facilitate the creation of exemplary research-based publications in our field. Historically, this has proven to be a difficult task. The linkage of research-based knowledge in science education to science teaching has often failed, resulting in the publication of some unreadable works of questionable validity.

NARST needs to inspire its membership to write manuscripts for teacher associations, presenting research-based knowledge in a useable form for today's busy teachers. These professionals cannot be expected to ferret out this practical knowledge from their libraries and integrate it into their teaching practices, given their inadequate university training in this regard and the unreasonable work loads currently demanded by their schools.

Today's researchers can help by submitting manuscripts so that editors of teacher publications can initiate the peer review process followed by author revisions. Manuscripts may cover such topics as "why it's more important what the student is actively doing than what the teacher is doing" and "why *minds on* is more important than *hands on.*" These works then can be modified to fit the stylistic format of each teacher publication.

In contrast to science education, researchers in reading education continue to do a good job of informing a large portion of reading teachers about timely developments. Specifically, the International Reading Association (IRA) has contributed a great deal to teachers' understanding about the application of research to classroom contexts. The IRA publishes research-based works in its periodicals (e.g., *The Reading Teacher, Journal of Reading*) and in its books (e.g., *Becoming a nation of readers*). Our teacher associations serving teachers with similar interests have contributed complementary works including the National Council of Teachers of English's (NCTE) book *Counterpoint and Beyond: A Response to Becoming a nation of readers.* Such analogous publications produced by science teacher associations may have a similar value—providing science teachers with stimulating and informed, research-based discussions including constructive and provocative debates about competent classroom practices.

The consequences of failing to provide science teachers with research-based knowledge is manifested in the everyday faddisms so prevalent in classrooms and other areas of education, as described in Robert Slavin's excellent generic article in this year's June issue of *Phi Delta Kappan.* Slavin describes how so many of the recent "gee whiz" innovations have failed to match the expectations of teachers. He reasons that the failures of many faddisms are due in large part to teaching strategies and programs with shaky research bases and imcompetent classroom implementations, resulting in wasting large amounts of money, time and learning opportunities. He includes in his list of failed programs popular versions of "cooperative learning," mastery learning, open school plans, and Madeline Hunter's model of instructional theory into practice. Such heralded panaceas in their sometimes implemented form promised much more than the research suggested in the first place, and not surprisingly, delivered an awful lot less to teachers.

But editors and other teacher-oriented association officials in our field can't accomplish very much without our full cooperation. NARST, as the leading world-wide research organization in science teaching, must become proactive by doing more to stop the spread of folklore and unsubstantiated innovations and increase our cooperation with school and university administrators, and teacher associations' editors.

1990 Conference Registration Materials
April 8 - 11, 1990

The 1990 Annual Meeting will be held at the Atlanta Hilton and Towers Hotel from April 8 to April 11. The meeting will begin with two professional development workshops at 2:00 on Sunday afternoon, April 8. There is an additional charge for these workshops to cover the cost including materials. The first general session is scheduled for Sunday evening at 7:00 to be followed by a reception at 9:00 p.m. Registration materials are being mailed on December 10, 1989. To preregister for the conference, please complete and return the registration form with appropriate fees paid in U.S. funds. The deadline for preregistering is March 10, 1990. The form at the bottom of this page may be used to preregister if you have not received a registration packet.

Hotel reservations should be requested directly from The Atlanta Hilton and Towers. If you phone in your reservation [(404) 659-2000], be sure to identify yourself as a member of NARST registering for our annual meeting so that you receive the special room rates of $109.00 plus tax for a single or a double room. If you plan to attend NSTA before the NARST meeting, you will be able to stay at the hotel for these same rates.

I will be pleased to answer questions about conference preregistration procedures or procedures for reserving a room. My office phone number is (513) 556-3582 and my home number is (513) 729-1834.

REGISTRATION FORM

1990 ANNUAL MEETING

NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

The Atlanta Hilton and Towers
Atlanta, GA

April 8 - 11, 1990

Registration fee includes the Annual Awards Luncheon

I wish to preregister as: (check one)

__ Member @ $70.00
(on site registration fee $80.00)

__ Emeritus Member @ $20.00
(on site registration fee $31.00)

__ Student Member @ $20.00
(on site registration fee $31.00)

__ Non-Member @ $85.00
(on site registration fee $96.00)

Total Payment Enclosed $_____

I also wish to register for the following Professional Development Workshop scheduled for Sunday, April 8 from 2:00 to 5:00 p.m.

__ Interpretive Research in Science Education with Dr. James Gallagher and Dr. Kenneth Tobin.
Registration fee, $10.00 / Student Members, $5.00.

__ Use of the IBM PC for Data Analysis in Science Education Research with Dr. Arthur White.
Registration fee, $10.00 / Student Members, $5.00

PLEASE PRINT — ABBREVIATE AS NECESSARY. Provide Complete Mailing Address Including ZIP Code.

Name (Last, First)

Mailing Address City State ZIP

Country

Please return the completed registration form with the appropriate fees to
Dr. Glenn Markle
NARST
University of Cincinnati
Cincinnati, OH 45221-0002.

Checks or money orders **in U.S. funds** should be made payable to NARST.
Thank you.

Delta Travel Discounts

Delta Air Lines Special Meetings network is pleased to have the opportunity to offer its personalized services for your upcoming meeting. We specialize in coordinating travel arrangements for meetings and strive to provide the best service possible at the lowest applicable fares available.

Provisions have been made to allow a 5 percent bonus off most Delta domestic published fares, if all rules and conditions of the air fares are met. Some promotional fares with discounts greater than 75 percent off the normal round trip day coach fares may not be included in this offer.

For passengers not qualifying for published discounts, a 40 percent discount will be offered on Delta's domestic system for travel to the meeting. For travel into or out of Canada, attendees will receive a 35 percent discount. This discount will be based on the full nondiscounted round trip coach rates. To take advantage of these fares, follow these simple rules:

1. Valid for travel: April 5-14, 1990, inclusive.
2. Valid for travel into: Atlanta, Georgia.
3. Tickets must be purchased at least 7 days prior to departure.
4. This discount has limited seat availability.
5. Valid for travel round trip on Delta only.
6. Call Delta or have your Travel Agent call 1-800-221-1212, and ask for Special Meetings Network. We are open daily from 8:00 a.m. to 11:00 p.m. Eastern Time and will be happy to assist with your reservations.
7. Refer to File Reference Number: D28027.

International Conference on the History and Philosophy of Science and Science Teaching Journals Available

An International Conference on the History and Philosophy of Science and Science Teaching was held on November 5-10, 1989 at Florida State University. During the conference over 150 papers were presented. Philosophers, historians, teacher educators, and scientists from 18 countries and 28 U.S. states were in attendance. The proceedings of the conference are published in a collection of several journals. A limited number of the journals are still available for purchase. These journals were published prior to the conference so the attendees could prepare for the meeting. The journals that are available are: *Interchange,* ($10); *Synthese,* ($10); *Studies in Philosophy and Education,* ($10); *Educational Philosophy and Theory,* ($10); *Pre-Conference Proceedings,* 358 pages, ($15).

A three volume set of proceedings of the conference will be published soon and can be ordered now. These include: *Post-Conference Proceedings, ($15); Science Education, ($10); International Journal of Science Education,* ($10).

Send requests to: Kenneth Tobin, 203 Carothers Hall, Florida State University, Tallahassee, FL 32306, [(904) 644-2792]. Checks need to be made payable in U.S. funds to Florida State University.

NARST MONOGRAPHS AVAILABLE

A Theory of Instruction: Using the Learning Cycle to Teach Science Concepts and Thinking Skills, A. Lawson, M. Abraham, and J. Renner, $6US

Learning Environment Research in Science Classrooms: Past Progress and Future Prospects, B. Fraser, $6US

Send orders with check payable to NARST to Glenn C. Markle, NARST Executive Secretary, College of Education, University of Cincinnati, Cincinnati, OH 45221-0002

NARST Monographs Order Form

Please send me the following:
____ copy(ies) of *A Theory of Instruction* at a cost of $6US each
____ copy(ies) of *Learning Environment Research in Science Classrooms* at a cost of $6US each

Name: _____

Address: _____

_____

ZIP

SPECIAL OFFER FROM NSTA

The National Science Teachers Association has published *A Practical Guide to Modern Methods of Meta-Analysis* by Larry V. Hodges, James A. Shymanski, and George Woodworth. The list price for this book is $9.50. As a member of NARST, you can purchase the meta-analysis guide at the special price of $8.55, if your order is submitted on the following order form. All orders should be mailed to Dr. Glenn Markle, Executive Secretary, NARST, University of Cincinnati, Cincinnati, OH 45221-0002. Enclose a check or money order payable in **US funds** to NARST.

Meta-Analysis Order Form

Please send me ____ copy(ies) of *A Practical Guide to Modern Methods of Meta Analysis* by Hodges, Shymanski, and Woodworth at the special NARST member cost of $8.55.

Name: _____

Address: _____

_____

ZIP

NARST

April, 1989 No. 23

Research Matters...To the Science Teacher

COMPUTER-BASED TECHNOLOGY IN COLLEGE SCIENCE LABORATORY COURSES

By William H. Leonard

The microcomputer introduces several applications of computer-based technology to laboratory instruction in college science courses. Almost as soon as the microcomputer was used for science instruction, faculty, especially those in the physical sciences, began the development of computer-based applications. Furthermore, there are some interesting reports in the literature that describe the use of this technology and/or report the effects of computer-based instruction on student learning. This article reviews the recent literature on the use of microcomputer applications in college science laboratory courses with a focus on student educational outcomes.

Currently there are two major uses of computer-based technology in college laboratory courses: (1) direct instruction of laboratory concepts by simulation using traditional computer-assisted instruction (CAI) or by a more advanced version of CAI using an interactive videodisc system (IVI) and (2) using the microcomputer for data analysis and/or input of data with laboratory instrumentation interfaced to the microcomputer. The following discussion is divided into these two areas.

There are numerous studies using (CAI) in college science instruction, but only a few reports of use in conjunction with laboratory instruction specifically. In one study, students in an introductory chemistry laboratory course who used computer simulated experiments for four different laboratory investigations (kinetics, absorbance spectroscopy, emission spectroscopy, and equilibrium) did as well or significantly better than students performing the traditional laboratory investigation on the same topic. The CAI group also spent significantly less time learning the material (Calvin and Lasgowski, 1978). Curtis (1986) used a software system designed to teach students how to fit simple response functions to experimental data. Using modern data analysis techniques was found to help students with low and low-average mathematical skills more than it helped students with high skills. Miller (1986) found no differences in achievement or attitudes due to student use of CAI materials in a community college biology laboratory course.

Microcomputers interfaced laser videodisc players provide a combination of the advantages of the microcomputer and traditional television or videodisc images. The result of interfacing these two technologies permits a high level of interactivity between the computer and student, and high resolution, life-like video images of natural phenomena (Leonard, 1987a). In comparison of interactive videodisc versus the traditional laboratory to teach physical principles of standing waves and strings, no difference was found on pretest/posttest gains between the two groups of students, but that students in the two groups used different strategies to separate and control for variables based on the physical nature of the instructional materials available (Stevens, 1985). Waugh (1987) randomly assigned two groups of chemistry students studying equilibrium to either a traditional laboratory activity or simulation with an interactive videodisc system. The latter group scored significantly better on both laboratory quizzes and on their laboratory reports. Similarly, a large group of non-major biology students were assigned to either traditional laboratory exercises or simulations on an interactive videodisc system to learn about cellular respiration and about biogeography. Results showed no statistically significant differences between the groups on laboratory quizzes, laboratory reports, or laboratory final exam. Opinion data on a questionnaire indicated that students felt the videodisc instruction gave them more experimental and procedural options and more efficient use of instructional time than did conventional laboratory instruction. Students indicated interactive videodisc was equivalent for general interest, understanding of basic principles, help on examinations, and attitudes toward science. The conclusion was that interactive videodisc can, in some cases, provide comparable instruction to the wet laboratory (Leonard, 1987b & 1988a).

One of the most exciting developments in laboratory instruction is the interfacing of laboratory measurement devices to a microcomputer. Nicklin (1985) found that many physiological experiments could be improved and made more accurate by interfacing common physiological instruments to a microcomputer. He also found that the microcomputer could act as a "lab partner" for students working individually on an experiment and that interfacing was not expensive. Old kymograph transducers interfaced with microcomputer-based workstations for undergraduate physiology laboratories were found to be very functional and successful (Rhodes, 1986). Morgan, Markell, and Feller (1987) have given a complete description of interfacing muscle physiology measuring devices to a microcomputer. One of these is a pistol grip transducer that is used to study contraction of the human trigger finger muscles. An excellent and illustrative guide for inexpensively constructing interfaces for twelve common laboratory instruments such as a thermistor, motion time, pH meter and humidity meter has been prepared by Vernier (1987). A simple and inexpensive interfacing kit, called *Science Toolkit,* is available from Carolina Biological Supply and other science supply companies. The basic module for the Apple II sells for $70 and contains experiments in biology, chemistry, and physics. Additional modules for speed and motion, earthquakes, and human physiology are available for $40, each with additional experiments. A variety of other commercial interfacing kits are available as well. For example, IBM is developing a Personal Science Laboratory (PSL) that can be used in college science laboratories.

There are educational benefits of using instruments interfaced to a microcomputer in the laboratory. These benefits include, reducing cost, improving effectiveness, saving student time (and thus preventing boredom), learning to use state-of-the-art scientific instrumentation, simplifying data analysis, making experimental

results more meaningful by allowing students to perceive relationships between independent and dependent variables as the experiment is completed, allowing students to more effectively comprehend abstract concepts, and providing opportunity for developing problem solving skills (Leonard, 1988b).

Ideas for classroom interfacing come from scientific research. Among those ideas being developed in research that may have interesting applications for the classroom are trackers for eye, head and hand gestures, tracers of eye direction and focus tracking, and voice recognition and synthesis (Foley, 1987). IBM currently has an interactive system capable of recognizing 20,000 words (98% of the typical English-speaking vocabulary). The development of much more powerful microcomputers, CD-ROM, and image capturing by microcomputers will soon be available for classroom use. Future possibilities for laboratory interfacing are almost unlimited.

The recent development and research on applications of computer technology for laboratory instruction in college science courses does suggest that applications of computer technology in the laboratory classroom is here to stay and that science faculty will continue to develop new applications for instruction. The temptation to tinker with this new technology is almost irresistible. The demonstrated educational benefits of computer applications for student learning also appears to be equivalent to or better than conventional laboratory instruction.

Recommendations to the Science Teacher

The first recommendation is that you try computer-based technologies in your laboratory courses. The interfacing instrumentation, for example, is not expensive and a teaching laboratory needs only one to a few microcomputers. Interfacing has been found to be useful and motivational in physiology, biology, chemistry, earth science, and physics laboratory courses. Other computer-based technologies, such as interactive videodisc and computer laboratory simulation are useful as well.

A second recommendation is that you experiment with creative applications of computer-based applications in your laboratory course. Your students can be creative as well. Adding this new dimension of technology to your laboratory investigations has all of the advantages listed above.

Finally, you are encouraged to share the results of your creative efforts with computer-based technologies in your laboratory courses through the science teaching journals. We can all help each take full advantage of these exciting technologies.

William H. Leonard is a Professor of Science Education and Professor of Biology at Clemson University, Clemson, SC 29634. He is a member of the National Association for Research in Science Teaching, an organization dedicated to improving science teaching through research.

REFERENCES

Calvin, C.S. and Lasgowski, J.J. (1978). Effects of computer simulated or laboratory experiments and student aptitude on achievement and time in a college general chemistry laboratory course.

Curtis, J.B. (1986). Teaching college biology students the simple linear regression model using an interactive microcomputer graphics software package. *Dissertation Abstracts International, 46*(7), a.

Foley, J.D. (1987). Interfaces for advanced computing. *Scientific American, 257,* 127-135.

Leonard, W.H. (1987a). Interactive Videodisc: Computer Instruction of the Future? *Collegiate Microcomputer, 5,* 197-201.

Leonard, W.H. (1987b). A comparison of student performance by interactive videodisc versus conventional laboratory. Paper presented to the Annual Meeting of the National Association for Research in Science Teaching in Washington, D.C., April, 1987.

Leonard, W.H. (1988a). A comparison of student reactions to biology instruction by interactive videodisc or conventional laboratory. *Journal of Research in Science Teaching,* in press.

Leonard, W.H. (1988b). Interfacing in the biology laboratory: State of the art. *The American Biology Teacher, 50.*

Miller, D.G. (1986). The integration of computer simulation into the community college general biology laboratory. *Dissertation Abstracts International, 47*(6), 2106A.

Morgan, R.M., Markell, C.S., and Feller, R.F. (1987). A microcomputer exercise on muscle Physiology. *Journal of College Science Teaching, XVII*(10), 23-27.

Nicklin, R.C. (1985). The computer as a lab partner. *Journal of College Science Teaching, 15*(1), 31-35.

Rhodes, S.B. (1986). A microcomputer kymograph. *Journal of College Science Teaching, 15 #6,* 523-527.

Stevens, S.M. (1985). Interactive computer/videodisc lessons and their effect on students' understanding of science. Paper presented to the Annual Meeting of the National Association for Research in Science Teaching in French Lick Springs, Indiana.

Vernier, D.L. (1987). *How to build a better mousetrap.* Portland, OR: Vernier Software.

Waugh, M.L. (1987). The influence of interactive videodisc simulations on student achievement in an introductory college chemistry course. Paper presented to the Annual Meeting in Washington, D.C., April, 1987.

The National Association for Research in Science Teaching is an organization that seeks to improve science teaching through research. For further information, contact the NARST Executive Secretary:

Dr. Glenn Markle
401 Teacher College
University of Cincinnati
Cincinnati, Ohio 45221

For further information on this topic, contact Dr. Joseph D. Novak, Department of Science and Mathematics Education, Cornell University, 404 Roberts Hall, Ithaca, New York 14853-5901.

NARST

April, 1989 No. 24

Research Matters...To the Science Teacher

USING INQUIRY LABORATORY STRATEGIES IN COLLEGE SCIENCE COURSES

By William H. Leonard

Systematic observations of college science laboratory classes in a large midwestern university during the late 1970s revealed that students were, for the most part, performing cookbook-like laboratories and were not learning the process skills of science. Instead, students spent a significant amount of laboratory time listening to the instructor transmit information. These observations are probably typical of most university laboratory courses in the sciences and that the use of investigative laboratory teaching strategies at the college level lagged behind those used in the secondary and elementary schools (Kyle, Penick and Shymansky, 1979). There are reports in the literature that most standard laboratory experiments in introductory college science courses contain directions to be followed explicitly so the experiment will generate usable data (Stewart, 1988). Stewart contends that if students are permitted to design their own experiments, the laboratory protocol becomes more important than the laboratory report, and time spent planning and organizing the experiment becomes more important than time spent ascertaining whether or not the results are as expected. Fogle (1985) states that introductory college students do not understand the nature of scientific questioning, and that common misuse of the terms hypothesis, fact, and theory is symptomatic of student misconceptions. He maintains that students must be allowed to experience scientific thinking firsthand.

During the past decade, some interesting experimental studies developed and tested alternative approaches to the traditional laboratory investigation. Most of the innovative approaches are modifications of the inquiry model and employ discovery or inductive approaches to learning. Utilization of science process skills, such as hypothesis formation, identification and manipulation of experimental variables, and inferring from data are characteristic of these newer approaches.

In one such study, students in a physical science class for elementary education majors employed concrete, manipulative laboratory experiences to learn about measurement, pressure, Archimedes' principle, machines and electricity. This class showed greater achivement on some of the concepts, a greater comprehension of all areas taught, and better attitudes toward science than a similar class taught without the manipulative laboratory experience (Splickler, 1984). Kern and Carpenter (1984) found a field-oriented, on-site, instructional approach to geology produced significantly more interest and enjoyment than a traditional laboratory approach. The laboratory approach associated with a learning center approach for college geology was found to have a significantly greater effect on short-term learning than did a more conventional laboratory approach (Tofte, 1982).

A number of studies of inquiry laboratory approaches have been done in introductory biology. Lawson and Smitgen (1982) found that a series of laboratory investigations to teach formal reasoning was found to improve significantly the ability of students to use formal operational thought. Similarly, cognitive development of college, non-major, biology students was found to be promoted by a laboratory program that emphasized investigation and accounted for limitations of student cognitive ability (Journet, Young, Stanley, and Scheibe, 1987). Walosz and Yeany (1984) found that training in integrated science process skill development improved the performance of college biology students in the use of integrated science process skills. A successful inquiry strategy developed originally by the Biological Sciences Curriculum Study (BSCS) was adapted for use in a university general biology laboratory program and tested experimentally for an entire semester against a well-established commercial program which was highly directive (Leonard, 1986). The BSCS orientation made systematic use of science processes, development of concepts via questioning and requirements of the student to make procedural decisions. The commercial approach primarily required following instructions exactly as stated and answering a few very specific questions. Students using the BSCS orientation scored similarly to those using the commercial approach on a pretest of selected biology laboratory concepts, but scored significantly higher on a post-test (Leonard, 1986). This study was later replicated with students at two small, private colleges. Again, the group using the BSCS orientation scored significantly higher on a test of biological laboratory concepts at the end of the semester (Hall and McCurdy, 1988). Finally, an extended discretion laboratory approach in which students were required to determine their own investigatory procedures and strategies was tested experimentally against a more directive laboratory approach in university general biology. Even though the former approach placed much greater demands on student creativity and decision making, student scores between the two groups on learning measures given at the end of the semester did not differ significantly. One conclusion is that students can learn at least as much when given fewer procedural directions on laboratory investigations (Leonard, 1984).

Studies on the use of investigative or inquiry approaches in college science laboratory courses suggest the following.

- Inquiry laboratory strategies are more student-involved and more inductive than traditional approaches.
- Inquiry laboratory strategies contain less direction and give the student more responsibility of determining procedural options.
- Inquiry laboratory strategies require students to make more extensive use of science process skills.
- Inquiry laboratory strategies produce significantly greater educational gains than traditional approaches.
- Inquiry laboratory strategies appear to work equally well for college students of all ability levels, not just the very academically talented.

Students appear to prefer inquire-style instruction as well. A

survey of 600 students in introductory, non-major science courses showed a clear preference for investigative laboratory activities to the standard, structured activities (Davis and Black, 1985). Inquiry laboratory programs have been found to be workable. For example, research supports recommendation for maintaining the spirit of inquiry in large-enrollment college laboratory classes, for designing process-oriented laboratory investigations, for reducing the cookbook from commercial laboratory investigations, and for helping laboratory instructors become better teachers (Leonard, Journet and Ecklund, 1988).

Meaningful laboratory instruction in college science courses appears to be distinguished from traditional strategies in at least three ways.

Students are engaged in a number of the science inquiry processes, such as observing, classifying, measuring, communicating, collecting and organizing data, inferring from observations, hypothesizing, manipulating experimental variables, analyzing data, and drawing conclusions from data.

Students have the opportunity to manipulate experimental materials, thus providing a "hands-on" experience.

Students learn in an experimental manner specific scientific concepts, such as "plants have cess walls and animals do not" or "some chemical reactions need heat to take place and/or some give off heat."

Recent research on investigative learning approaches in college science laboratory courses looks encouraging. Much more development of laboratory curricula using inquiry approaches and research which experimentally compares them to existing approaches is still needed. There is a definite trend toward wider use of inquiry laboratory strategies in college and university science courses. The use of such strategies is justified by recent research.

William H. Leonard is Professor of Science Education and Professor of Biology at Clemson University, Clemson, SC 29634. He is a member of the National Association for Research in Science Teaching, an organization dedicated to improving science teaching through research.

REFERENCES

Davis, W.E. and Black, S. (1985). Student opinion of the investigative laboratory format. *Journal of College Science Teaching,* 15, 187-189.

Fogle, T.A. (1985). Student-directed biology lab investigations. *Journal of College Science Teaching, XIV,* 345-348.

Hall, D.A. and McCurdy, D.W. A comparative study of a Biological Sciences Curriculum Study (BSCS) style laboratory and a traditional laboratory approach on student achievement at two private liberal arts colleges. Paper presentation at the Annual Meeting of the National Association for Research in Science Teaching at St. Louis, April 11, 1988.

Journet, A.R.P., Young, C.C., Stanley, C.M., and Scheibe, J.S. Studies on cognitive development in a non-majors investigative general biology laboratory. Paper presented to the Annual Meeting of the National Association for Research in Science Teaching, Washington, D.C., April, 1987.

Kern, E.L. and Carpenter, J.R. (1984). Enhancement of student values, interests and attitudes in earth science through a field-oriented approach. *Journal of Geological Education,* 32, (5), 675-683.

Kyle, W.C., Penick, J.E., and Shymansky, J.A. (1979). Assessing and analyzing the performance of students in college science laboratories. *Journal of Research in Science Teaching,* 16, 545-551.

Lawson, A.E. and Smitgen, D.A. (1982). Teaching formal reasoning in a college biology course for preservice teachers. *Journal of Research in Science Teaching,* 19, 233-248.

Leonard, W.H. (1984). An experimental test of an extended discretion laboratory approach for university general biology. Paper presented to the Annual Meeting of the National Association for Research in Science Teaching in New Orleans.

Leonard, W.H. (1986). An experimental study of a BSCS-style laboratory approach for university general biology. *Journal of Research in Science Teaching,* 23, 807-814.

Leonard, W., Journet, A., and Ecklund, R. (1988). Overcoming obstacles in teaching large-enrollment laboratory courses. *Journal of College Science Teaching,* 50 (1), 23-28.

Schellenberg, J.P. (1980). A comparative study of two laboratory approaches in a general education college physical science course. *Dissertation Abstracts International,* 03-A.

Spinkler, T.R. (1984). An experiment on the efficacy of intuition development in improving higher levels of learning and reasoning in physical science. *Dissertation Abstracts International,* 44 (1) 143-A.

Stewart, B.Y. (1988). The surprise element of a student-designed laboratory experiment. *Journal of College Science Teaching, XVII,* 269-270.

Tofte, W.L. 1982). The comparative effectiveness of learning center and traditional approaches for a college introductory geology laboratory course. *Dissertation Abstracts International,* 43, 358-A.

Wolkosz, M. and Yeany, R.H. (1984). Effects of lab instruction emphasizing process skills on achievement of college students having different cognitive development levels. Paper presented to the Annual Meeting of the National Association for Research in Science Teaching, New Orleans, April, 1984.

The National Association for Research in Science Teaching is an organization that seeks to improve science teaching through research. For further information, contact the NARST Executive Secretary:

Dr. Glenn Markle
401 Teacher College
University of Cincinnati
Cincinnati, Ohio 45221

For further information on this topic, contact Dr. Joseph D. Novak, Department of Science and Mathematics Education, Cornell University, 404 Roberts Hall, Ithaca, New York 14853-5901.

Journal of Science Teacher Education
The Journal of AETS

Information for Contributors

Manuscripts for publication and all correspondence regarding papers should be submitted to: David L. Haury, Department of Education, Lincoln Filene Center, Tufts University, Medford, Massachusetts 02155.

The Journal of Science Teacher Education (JSTE) was created to share PRACTICAL information and ideas concerning the preparation and inservicing of science teachers. **This journal is not intended to duplicate the efforts of *Science Education,* the *Journal of Research in Science Teaching* or any of the NSTA publications.** With these differences in scope and focus in mind, please submit manuscripts to the appropriate publication. Sections within JSTE include, but are not limited to: Feature Articles, Abstracts, Reviews, Reports, Innovations, and Letters to the Editor.

Feature Articles

This section accommodates manuscripts related to professional development. Feature articles will focus on methodology, instructional design, issues pertaining to student teacher supervision or teacher education, curriculum or program models, position statements, etc. Research articles, if submitted, must have a readily apparent, practical application to professional development. Manuscripts submitted for consideration in this section should range in length from four to twelve pages of double-spaced ten point type.

Abstracts

This section includes abstracts or brief reviews of research specifically applicable to professional development activities. The abstracts may be similar to those published in the occasional "PAR" section of the Phi Delta Kappan, or the Research Matters. . . to the science teacher distributed by NARST. The purpose of these contributions should be to consolidate relevant research as it applies to professional development activities. Manuscripts for this section are expected to range in length from three to eight pages of double-spaced ten point type.

Reviews

This section provides an opportunity for science educators to share critiques of programs, materials, or media used to promote professional growth among teachers. Just as the Abstracts Section interprets research findings in the context of professional development, this section evaluates curricular products and materials in that context. Reviews are to address the nature, quality, and usefulness of print materials, program plans, software, or other forms of media employed in teacher education activities. Manuscripts should range in length from two to four pages of double-spaced ten point type.

Reports

This section is a forum for relaying official pronouncements or reports of discussions pertaining to science teacher education. Participants in conferences or other professional meetings are invited to contribute their summaries of presentations, critiques, or discussions of findings, recommendations, or position statements pertinent to professional development activities. These reports serve as "mini-proceedings", tailored to the needs of science specialists involved in teacher education. Manuscripts should be limited to four pages of double-spaced ten point type.

Innovations

This section promotes an interchange of new ideas having to do with activities, techniques, or strategies that address specific concerns or needs in science teacher education. Though contributions to this section are expected to be research based and offer face validity, the emphasis is on practical innovations, novel approaches to old problems, and promising new ideas of potential merit. Authors are expected to focus on a specific need or concern in professional development and offer a practical pedagogical response that they have tried or observed, without undue interjection of familiar literature. Manuscripts are expected to range in length from two to four pages of double-spaced ten point type.

Letters to the Editor

This section includes letters submitted in response to published articles or position statements to heighten awareness of issues related to science teacher preparation or inservicing.

Guidelines

1. All manuscripts submitted for publication will be evaluated for their relationship and significance to practical aspects of science teacher pre-service and inservice education and on their technical quality for the type of scholarship they represent.
2. Manuscripts should be typed double-spaced (including quotations, footnotes, and references) on standard 8½ × 11 paper, with ample margins. Computer printouts of text are also acceptable. The author's name, position, and office address should appear on a separate cover page, and only on this page, to insure anonymity in the reviewing process. Include, also on separate pages, an abstract of no more than 150 words for feature articles, reviews, innovation articles, and reports.
3. Send three copies of each manuscript for editorial review. This review usually takes six weeks for processing. One of the three copies will be filed at the editorial office. Authors should submit one self-addressed, stamped envelope with each manuscript (does not apply to foreign contributors). After a manuscript has been reviewed for publications, authors will be informed of the manuscript status and if accepted, expected publication date and journal issue.
4. Communications to the Editor for section "Letters to the Editor" should contain expressions of opinion or information relating to articles previously published or to matters of interest to science educators. This section of the Journal will be the forum where the readers may express any reasonable view on any relevant matter.
5. All editorial correspondence, including manuscripts, should be addressed to David L. Haury, Department of Education, Lincoln Filene Center, Tufts University, Medford, Massachusetts 02155.
6. Under the provisions of the 1978 U.S. copyright law, the transfer of copyright from author to the publisher, heretofore implicit in the submission of a manuscript, must now be explicitly transferred to enable the publisher to assure maximum dissemination of the author's work. A copy of the transfer agreement will be included along with your galley proofs, if not already on file. Additional copies are available from the Editor or authors may photocopy the agreement from issue 1 of the journal. A copy of that agreement, executed and signed by the author, is required with each manuscript submission, after issue #1. (If the article is a "work made for hire" the agreement must be signed by the employer.)
7. Authors who are not members of The Association for the Eucation of Teachers in Science (AETS) will be assessed a publication fee of $50.00 per article. A nonmember author may avoid this charge by joining AETS prior to manuscript publication. Membership dues for AETS are payable at the beginning of each calendar year. Applications for membership and payment of dues should be mailed to Dr. William Baird, AETS Executive Secretary, 5040 Haley Center, Auburn University, Auburn AL 36849-5212.

Elections Committee Report

The Elections Committee is pleased to present the following candidates for election in 1990. Each of the individuals identified has been contacted and has agreed to have his/her name placed in nomination and to serve if elected.

PRESIDENT-ELECT

Anton E. Lawson, Arizona State University
Russell H. Yeany, University of Georgia

BOARD MEMBERS-AT-LARGE

Pamela Fraser-Abder, New York University
Dorothy Gabel, Indiana University
Thomas R. Koballa, Jr., University of Texas at Austin
Peter A. Rubba, Pennsylvania State University

PRESIDENT ELECT NOMINATIONS

The two candidates that have been nominated for President Elect are Anton E. Lawson and Russell H. Yeany.

ANTON E. LAWSON

Anton E. Lawson is currently Professor of Zoology at Arizona State University and Director of the Program for the Enhancement of Biology Teaching in Arizona. During the past 20 years, Lawson has been a regular contributor to the *Journal of Research in Science Teaching.* His contributions have three times, in 1976, 1985 and 1987, been awarded the prestigious JRST Award for the most significant contribution to the journal for that year. In 1986 Lawson was the first recipient of NARST's highest award, its Distinguished Contributions Award, for his "outstanding and substantial contributions to the field of science education through research."

Lawson is a 1967 BS graduate in zoology of the University of Arizona, a 1969 MS graduate in marine ecology of the University of Oregon, and a 1973 Ph.D. graduate in science education of the University of Oklahoma. Lawson has held research positions at Purdue University and the University of California-Berkeley prior to assuming his faculty position at Arizona State. He has published extensively in the fields of psychology and educational psychology as well as in science education with over 140 publications to his credit. He has written eight books including *Using the Learning Cycle to Teach Science Concepts and Thinking Skills, The Psychology of Teaching for Thinking and Creativity, Biology: A Critical Thinking Approach,* and *Basic Biological Theories.*

Currently associate editor of the *Journal of Research in Science Teaching* and member of NARST's Distinguished Contributions Award Committee, Lawson has served as associate editor of *School Science and Mathematics,* as a member of the NARST Executive Board, the *JRST* Editorial Board, the Association for the Education of Teachers in Science Editorial Board, and the Publications Panel of the National Association of Biology Teachers. Lawson has also presented papers at numerous national and international conferences including the recent United States-Japan Seminar on Science Education in Japan, the International Adolescent Development Seminar in England, and the Symposium on a Unified Conception of Thinking in British Columbia. In 1981, the Association for the Education of Teachers in Science recognized Lawson as its Outstanding Science Educator of the Year for his many contributions to the field of science teacher education.

RUSSELL H. YEANY

Dr. Yeany holds the Ph.D. from the University of Colorado and a Master's degree and a Bachelor's degree in biology from Clarion University. Currently he is on leave as Head of the Science Education Department at the University of Georgia while serving as interim Director of the School of Teacher Education at the University of Georgia, where he holds the rank of Professor of Science Education.

During his tenure at Georgia, he has developed and taught courses in the Secondary Science Teacher Program and served as Coordinator of the Science Education Research and Evaluation Laboratory. He currently coordinates all of Georgia's funding related to science in institutions of higher education under the U.S. Office of Education program.

Yeany's research interests have lead to numerous publications in three areas: influences on teachers' science teaching strategies; the effects of diagnosis and prescription on science learning; and the assessment of and influences on science process skill learning. He is a regular presenter at national, regional, and state meetings reporting research related to the teaching and learning of science and the preparation of science teachers. In addition to his research skills and interests, Yeany has had considerable involvement in the evaluation of large-scale science education projects. He has served as principal evaluator of projects funded by the National Science Foundation, the National Science Teachers Association, the U.S. Department of Education, and many state agencies.

Yeany has been a member of NARST since 1972. During that time, he has served on numerous committees and the *JRST* Editorial Board. He was elected to the Executive Board in 1981 and served as Editor of the *Journal of Research in Science Teaching* from 1984 through 1989.

The Association for the Education of Teachers of Science recognized Yeany as the Outstanding Science Educator of the Year in 1977 and presented him with the AETS Research paper Award in 1984. He received the NARST Research Application Award several times and was presented with the NARST Outstanding Paper Award in 1986.

BOARD MEMBERS AT LARGE

The following nominations have been made for members of the Board. The persons nominated are Pamela Fraser-Abder, Dorothy Gabel, Thomas R. Koballa, and Peter A. Rubba. Two positions will be available starting in 1990. Board members serve for a term of three years.

PAMELA FRASER-ABDER

Pamela Fraser-Abder earned her undergraduate degree in Natural Science from the University of the West Indies, St. Augustine Campus; her M. Ed. in Science Education with a minor in Educational Psychology in 1976 and her Ph.D. in Science Education in 1982, both from the Pennsylvania State University. She also holds a Post-Doctoral Certificate in Human Resources and Education Planning.

Abder recently joined the Faculty of Science, Mathematics and Statistics Department of the School of Education, Nursing, Health and Arts Professions of New York University, after spending 12 years as a lecturer in Science Education at the Faculty of Education, U.W.I. St. Augustine, Trinidad. Her main goal at N.Y.U. is to provide academic and professional leadership in the area of science and technology in an urban environment through teaching, research and development, and community service with particular emphasis on women and minorities.

Her research interests include urban science and techology teaching and learning at the elementary, secondary, and tertiary levels; and problems related to science curriculum development, implementation, and evaluation, teaching, and learning in multicultural communities. Her publications include 17 books (workbooks, teacher's guides, and textbooks) on elementary science now used in the Caribbean and Africa, a UNESCO Sourcebook of Science Education Research in the Caribbean, and research articles in national and international journals.

Abder has presented papers yearly at the NARST annual meeting, and served as chair and/or discussant for NARST sessions. She has served on the ad hoc Committee on International Issues since

its inception, chairing this Committee for the last two years. She is also one of the founder members of the Consortium of Science Education Research in Latin America, the United States, and the Caribbean.

DOROTHY GABEL

Dorothy Gabel is Professor and Coordinator of Science Education at Indiana University in Bloomington. She recently returned to Indiana University after spending 20 months at the Program Director for the Teacher Preparation Program at the National Science Foundation.

Gabel received her baccalaureate degree in chemistry from Rosary College and her master's degree and doctorate from Purdue University. She is past president of the Hoosier Science Teachers Association, was Research Division Director of the National Science teachers Association, and is currently president of the School Science and Mathematics Association.

She has been involved in classroom research since 1972 and has been the recipient of NARST's Award for Outstanding Research emphasizing Classroom Applications four times. She has also received the JRST Award twice.

In addition to many research reports, Gabel's publications include an introductory science textbook for elementary education majors, a high school chemistry problem solving text, and a high school chemistry textbook. Gabel was the author of the *Summary of Research in Science Education for 1978,* and is an author and editor of NSTA's publication on *What Research Says to the Science Teacher About Problem Solving.*

Gabel's activities in NARST include serving on the Financial Advisory Committee, the editorial board of *JRST,* the Program Committee, and the Research Committee, as well as presenting research reports at most annual meetings and publishing in the *Journal of Research in Science Teaching.*

THOMAS R. KOBALLA, JR.

Thomas R. Koballa, Jr. is an Associate Professor at the Science Education Center, The University of Texas at Austin. He holds a B.S. in biology and M.A. in science education from East Carolina University, and a Ph.D. in Curriculum and Instruction/Science Education from The Pennsylvania State University.

Koballa joined the faculty of the Science Education Center, UT-Austin, after one year on the faculty at Pikeville College, Kentucky. At UT-Austin he teaches undergraduate and graduate courses in science education and directs graduate student research. He is the recipient of research and teacher training grants from the National Science Foundation, the University Research Institute of the University of Texas, and the National Science Teachers Association. Koballa has authored and/or co-authored more than 30 articles and book reviews in the *Journal of Research in Science Teaching, Science Education,* and *School Science and Mathematics,* and has served as editor of the *Attitue Research in Science Education Newsletter.*

Koballa has been an active NARST member since 1981. His service to the organization includes membership on the *JRST* Editorial Review Board (1984-1988), the JRST Awards Committee (1983-1986), the NARST Program Committee (1985-1987), and the NARST Research Committee (1986-1988). Koballa's research interests in persuasive communication design and attitude change are reflected in his recent contribution to the NARST *Research Matters to the Science Teacher* series entitled "Changing and Measuring Attitudes in the Science Classroom."

PETER A. RUBBA

Peter A. Rubba is an Associate Professor of Science education and of Science, Technology and Society at The Pennsylvania State University. He holds a B.S. in Chemistry/Math from Ashland College (1969), and a M.A. in History and Philosophy of Science (1974) and an Ed.D. in Science Education (1977) from Indiana University-Bloomington. He is a former chemistry, general science, and physics teacher. Rubba joined the faculty at Penn State in 1984 after eight years on the faculty of science education at Southern Illinois University at Carbondale.

At Penn State, Rubba teaches undergraduate and graduate level science education courses. He has served, since 1988, as Professor in Charge of Science Education. He formerly served as the first director of the Center for Education in Science, Technology and Society (1985-1988). His research focuses on the integration of STS and science instruction at the middle/junior high and high school levels, and teacher development in STS education.

Rubba has published in the *American Biology Teacher, Bulletin of Science, Technology and Society, Journal of Chemical Education, Journal of Research in Science Teaching, Science Education, School Science and Mathematics, The Science Teacher,* and other professional journals, and has written for NSTA and AETS publications. He has been a frequent presenter at AETS, NARST, NSTA, TLC, and state level professional meetings.

Rubba's interest in science teacher education is highlighted in teacher education grants he has received, including among them seven NSF teacher enhancement projects, six state level teacher training grants, and awards from ACTION, as well as grants from the GTE Education Foundation to support Minority Doctoral Fellowships in Science and Mathematics Education. He has, in addition, received research grants from the U.S. Department of Education and private foundations.

Rubba's recent service to science education professional organizations inlcudes: membership on the planning committee for the December 1989 NSTA Regional Convention in Atlantic City, the AETS Board of Directors, the *SSM* review panel, and chair of the Program Committee for the AETS portion of the 1987 NSTA Area Convention in Pittsburgh. His service to NARST includes membership on the NARST Awards Committee (1979-1981, 1984-1987), the *JRST* Editorial Review Board (1985-1989), and the NARST Program Committee (1987-present).

Keynote addresses will be presented by Iris Weiss who will discuss the proposed evaluation of the NSTA Scope and Sequence project, Ernst von Glasenfeld who will speak on constructivists perspectives on science education, and Jo Ellen Roseman who will describe phase 2 of the AAAS Project 2061.

Registration materials for the annual meeting will be mailed to all members on December 10, 1989. All who plan to attend the annual meeting are urged to preregister to take advantage of the lower registration fee (and to improve the efficiency of the registration desk at the annual meeting!).

Call for Topics and Authors Research Matters

The Research Matters section of NARST News helps to translate research into practice. Reprints of these papers are distributed at NSTA conventions and are used as readings in many science education courses. If you have suggestions for topics or would like to be an author, please contact Francis Lawrentz, Department of Curriculum and Instruction, University of Minnesota, Minneapolis, MN 55455.

NARST Membership Application/Information

I am interested in becoming a member of the National Association for Research in Science Teaching.

_____ Please send me information about the Association and a membership application form.

_____ Please enroll me as a member of NARST for the 1990 calendar year.

If enrolling as a member, please check the appropriate category and enclose a check to NARST **payable in U.S. funds.**

_____ Regular membership @ $54.00 per year.

_____ Student membership @ $30.00 per year.

I attest that _____
is eligible for student membership in the National Association for Research in Science Teaching.

_____
NARST Sponsoring Member

NAME: _____

ADDRESS: _____

_____
city state zip

_____
country

Please send membership application/information requests to Dr. Glenn Markle, Executive Secretary, NARST, University of Cincinnati, Cincinnati, OH 45221-0002.

University of Cincinnati
Cincinnati, OH 45221-0002

Non-Profit Org.
U.S. Postage
PAID
Cincinnati, Ohio
Permit No. 7281

Patricia E. Blosser

2606 Brandon Road
Columbus, OH 43221