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# JNCHC

## JOURNAL OF THE NATIONAL COLLEGIATE HONORS COUNCIL

Fall/Winter  
2000

Vol. I, No. 2

### SCIENCE IN HONORS

Essays by...

Thomas P. Arnold et al.

Paul Homan

Herbert Levitan

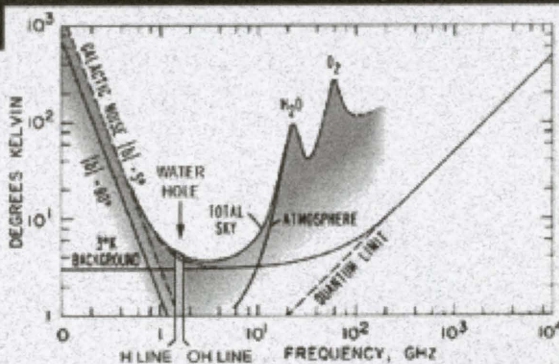
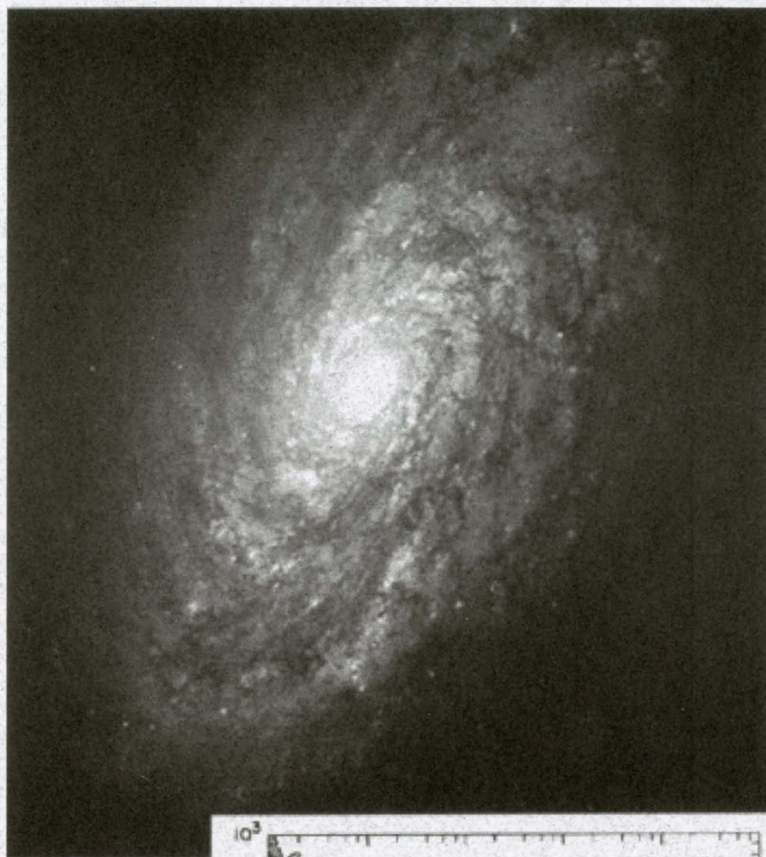
Lillian F. Mayberry

Dail Mullins

Ursula L. Shepherd

Susan Tomlinson

Len Zane



A Publication of the National Collegiate Honors Council

### **ON THE COVER**

In the background is a Hubble telescope image of the spiral galaxy ngc4414, located some sixty million light years away. In both size and structure, ngc4414 resembles our own "island universe," the Milky Way Galaxy, which contains about two hundred billion stars and is home to the only intelligent life forms known in the universe.

In the foreground is a graph which shows the "noise" (Degrees Kelvin) coming from the sky as a function of frequency (GHz) as received by the one-thousand foot diameter National Radio Astronomy Observatory telescope at Arecibo, Puerto Rico. As part of the Search for Extraterrestrial Intelligence (SETI) project sponsored by the Planetary Society and the University of California at Berkeley, the National Collegiate Honors Council sponsors a SETI@Home group site which allows students and faculty to download screensaver software which helps analyze data received from the Arecibo facility.

For more information, go to <http://setiathome.ssl.berkeley.edu/>, or email Dail W. Mullins, Jr. at [drdoom@uab.edu](mailto:drdoom@uab.edu).

Photomontage by Dr. Michael Neilson.

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# J N C H C

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**JOURNAL OF THE  
NATIONAL COLLEGIATE HONORS COUNCIL**

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A PUBLICATION OF THE NATIONAL COLLEGIATE HONORS COUNCIL

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## SCIENCE IN HONORS

### JOURNAL EDITORS

**ADA LONG**

**DAIL MULLINS**

**RUSTY RUSHTON**

**UNIVERSITY OF ALABAMA AT BIRMINGHAM**

**The National Collegiate Honors Council** is an association of faculty, students, and others interested in honors education. *Joan Digby*, **President**, LIU CW Post; *G. Hew Joiner*, **President Elect**, Georgia Southern University; *Rosalie Otero*, **Vice President**, University of New Mexico; *Earl Brown, Jr.*, **Exec Sec/Treas**, Radford University; *Bob Spurrier, Jr.*, **Past President**, Oklahoma State University; **Executive Committee** *Brian Adler*, Valdosta State University; *Bernice Braid*, LIU Brooklyn; *Connie Hood*, Tennessee Tech University; *Joanna Joyner*, University of Utah; *Herald Kane*, San Diego City College; *John Madden*, Cerritos College; *Virginia McCombs*, Oklahoma City University; *Ann Raia*, College of New Rochelle; *Lee Robinson*, College of Charleston; *Kathy Rogers*, University of Alabama (Tuscaloosa); *Jon Schlenker*, University of Maine (Augusta); *Blake Standish*, University of New Mexico; *Shirley Thomas*, John Brown University; *Casey Tippens*, Oklahoma State University; *Steve Wainscott*, Clemson University; *Marcus Ward*, Alcorn State University; *Norm Weiner*, SUNY Oswego; *Jack White*, Mississippi State University.

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## EDITORIAL POLICY

*Journal of the National Collegiate Honors Council* is a refereed periodical publishing scholarly articles on honors education. The journal uses a double-blind peer review process. Articles may include analyses of trends in teaching methodology, articles on interdisciplinary efforts, discussions of problems common to honors programs, items on the national higher education agenda, and presentations of emergent issues relevant to honors education. Submissions may be forwarded in hard copy, on disk, or as an e-mail attachment. Submissions and inquiries should be directed to: Ada Long / JNCHC / UAB Honors Program / HOH / 1530 3rd Avenue South/Birmingham, AL 35294-4450 / Phone: (205) 934-3228 / Fax: (205) 975-5493 / E-mail: adalong@uab.edu.

## DEADLINES

March 1 (for spring/summer issue) September 1 (for fall/winter issue).

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# CALL FOR PAPERS

JNCHC is now accepting articles for its first general interest issue. Articles may be on any topic consistent with our editorial policy (see page 2 of this issue). The issue will also include articles that were accepted in 1996 for the *Forum for Honors* but were never published.

**DEADLINE FOR SUBMISSIONS IS MARCH 1, 2001.**

The subsequent issue of *JNCHC* (deadline September 1, 2001) will be dedicated to the topic of the Creative Arts in Honors.

## SUBMISSION GUIDELINES

1. We will accept material by e-mail attachment, disk, or hard copy. We will not accept material by fax.
2. The documentation style can be whatever is appropriate to the author's primary discipline or approach (MLA, APA, etc.).
3. There are no minimum or maximum length requirements; the length should be dictated by the topic and its most effective presentation.
4. Accepted essays will be edited for grammatical and typographical errors and for obvious infelicities of style or presentation. Variations in matters such as "honors" or "Honors," "1970s" or "1970's," and the inclusion or exclusion of a comma before "and" in a list will be left to the author's discretion.
5. Submissions and inquiries should be directed to:

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# DEDICATION



Len Zane at East Monument Peak in Red Rock Canyon.  
Photo by Brandon Rufkahr. © 2000 by Branch Whitney.

This issue of JNCHC is dedicated—with affection, respect, and appreciation—to Dr. Len Zane, who this year “stepped away” from the position of Dean of the Honors College at the University of Nevada, Las Vegas, and has returned to teaching physics full-time. Len has been a significant influence on the National Collegiate Honors council during the past fifteen years, hosting the National Conference in 1988 and serving in numerous elected and appointed positions, including President in 1996. Len has been a dogged advocate of excellence in mathematics and science in honors education. Read his essay on pages 13-20 of this issue.





# *EDITOR'S NOTE*

**DAIL MULLINS**

**UNIVERSITY OF ALABAMA AT BIRMINGHAM**

Welcome to the second issue of the Journal of the National Collegiate Honors Council, which is devoted to the topic of “Science in Honors” and is dedicated to Len Zane, recently retired as dean of the Honors College at the University of Nevada Las Vegas and a seminal figure in our organization’s efforts to raise the level of consciousness about science and mathematics education in our Honors programs. As I indicate in my own essay (“A Biochemist in Honors”), science and mathematics are the only curricular areas which enjoy special committee status within the NCHC hierarchy, thus suggesting that they are perhaps problematic topics for many administrators and faculty in Honors education. Thus, it is hoped that the contents of this special issue will be helpful and instructive for members, especially those who may struggle with these areas of learning and pedagogy in their own programs.

As can be seen from the Table of Contents, we have divided this issue into three main sections: “Scientists in Honors,” “Teaching Science in Honors,” and “Funding for Science in Honors,” as well as an “Epilogue” which is introduced by Ada Long. The first section contains essays by both Len Zane and myself, each recounting the experiences of a formally trained scientist who chose to enter the world of undergraduate Honors education. While summarizing very different experiences in this world, it is perhaps interesting to point out that both Len and I stress the importance of Honors courses for non-science majors which focus on the “big picture” in science and mathematics—calculus, evolution, relativity, the origin sciences, etc.

Introducing the second section, Susan Tomlinson, in her wonderfully cogent and entertaining essay “The Curiosity Shop,” underscores the importance of avoiding the many sterile trivialities and seemingly endless obscure facts of science when dealing with non-science majors, especially in the laboratory setting where, she believes, students should instead learn their most valuable lessons

about the nature and role of science in our lives today. Making reference to her own field of geology, Susan argues that laboratory sessions should be turned into places of “wonder and amazement through tinkering and puttering” rather than the sterile “cookbook” labs of traditional introductory courses, and she offers more than a few helpful suggestions for how this might be achieved.

In her article, “Creative Approaches to Teaching Science in an Honors Setting,” Ursula Shepherd first surveys the three types of Honors students (with respect to science) encountered in the program at the University of New Mexico (and, I daresay, most programs): (1) traditional science majors; (2) “well-rounded” students who like science but for one reason or another have chosen to go into another area of academic study; and (3) those students who are not at all inclined toward science, who may be anxious about their academic abilities in this area, but who need such a course to fulfill their requirements for graduation. As she elaborates, such diversity of student interest in science “places great demands on curriculum development but also provides for some especially rich rewards.” Faculty and administrators with similar problems and issues will be especially interested in her suggestions for enhancing the exposure of “science-shy” students to science through a program of well-crafted interdisciplinary courses.

In “Funding for Science in Honors,” Herb Levitan, Program Director of the Division of Undergraduate Education at the National Science Foundation and a member of the NCHC Science and Mathematics Committee, presents an overview of his agency’s efforts and interest in supporting innovative undergraduate programs in science education, including Honors courses, outlining three main “tracks” of funding opportunities. Herb then discusses both the advantages and challenges of such opportunities for Honors Programs.

Rounding out the third section of this issue, Tom Arnold, Frances Frierson and Neil Sebacher of Valencia Community College in Orlando, Florida, and Lillian Mayberry and Jack Bristol of the University of Texas at El Paso (UTEP) describe programs at their respective institutions which have taken advantage of the funding opportunities discussed by Herb Levitan. In the first article, Tom

Arnold and his colleagues describe a biology research program for their Honors students which involves a cooperative effort with three “partnering” four-year research institutions: the University of Florida, the University of South Florida, and the University of Central Florida. Students at Valencia complete the Honors Biology curriculum during their first year, take the research methods training course their second year, and then spend the summer at one of the partnering universities involved in a research internship. With planning, these students can then enroll full-time in the four-year partnering institution.

Continuing the theme of “partnering,” albeit between academic units within the same institution, Lillian Mayberry, a biologist and director of the Honors program at UTEP, and Jack Bristol, former Dean of the Colleges of Science, describe an NSF-funded program which provides Honors opportunities for students seeking teacher certification in the sciences at their institution. Included in their program are a variety of field-based courses which students can use not only for Honors credit but also as guides for the development of elementary and secondary education teaching modules preparatory to their transition into the classroom.

The editors and staff of JNCHC hope you enjoy and learn from this latest issue. It is our hope that you read the articles—and read them again—with the idea in mind that you will strive to find ways of improving the science (and mathematics) education of your students no matter what their respective majors, interests, and life goals may be. Speaking for myself, I can only underscore the comments of Rosalie Otero, the Vice President of NCHC, as quoted by Ursula Shepherd in her article:

*It is difficult to envision how one will be able to live effectively in the twenty-first century without having achieved scientific literacy. While every educated person will certainly not be a scientist, every educated person must possess sufficient knowledge of the scientific method and of fundamental concepts of the natural sciences to make informed decisions.*

Amen!



# SCIENTISTS IN HONORS



# A Physicist in Honors

LEN ZANE

UNIVERSITY OF NEVADA, LAS VEGAS

## CONTEXT

I have been asked to provide a retrospective connecting my recent decision to resign as dean of the Honors College at the University of Nevada, Las Vegas (UNLV) with my involvement in NCHC as a proponent for the inclusion of more and better mathematics and science in honors education. My career in honors began in 1985 when I was appointed the first director of UNLV's Honors Program and formally ended this past summer with my return to the Physics Department at UNLV. During the period between the Pittsburgh conference in 1995 and the San Francisco conference in 1996, I had the pleasure and honor of serving as NCHC President. In between those endpoints, 1985 and 2000, I have presented several workshops on the topic of science and mathematics education at honors conferences and had various musings about pedagogy published in honors journals (see References). What follows is a summary of successes and failures intermingled with suggestions on science and mathematics education in honors with an overlay of more general observations gleaned from fifteen years in honors.

## BACKGROUND

The honors curriculum at UNLV has strong requirements in both mathematics and science because of the resonance of two influences: one internal to campus and the other external. The obvious internal influence was my background in science and mathematics and my role as the chair of the committee that designed the Honors Program at UNLV. The external influence is less obvious.

In order to build support for honors on campus, I contacted Lothar Tresp at the University of Georgia, who was then the Executive Secretary and Treasurer of NCHC, and requested information about Honors Programs that could serve as models for our incipient



## A PHYSICIST IN HONORS

program. One of the schools Lothar suggested was the University of Utah. It had the advantage of being recognized as an outstanding example of honors and was geographically close to UNLV, at least by the wide-open spaces standards of the west.

When I called Dick Cummings, the Director at the University of Utah, he was very helpful and sent a wealth of material that I shared with the committee. Unbeknownst to me or the committee, we happened to have a sample honors curriculum from a school that required all students in honors to do at least one quarter of calculus. Although the majority of faculty on the committee came from disciplines that did not require calculus, the combination of my bias and the curriculum at the University of Utah carried the day. One semester of calculus was included in the committee's recommended honors curriculum for all students earning an honors degree at UNLV without a single dissenting voice.

UNLV has a general education science requirement of two science courses including at least one with a laboratory. It was straightforward to require students in honors to complete two science courses with laboratories. Both the calculus and science requirements will be discussed in more detail below. But before the practical and philosophical bases for these courses are presented, one more accidental but important decision about the honors curriculum at UNLV has to be pointed out.

As implied above, UNLV has a general education requirement. Coincidentally, the general education curriculum was going to begin at the same time as the honors curriculum was implemented, the fall of 1985. Consequently the honors curriculum was designed to be a more robust version of the general education requirements. This honors curriculum was the same for all students regardless of major on campus. The uniformity of requirements for all students was, at least overtly, predicated on what turned out to be the false assumption that the published general education requirements were going to apply uniformly from department to department and college to college. As it turned out, various programs on campus had special dispensation from this or that requirement making the general education requirements substantially less robust than they first appeared to be. These dispensations did not apply to the honors version of the requirements, at least partially due to the fact that when the honors

## LEN ZANE

version was approved there was not a widespread understanding of the dispensations that had been granted to various programs, and this has helped to distinguish and clarify the honors core from the regular core.

The honors curriculum at UNLV ended up requiring substantially more honors courses in science and mathematics for non-technical majors than most other institutions offering honors. This was not an explicit decision but came about quite naturally as explained above. It did not take long for me to realize that it is much easier to require courses of all students than it is to muster the faculty and institutional support to offer those courses in a consistent and predictable manner!

### VISION

The plan was to design new courses in mathematics and science for honors students majoring in non-technical areas. These courses would be taught under the HON imprimatur. I had colleagues in mathematics and science do the actual planning (I served on the science committee). The design parameters for the mathematics course were a two-semester sequence for students coming out of high school with three or more years of mathematics. The second semester of the sequence would be an introduction to calculus.

The science course was designed to be four-credits each semester and interdisciplinary. The common theme was evolution. How did the universe come into existence? Where did organic molecules come from? How did the earth become habitable? How did life arise? The first semester ended up being a combination of physics/astronomy and chemistry, and the second semester combined biology and geology. There was a laboratory each semester. The original concept had the science courses being sequential with the introductory calculus course as a prerequisite.

### PHILOSOPHY

This is really a parenthetical insert. At the time these courses were being put into place there was no philosophical soul searching about the role of these courses in the honors curriculum. Over time, the rationale for the courses has been challenged by students and some faculty. Hence some veneer of plausibility had to be developed to

## A PHYSICIST IN HONORS

defend what, to some degree, had become one of the defining characteristics of honors at UNLV. Please keep in mind that, for better or worse, honors began at UNLV with strong components in mathematics and science for non-technical students. It is much easier to defend the status quo than to argue for change.

Calculus was chosen as the central theme for the mathematics sequence because it was viewed as a pivotal development in the growth of science and technology and as one of the great achievements of human thought. The idea of the limit and the role of the derivative and integral played a role in mathematics similar to that of evolution in biology. Hence it was felt that all educated people ought to be familiar with the intuitive simplicity of calculus. Also, when the curriculum was being developed, there was a presumption that the honors science sequence would require the calculus course as a prerequisite.

The science sequence was somewhat easier to defend. First, on the surface it is not qualitatively different from the regular science requirement. Second, there is more recognition that educated citizens living in a world with accelerating technology ought to have some minimal understanding of the current scientific world view. One of the points of emphasis in the science sequence has been the role of experiment and observation in science, presenting science as a method for seeking truth and not as a compilation of Truths.

More generally, one of the themes in honors became communication. Understanding the language and mode of speaking in mathematics and science was seen to have value in and of itself. In fact, one of the explicit themes of the honors science course—which, like many things, got lost in the reality of staffing the sequence—was to help students appreciate the way scientists from different disciplines view the “scientific method” in dissimilar, discipline-centric ways.

Mathematics, and mathematicians, have a standard of proof that is higher and more rigorous than that found in any other discipline. Although students rail against having to learn proofs in mathematics courses, learning how to prove something to the satisfaction of a mathematician is extremely valuable, even as it is often frustrating! The following comes from a list of suggestions distributed to faculty teaching lower division honors courses:

## LEN ZANE

*The content of lower-division honors courses runs the gamut from rhetoric to calculus, a spread that makes generalizations about process difficult. With that caveat, I will now generalize. The emphasis in an honors course should be on communication—both written and oral. This may seem bizarre for a calculus course (or a physics course), but aren't examinations a way for students to communicate what they have learned and understood about some topic, for example, a short story, essay, chain rule differentiation, or Newton's three laws. Different disciplines have different modes of communication built on different paradigms.*

### IMPLEMENTATION

The mathematics sequence has been offered every year since 1985. The original titles for the courses were *Honors Precalculus* and *Honors Introduction to Calculus*. After several years, the titles changed to *Honors Mathematics I and II*, but the purpose of the sequence remained unchanged. The name change came about primarily due to preconceptions held by mathematicians about precalculus and, to a lesser degree, calculus. The honors precalculus course ended up being a revamped version of the regular precalculus course. This missed the point of the sequence. The name change came about as a strategy to encourage the people teaching the honors mathematics sequence to be more creative with respect to the material covered. The Mathematics Department has been very supportive with respect to staffing this course but less supportive with respect to buying into the concept and accepting ownership of the sequence.

The science sequence, with two faculty teaching each semester, has been offered every year since 1986, the first year that the honors program at UNLV had sophomores. This course uses a disproportionate amount of faculty time because of team teaching and the required laboratory. Over the years, the second semester, a combination of biology and geology has been taught more consistently as an integrated course. There has been a tendency for the first semester to be taught serially, first by a physicist and then by a chemist. Although

## A PHYSICIST IN HONORS

staffing this course has been a problem in the past, there now appears to be solid support for the science course at the college level. The material in the science sequence never actually required calculus; hence that prerequisite requirement has quietly disappeared. The science courses have also evolved away from the original idea of two courses that formed a coherent sequence. Now they are offered as two distinct courses that can be taken in any order.

### EVALUATION

The major success UNLV has had with respect to these courses is that both the mathematics and science courses have been taught consistently, that is on a regular basis. Also the requirements have survived fifteen years and, with luck, will continue to help define the meaning of an honors education at UNLV. Unfortunately, it has been more difficult to get students to buy into these requirements. Every semester, there are some number of students who wonder why \_\_\_\_\_ (fill in the blank with the major of your choice) need to take calculus and/or science. Of course the majority of students take the courses and successfully complete them without giving much thought to the efficacy of the requirements. A small number of students actually recognize the value of the courses and embrace the requirements. But they are clearly a minority. This has made the sequence less fun to teach than it ought to be for faculty. Consequently, there is continual and persistent pressure from students to relax these faculty-intensive requirements and little enthusiasm from faculty to defend them. I am curious to see if these courses and requirements survive the change in leadership of the Honors College.

### SUMMARY

The Honors College at UNLV now has over 600 students participating. Eighty percent of the graduates come from four colleges: Liberal Arts, Business, Science, and Engineering. The remaining graduates come from the colleges of Hotel, Education, Urban Affairs, Health Sciences, and Fine Arts. There are undoubtedly students who decide against participating in honors because of the science and mathematics requirements, and others who participate but do not complete those requirements. On the other

## LEN ZANE

hand, the sheer number of participants and their distribution among different colleges suggests that the requirements have not been a major deterrent to the growth of honors at UNLV.

### A WORD ON STEPPING AWAY FROM HONORS

Although I never doubted that I would return to the Physics Department before the end of my career at UNLV, I could never quite bring a plausible transition scenario into focus. I had difficulty picturing being on campus watching someone else run honors. I had always imagined some singular event initiating the transition back to physics. My epiphany this summer was realizing that there never would be such a singular event! That the only way to allow honors to outgrow my vision was to step away, not step aside. Stepping aside implies less distance between the starting and ending points. Although I am happy to be consulted as a senior statesman of honors whenever the powers that are deem that reasonable, I had and still have no interest in casting a shadow, albeit a small one, on the post-Zane Honors College at UNLV. In fact I have been having so much fun twiddling equations that my career as a university administrator seems like a faint memory of a previous life.

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# A Biochemist in Honors

**DAIL W. MULLINS, JR.**

**UNIVERSITY OF ALABAMA AT BIRMINGHAM**

*What a long, strange trip it's been.*

– Jerry Garcia

In 1984—quite unlike the depressed protagonist of George Orwell's novel—I found myself happily ensconced as a senior research associate in the department of biochemistry and molecular genetics at the University of Alabama at Birmingham (UAB). I had received my Ph.D. in biochemistry from the same institution nine years earlier; had left for two years to do a post-doctoral fellowship in the field of cancer biology at Georgetown University and the National Institutes of Health; but had returned to UAB at the invitation of my doctoral mentor, Jim Lacey, to work on a project grant he had been awarded from the National Aeronautics and Space Administration in the area of origin of life science.

Jim had received his own doctorate in biochemistry from UAB not too many years before I began work with him as a graduate student in 1971. His own postdoctoral studies had been done with Sidney Fox, one of the pioneers of origin of life research and the discoverer of thermal proteinoid microspheres—tiny cell-like structures produced under prebiotic conditions, though devoid of any of the customary biochemical “trappings” of life. Jim's interests then—and later my own—had to do with trying to understand how a genetic apparatus could have become incorporated into such structures, thus transforming them from mere proteinaceous “bubbles” into metabolizing, reproducing, and evolving entities—in other words, life.

It is perhaps difficult to convey to most people not professionally involved in science—especially one of what Victor Weisskopf termed the “cosmic,” or origin, sciences—what an extraordinary thing it is to be able to wake up every morning and spend much of the day thinking about one of the “greatest mysteries”: what is the nature of life, how did it begin on earth, and what might be its ultimate fate?



## A BIOCHEMIST IN HONORS

Poets and philosophers, mathematicians, literary theorists and psychologists have their mysteries, to be sure—but I am convinced that only those who strive to take a measure of the larger cosmos and its origins deal routinely with truly palpable mysteries, or what the philosopher David Hume termed “matters of unspeakable importance.” That belief is, I hope, the only arrogance I shall have to bring to the story that follows.

While in my research position at what is termed the “medical end” of the UAB campus, I did have fortunate occasion to lecture three or four times a year to first-year medical and dental students, and I had accepted a position as a part-time instructor in biochemistry in the university’s graduate nurse anesthesia program. While I enjoyed these teaching “diversions” very much, my principal duties and greatest professional satisfactions were confined to the laboratory setting: planning, carrying out, and analyzing a variety of “bench top” chemical reactions designed to uncover and elucidate any hidden physico-chemical patterns in the nature and functioning of the contemporary genetic code. In short, I had been hired—like many in science—not as a teacher but as a researcher and generator of external funding.

It was, though, my enjoyment of occasional instructional interludes which caused me to take a second look at a campus-wide memorandum that crossed my desk in the winter of 1984 from Ada Long, a faculty member in the department of English and the director of UAB’s newly established Honors Program for undergraduates. In her memo, Ada described the nature and philosophy of the nascent program, gave a brief synopsis of its first interdisciplinary course offering the previous fall term, and solicited both suggestions for the upcoming course theme and volunteers to help teach it. Although I was familiar with the concept of team-taught “interdisciplinary” courses through my participation in the first-year medical students’ biochemistry curriculum—which employed both physicians and research scientists from such fields as biochemistry, internal medicine, physiology, pathology, molecular biology, endocrinology, and neuroscience—the overall and day-to-day conduct of the course never varied from a single-minded focus on the biochemical intricacies of health and disease, and certainly the course lecturers

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departed not at all from the realm of science itself. In her memorandum, however, Ada seemed to be describing what appeared to me to be a true multi-disciplinary (and so quite novel) course offering—one with instructors from such diverse areas as English literature, mathematics, history, and economics, all invited to bring their varied expertise to bear on a single theme.

Intrigued, I gave the matter some thought and then responded with a memo of my own, outlining in the roughest of fashion an interdisciplinary course which focused on the contemporary scientific understanding of origins—the universe, the Earth and solar system, life, and the human species. Since all human cultures without exception—including scientific cultures—have origin stories, the topic seemed to me to lend itself handily to the kind of true interdisciplinary enterprise I thought Ada might have in mind. I offered to help plan and—if I could find the time—help teach such a course. In retrospect, I have to admit that my motives were partly selfish in that I was seeking a forum to share with undergraduate students my love and excitement for what mattered most to me in my intellectual life. It did not dawn on me until much later that such a motivation was exactly what Ada was looking for!

I next met with Ada in her office at the “liberal arts” end of the UAB campus to discuss my proposal. She was quite enthusiastic about its basic theme; accepted it—with some tinkering—as the Honors Program’s course offering the following fall term; invited me to participate in its planning and instruction; and then set about the task of assembling a cadre of additional faculty to help with its instruction. I, in turn, sought and obtained permission from my co-workers in the lab—and NASA—to take a kind of “leave of absence” for a term, and then began the task of trying to prepare for whatever it was that I had gotten myself into! What I had gotten myself into turned out to be—without question or hyperbole—one of the most interesting and rewarding experiences of my life.

The course which resulted from all this activity was titled *The Cosmic Quest: Perspectives on Determinism and Free Will*. My original proposal of an “origins” theme seemed sabotaged by that philosophically “beleaguered” title, but it was not, and I managed to fit in lectures and discussions on virtually every relevant topic of

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personal interest to me, and then some. Full-time faculty included representatives from the departments of English, biochemistry, psychology, and history, but the course relied as well on several guest lecturers from astrophysics, anthropology, linguistics, computer science, and geology. What I found most novel and interesting about the course, though—besides being able to teach science from my head and heart rather than a textbook—was that the faculty were expected to be in attendance as students themselves for all the lectures and class discussions, not just their own. In the medical center setting it was rare for basic science classes to be attended by faculty other than the instructor, even in team-taught courses, and so my experience in the Honors Program was a pleasantly exciting and unique one. Not only did I get to help teach a course—I got to take one as well!

I guess Ada liked the job I had done—perhaps she mistook the glorious fun I had for pedagogical expertise!—for in the months that followed she offered me the position of associate director of the Honors Program and also arranged an appointment—through her contacts with the higher administration—as an associate professor in UAB’s School of Education. It was, as I described it to my friends and colleagues in the laboratory, the proverbial “offer I could not refuse.”

Money was a factor, to be sure. As the recently divorced father of a young child, I was beginning to grow tired and apprehensive about living grant-to-grant as a research associate, and the administrative and teaching positions Ada offered seemed to me a kind of refuge from that uncertainty. But I had also had the grandest time teaching in the Honors Program—perhaps teachers really are frustrated actors (or in my case, rock stars!)—and the thought of repeating that experience again and again was immensely attractive. I had also learned recently that surveys from the U. S. Department of Labor indicated most Americans over the course of their lives change jobs ten times—and careers three times—and so these data seemed to provide a kind of statistical security blanket for me, at least suggesting that such a major life change was not without precedent.

I did not teach in the Honors Program the following year, 1985, spending that time instead in transition between my former position in biochemistry and my two new homes at the Honors House and the

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School of Education. In effect, I really had three quite different jobs that year. Some days would be spent in the laboratory, going over my research logs with Jim Lacey, explaining some of the nuances and peculiarities of the reactions I had been running, composing final manuscripts, and going over the application files for my replacement. Other days would be spent with Ada and her administrative assistant, Debra Strother, trying to get a handle on the “ins-and-outs” of the Honors Program—one disaster was Ada’s attempt to get me to oversee and manage the Program’s budget, something I resisted mightily and finally managed to convince her was a terrible mistake by revealing that I never balanced my own checkbook, relying instead on the bank to let me know if things went awry. And then, of course, there was the School of Education. Why the vice-president for Academic Affairs had chosen to place me there as part of a joint appointment remains somewhat of a mystery even today, though I have to assume it had something to do with the then recently released *Nation at Risk* report and its damning indictment of (especially) mathematics and science education in the United States. Just exactly what I was expected to do about this is part of the mystery, although I have to say that my tenure in the School of Education has been—well, an education—and it is something I plan to reflect upon and write about in my “sunset” years.

And so it was that I came to leave the world of scientific research and join the curious realm of academia, teaching, and Honors education. Some of my friends in biochemistry were aghast; some were puzzled; some just curious; but all were supportive—and I guess I felt the comfort of knowing that, if worse came to worse, I always had the option, at least for a time, of returning to that world. In science today, though, one cannot stay away from the “thick of things” too long, as the “thick of things” becomes thicker by the month!

From the beginning of my involvement with the Honors Program at UAB and, in turn, the NCHC, my interests have focused mainly on science education, and for obvious reasons. I was struck early-on by the fact that science and mathematics are the only curricular areas which enjoy a separate committee status within the hierarchy of NCHC. And while I don’t know the full history of this committee—

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despite having served as its chair for a number of years—I was given to suspect that Honors Programs generally are more likely than not to be administered by faculty from the arts and humanities, or perhaps the social and behavioral sciences, rather than the natural sciences or mathematics. Science and mathematics thus seemed to be viewed as curricular areas deserving of special attention, advice, and counsel from the larger membership. This suspicion was more-or-less confirmed by the results of a survey conducted by Ada Long in preparation for her 1995 monograph, *A Handbook for Honors Administrators*. These data indicated that, of 136 Honors administrators who responded, only about seventeen percent listed their primary academic affiliation with the natural sciences or mathematics. Thirty-two percent of the respondents were members of either English or history departments, and another twelve percent reported themselves to be associated with such fields as the arts, foreign languages, women's studies, drama and theater, and communication studies.

Another problematic issue, though one usually and correctly seen as a strength of NCHC, has to do with the tremendous curricular diversity among Honors Programs throughout the country and so just how the Science and Mathematics Committee—and NCHC generally—can best lend assistance to such a varied assemblage of programs and requirements. Some colleges and universities, for example, have Honors Programs which satisfy core curriculum, or general studies, requirements, including science; others have courses which meet only departmental, or major, requirements. Some institutions offer interdisciplinary coursework for honors students; others only strict disciplinary studies. Still others require a final thesis or some other written document for graduation; many require only successful completion of a set of prescribed courses. It is thus difficult to imagine a blanket set of helpful guidelines for honors faculty with respect to science and mathematics instruction—or any other discipline, for that matter.

If there is one common theme which does seem to pervade the intersection of science, mathematics and honors education, however, it is the difficulty many programs seem to have in recruiting science faculty for their courses, interdisciplinary or otherwise. As I have

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tried to indicate above, I am neither unfamiliar with nor unsympathetic to this problem. By the same token, I have no ready answers for the dilemma and have said as much to correspondents who have sought my advice and counsel on such matters. With some exceptions (e.g., theoretical physics or mathematics), most science faculty in academia do have physical and temporal constraints imposed upon them which are not typically shared by other scholars. This is no doubt especially true in the life sciences, by far the most popular field of science electives for non-science majors. As I have tried to explain to my colleagues in the arts and humanities, “doing” science often means being in a particular place at a particular time (e.g., the laboratory or the field), unlike the situation for those whose non-teaching professional responsibilities can often be carried out in an office, library, or even at home, and on an altogether more flexible schedule. Too, one cannot ignore the hard realities of our academic environment today which, after all, simply reflects the orientation of our society and culture toward the scientific and technological. Research into the genetic basis of disease, solid state physics, or our simmering environmental problems simply attracts more funds from extramural sources—and so their concomitant indirect cost monies—than does the work of literary scholars, musicians, or historical scientists, and so often requires more “budgetary attention” from its recipients. It is, alas, a problem not likely to be solved by the likes of the NCHC, except perhaps to the extent that we can offer honors administrators the tools and techniques for identifying those science faculty who do recognize the importance of excellence in undergraduate education and who might be willing and able to forego a semester or two of their own work in the furtherance of that recognition.

Several years ago I submitted an essay to the quarterly newsletter of the International Society for the Study of the Origin of Life (ISSOL) in which I “chastised” its members for not taking a more vigorous and active role in the science education of undergraduates on their campuses, and especially the science education of future pre-college teachers. My article had been prompted by two issues quite unrelated to honors education: (1) the continued decline in the performance of American elementary, middle school, and high school students on

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nationally and internationally administered science and mathematics tests, and (2) the on-going and seemingly endless controversy in my own state, and others, over the teaching of evolution in public school science classrooms. Taking a cue from a similar controversy surrounding sex education in our public schools, I argued that the members of ISSOL—by virtue of their work in fields of science which most students intuitively find both fascinating and disturbing (recall David Hume’s “matters of unspeakable importance”)—had a special responsibility toward undergraduate students on their campuses to involve themselves in courses which “talk” to our students about what they both “want and need to hear.” I also argued that the origin sciences can perhaps be used as a kind of “leverage” to introduce and entice students to the extraordinary world of science itself and help them realize that science can be more than a subject to be dreaded as part of their core curriculum requirements—that it can be interesting, relevant and, if taught well, fun.

Mostly, I am afraid, these pleas fell on deaf ears although I received many letters, emails, and phone calls from colleagues in ISSOL who agreed with my comments and who vowed to “do better” in their responsibilities as teachers of young minds—and future research scientists. It is an interesting fact that I have encountered few if any academic scientists who chose to go into their respective fields in order to teach science; most recognized that this would be a necessary part of their duties, but rarely did they see it as the primary motive for their choice of careers. Certainly, this would describe my own experience. Contrary to this view, however, Ada Long has told me that, in her opinion, it is usual to encounter doctoral candidates in English literature who are anxious to teach and share with students the writings they love; though they recognize that research and publishing will be a necessary part of their academic lives, it is the classroom that pulls them most strongly toward a scholarly life.

If there is a lesson in all of this for those of us concerned about science and mathematics teaching in Honors, it is that there are faculty members in these disciplines at most colleges and universities who do have respect and concern for the classroom; who can conduct both classes and laboratory training sessions which leave students eager to learn more; and who can perhaps help prepare a next

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generation of teaching scientists even more willing to share their knowledge and expertise with young minds. The challenge for Honors directors and administrators then is to find ways at their own institutions to identify and recruit such faculty for their programs. Perhaps it is in that arena that the Science and Mathematics Committee should be focusing its own activities and attention.

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# TEACHING SCIENCE IN HONORS



# The Curiosity Shop (Or, How I Stopped Worrying About Delta Shapes and Started Teaching)

SUSAN TOMLINSON  
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There is a program on the Food Network called “Cooking Live.” I happen to be a regular watcher of this very informative show, which is hosted by a personable and knowledgeable chef named Sara Moulton. What sets this particular cooking show apart from the others is that it is less about entertainment than it is about actually teaching the viewer how to make proper pancakes, or how to chop an onion, or how long chicken can marinate safely at room temperature. (I think I remember Sara saying one half-hour, tops, though the FDA says never.) It is a wonderful mix of process and content.

It is also partly interactive. Viewers may call with questions or input while the show is being aired. This they do in legions. I actually tried it once myself. Sara asked for suggestions for a recipe for *sopapillas*, a southwestern specialty that I happen to know. For half an hour I dialed and redialed, only to be met with the busy signal of all the other chef wannabes calling with their *sopapilla* recipes. When someone else was tapped for the simple recipe,<sup>1</sup> I was somewhat relieved; I was really only calling out of a sense of duty—if I know the

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<sup>1</sup> Sopapillas

4 cups sifted all purpose flour  
1 ½ teaspoons salt  
1 teaspoon baking powder  
1 tablespoon lard or butter  
1 package active dry yeast  
¼ cup warm water (105° to 115° F.)  
1 ¼ cup scalded milk, approximately  
1 quart lard or cooking oil

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answer to a question, I feel compelled to share the information. My husband says this makes me a know-it-all. I prefer to think of myself as a teacher.

If I *had* been chosen by the Food Network's telephone gatekeepers, I would have probably started my conversation with Sara the same way everybody else does, by saying, "First of all, I just *love* your show."

Everybody says it—everybody—without fail. I've even started listening (possibly from a sense of know-it-allness) for someone to ask Sara a question just once without the requisite preface: "First of all, I love your show." They always say these words or some variation thereof. And they mean it, too.

I commented on this phenomenon once to my husband, who also happens to be a teacher (though he claims not to be a know-it-all). Wouldn't it be fabulous if our students started every question they asked of us by saying, "First of all, I *love* this class?"

Of course, this never happens. People may say it with giddy abandon to Sara Moulton about a cooking show, but how many of us pontificate about geology, or chemistry, or physics—which, unlike *sopapillas*, good as they are, are Really Important Stuff—have such a lovely thing happen *every single day* for *every single question*? None, that's how many. Now why do you think that is? In both instances, a lecture is occurring. Content is delivered. People are probably taking notes. There will be assessment (either your *sopapilla* works, or it doesn't). And style-wise, Sara Moulton doesn't do anything more entertaining than most of us probably do in the classroom. In fact, I dare

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- 1 Combine dry ingredients and cut in 1 tablespoon lard.
  - 2 Dissolve yeast in water. Add yeast to scalded milk, cooled to room temperature.
  - 3 Make a well in center of dry ingredients. Gradually add liquid to dry ingredients, working into dough until it becomes firm.
  - 4 Knead dough 15 to 20 times; set aside for 10 minutes.
  - 5 Heat 1 quart of lard to 450° F. in a deep fryer.
  - 6 Roll dough to ¼ inch thickness, then cut into triangles. Fry the *sopapillas* a few at a time in the fat, holding them down until they puff up and become hollow.
  - 7 Drain on paper towels; dust immediately with a sugar-cinnamon mixture.
  - 8 Serve with honey.

From Jane Butel's *Tex-Mex Cookbook*, 1980, Harmony Books, Crown Publishers, Inc., New York

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say I work harder to be entertaining than Sara does. (My Mars hair, for example, is a big hit. I've never once seen Sara demonstrate what hair would look like in the lesser gravity and high winds of Mars.) Sara simply stands behind a big kitchen island and talks. Once in a while she walks over to the refrigerator while she's talking. That's about it for excitement. Clearly, people are tuning in for *content*. Personally, I don't think content about chopping an onion can compete with content about the challenging atmosphere on Mars. Or the creepiness of relativity theory. Or, especially, the scary, elegant, bookkeeping-like certainty of genetic coding. So what's Sara got that we poor science educators don't have?

Well, how about a self-selected audience, for a start. Most people tuning in to "Cooking Live" each night are genuinely interested in learning something about the subject, whereas in the Integrated Science class that I teach for the Honors College at my university, I rarely ever run across a student who is taking the class purely for enjoyment. In fact, it is worse than that. Recently, I've begun surveying non-science majors for their attitudes toward science labs before course instruction actually begins. In particular, I am interested in what student attitudes are toward the labs because I have always intuitively felt (as probably most of us do) that labs should be fun. After all, if our students are not actively enjoying the labs, is there any reason that we should expect them to want to learn about science? And if they don't enjoy learning about science now, under our earnest tutelage, can we expect them to want to continue to learn about it after they graduate and leave the classroom?

The results of my first survey (which consisted of an Honors integrated science class) are shown in Figures 1 and 2 below:

Total Pre-Survey HONS 2115-H02 Sp 2000	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I enjoy science labs		6	8	8	1
Science labs are fun		7	8	7	1
I have learned a lot from science labs		6	11	6	
Science labs have increased my interest in science		6	6	8	3
Science labs have helped me understand the methods of science	1	13	5	3	1

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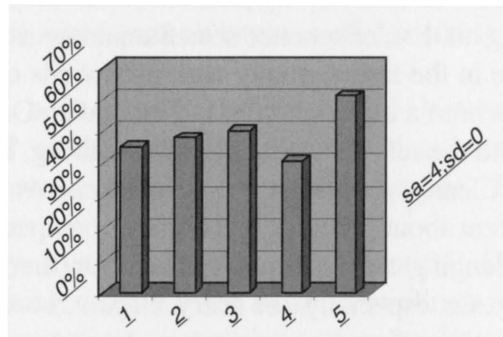


Figure 1

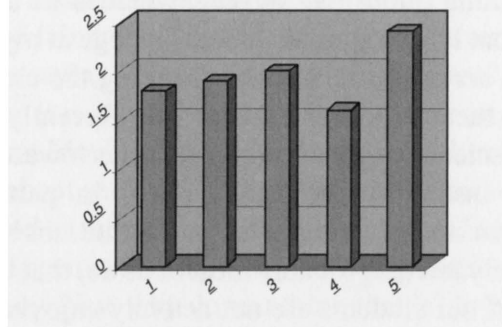


Figure 2

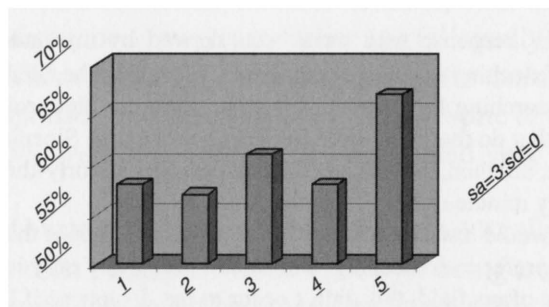
**Figures 1 and 2. Pre lab survey results, HONS 2116-H02, Spring, 2000.** Chart reflects a weighted average where Strongly Agree = 4 and Strongly Disagree = 0. Numbers 1 – 5 correspond to questions 1 – 5 shown above.

I surveyed the integrated science course because I was curious about what kind of audience I was facing as I began my instruction. The answer appeared to be, on the basis of my one-time survey, a somewhat unenthusiastic one. On the whole, if we were to apply a letter grade using a standard grade point average (on a 4.0 scale) to the survey results, the students would give the labs something on the order of a “D” to “D+” for enjoyment. When queried about whether they believe they’ve learned anything in past experiences, the labs fare a little better, earning the grade of “C-.” And as far as actually increasing their interest in science, labs earn the grade of “F.”

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The results of the survey intrigued me. I was inheriting a class that had just completed the first part of a two-semester sequence. In the first semester, the labs were the standard “cookbook” labs—start and finish the exercise in one class period; success depends on finding a “known” result (or “verification” labs). This is how science labs were taught to me when I was learning science; it is how I’ve taught labs for many years myself. I was disturbed enough by these findings that I decided to survey two geology labs (my field of study), which are (still) being taught in exactly the same manner in which I was taught many years ago. Here are the results of those surveys:

Total Pre-Survey GEOL 1101-301, -302 SSI 2000	Strongly Agree	Agree	Disagree	Strongly Disagree
I enjoy science labs	3	13	7	1
Science labs are fun	4	11	7	2
I have learned a lot from science data	5	12	5	1
Science labs have increased my interest in science	4	11	8	1
Science labs have helped me understand the methods of science	7	11	5	1



**Figure 3. Pre-lab survey results, GEOL 1101-301, -302, First Summer Session, 2000.** Chart reflects a weighted average where Strongly Agree = 3 and Strongly Disagree = 0. Numbers 1– 5 correspond to questions 1– 5 shown above.

For the physical geology labs, I left out the column giving the students the chance to be neutral in their response (making it more difficult to give their responses a “grade” since, with only four choices, I would have to leave out a letter). In this instance, the



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students' attitudes seem slightly more positive than those of Honors class but still fall dismally short of a spirited endorsement.

On an even lighter note, one very pretty summer day, having spent the morning frittering my time away as I pondered these results and the potential impact on the deeper meaning of science *education* (the theories of which I, as a scientist, am embarrassingly ignorant), I was overcome by curiosity: just how bad is our problem? I decided to get down to the basics. I grabbed a notepad and ran outside my office, where I randomly selected 105 students as they walked across campus and asked them the following question: *if given a choice between going to science lab and sleeping, which would you prefer?*<sup>2</sup>

83% of the non-science majors polled prefer sleeping to going to science lab.<sup>3</sup>

We (most of us on campus, apparently) are a long way from having students say, "First of all, I just *love* this class." Unlike the passionate viewers of "Cooking Live," our students come to lab not because they are curious to learn something new, but simply because it is a requirement for a grade.<sup>4</sup> And worse, most would prefer not to be there at all. Far from telling us how much they love the class, the first question most of us get at the start of lab is "Will we have to stay

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<sup>2</sup> The students' response may have been skewed by my underestimating the attraction of sleeping to college-age people. In picking the alternative to science lab, I was searching for something benign—less fun than rollerblading (who *wouldn't* rather do that) and more fun than a root canal. Sleeping seemed like a good choice, but then, that is from the perspective of a forty-three-year-old who resents every minute of her life that is stolen by sleep.

The survey would have been better if I'd also asked them if there was *any* class they would prefer over sleeping. But since I was really only interested in what they thought of *my* field, this didn't occur to me. I suppose if I ever get serious about these surveys I'll have to do a more thorough job.

Also, I didn't run this survey by the Human Subjects Committee first and so had to make my apologies to them later (along with submitting the requisite paperwork) in order to comply with University policy. (I'm not used to gathering data by survey; rocks don't really have opinions.) Spontaneity bites the dust.

<sup>3</sup> 63% of the *science* majors preferred sleeping—a figure I find equally alarming, but this is a problem outside the parameters of this paper.

<sup>4</sup> Many of the students polled waffled at first, citing the necessity of going to lab to get a good grade. When I told them they would not be graded on lab, the overwhelming choice was sleeping.

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the whole period today?” This is hardly the sign of an eager learner.

Should we care? After all, we all have to do things we don't want to do. I don't particularly enjoy having my teeth cleaned, but I recognize it as an important step in the process of keeping them around. Knowledge is good for them, *ergo*, students should acquire knowledge whether they like it or not. So what's wrong with force-feeding science knowledge to reluctant learners? (Instead of the “classroom,” we could even call this the “enforced learning format.” Hey...I smell a grant.)

Let's look at the question from a different perspective. What is it we want to accomplish with a science lab? I think there are two possible answers: one for science majors and one for non-science majors. For many years, I taught a section of physical geology, a freshman lab science course, as if I were teaching to a roomful of science majors. I expounded on things geologic with missionary zeal, thinking that material I was teaching the students was something everyone ought to know when, in reality, many of the things I taught were only things that geology majors needed to know. I invested a lot of energy into the class, and I presume the students (at least the ones who passed) did, too. Then, as fortune had it, I started working in another office with two former students of mine, both of whom had taken geology from me a few years earlier and (allegedly) enjoyed it. A couple of offhand geologic comments I made to them—and their subsequent responses—led me to suspect that, in spite of the fact that they'd *both done well in my class*, they'd retained very little of the knowledge.

Well! I had busted my gums teaching them that Really Important Stuff, and they didn't retain it? Once I got over being a tad insulted, I became curious. How much had they forgotten, and were they the only ones? I made up a little test, using some standard questions such as I might have asked over very basic material in my class,<sup>5</sup> and asked my co-workers to take it. I also managed to track down two other

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<sup>5</sup> Examples of the “easy” questions are: define the Principle of Superposition; does water go faster around a point bar or cut bank; how does Mount St. Helens differ from volcanoes in Hawaii, etc. “Harder” questions cover things like explaining Bowen's Reaction Series and how artesian wells form. It turned out that it made no difference whether the questions were “easy” or “hard”; the former students missed nearly all of them uniformly.

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former students and asked them to take it as well. In addition, I recruited a woman who'd taken someone else's geology course. All of them save one had earned an "A" in the course; the exception had earned a high "B." All of them were non-science majors and all of them had taken geology within the last five years. All of them (allegedly) enjoyed the course.

None of them passed. In fact, nearly all of the questions were answered incorrectly or not at all, resulting in an average score of 13 out of a possible 100. They had retained less than 15% of what they'd labored so hard to learn.<sup>6</sup>

I suspect that this is not unique to my geology classes. And, is anybody really surprised at this result? I'm willing to bet money that people who study things like long-term memory could have predicted this right down to the percentile.

Admittedly, this pop quiz was given to a microscopic sample size. It is difficult to find former students, and at the time I wasn't interested in doing a real study, I was just satisfying my curiosity. Nevertheless, it got me thinking about the purpose of my teaching. If it is about them learning Really Important Stuff for life, I might as well pack my duffel and go work on a tuna boat because that clearly wasn't happening.

All of this—working very diligently to teach the students content only to have them remember very little of it—puts me in mind of my favorite zen koan:

*"A man was rowing his boat upstream on a very misty morning. Suddenly, he saw another boat coming downstream, not trying to avoid him. It was coming straight at him. He shouted, 'Be careful! Be careful!' but the boat came right into him, and his boat was almost sunk. The man became very angry, and began to shout at the other person, to give him a piece of his mind. But when he looked closely, he saw that there was no one in the other boat"*<sup>7</sup>

Usually, when I meditate upon this parable, I do so to remind

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<sup>6</sup> Actually, one person skewed the curve with a whopping 31%. When that anomalous datum is removed, the mean is 8.5%.

<sup>7</sup> Hanh, Thich Nhat, "Being Peace," in, *365 Zen: Daily readings*. 1999, Jean Smith, ed. Harper Collins, New York.

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myself that it is useless to become agitated over mindless forces of nature like, say, timely reimbursement from the university for travel expenses. But since I like it and it is the only zen koan I have memorized, I'm going to use it in this instance as well to illustrate the futility of expecting a student to retain much in the way of content beyond the moment the class is officially ended. I can care deeply about the need for them to know facts – they can even care about it, too; it just probably isn't going to happen in the long term. Maybe having that expectation is like shouting at an empty boat.

To sum up all my surveys and pop quizzes, not only are students not having any fun in their lab science (see above), they apparently are not retaining much content in the long term, either.

What's it all for, then? Since coming to work for the Honors College (which, by its nature, allows me a lot of room to re-think my approach to teaching), I have thought long and hard about what characterizes an Honors graduate. Is it someone who knows a lot of Stuff at the end of four years? Yes, certainly we hope for that. But I think I want more than that—no, something *better* than that. I want to take my non-science-major science-phobes and turn them into people who are inquisitive about the natural world. What I want to accomplish, I have realized, is to turn them into eager learners, just like those wannabe cooks tuned into “Cooking Live.” I want them to *want* to know. I want them to go on to graduate from the Honors College and the University hungry to learn more. I want them to be interested in science now, and forever. If they are, they'll be able to learn the facts they need—even when I'm not around. Boring them in lab is not the way to accomplish this.

This puts me in mind of another zen saying: “Scratch first, itch later.”<sup>8</sup> I don't really know what this means. (That is often the way with me and zen sayings.) But I'm going to use it in the context of: teach them stuff first, let the interest come later. I think this is exactly backwards (my apologies to the zen master). What is the point of scratching if you don't have an itch?

Admittedly, my surveys are few so far. Nevertheless, on the basis of those I've given, I think they are confirming what I'd begun to

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<sup>8</sup> Shigematsu, Soiku, “A Zen Forest,” in, *365 Zen: Daily readings*. 1999, Jean Smith, ed. Harper Collins, New York.

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suspect (and education people probably already know) after several years of teaching: students don't seem to be enjoying science labs. They don't seem to be learning much, either. Maybe the way we've been teaching science has been killing the itch altogether. Science labs should be a sort of curiosity shop—a place where we build wonder and amazement through tinkering and puttering. This, instead of a place where students go through the listless motions of verifying information the teacher has decided they need to know.

Okay, so we have to create an itch. Just how do we go about doing this?

One day, not long ago, I picked up an issue of *Scientific American*. In it, there was an article on spinal cord injuries.<sup>9</sup> It was written as if the reader had no prior knowledge of the physiology of the spinal cord, let alone what actually causes paralysis when an injury occurs. The intro was direct and compelling. Like a somber litany for sailors lost at sea, it listed one paralysis injury after another: gymnast Sang Lan, gunshot victim Richard Castaldo, football player Dennis Byrd, infant Samantha Jennifer Reed.

Intrigued by the title, “Repairing the Damaged Spinal Cord,” I had originally picked up the magazine and started to read the article for the same reason anyone else would—hoping that there was hope, fearful that there wasn't. We all want to believe that there is something—anything—that we can do to make something so terrible all right again. The title and the teaser above it, “Once little more than a futile hope, some restoration of the injured spinal cord is beginning to seem feasible,” promised something of that, so I was curious enough to read. The introduction, by putting human faces on the tragedy, drew me in further.

By the second page, I had learned about the following: neurons, dendrites, axons, synapses, the descending motor pathway of neurons which controls the smooth muscles of the internal organs and the striated muscles, the ascending motor pathway which transmits sensory signals from the extremities and organs, the transducer cells that allow this to happen, white matter, myelin, glial cells, astrocytes,

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<sup>9</sup> McDonald, John W., and the Research Consortium of the Christopher Reeve Paralysis Foundation, “Repairing the Damaged Spinal Cord,” *Scientific American* (September 1999): 64-73.

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microglia, and oligodendrocytes. There was also a diagram that illustrated the four divisions of the spinal cord as well as each of the associated nerves and what they controlled.

I knew and understood the roles of each of these items *by the second page of text*, and still, in spite of the fact that it was a hefty amount of information to swallow at once, I never lost interest in the article. Now, people who know me well will tell you that I have the attention span of one of those glial cells. This is especially true when it comes to reading science writing. So why was it that this article could keep my attention even through the fairly technical, not terribly exciting information that I needed to understand the rest of the story?

First of all, it led with relevance. It didn't start with the definitions; it provided them *after* I was hooked. Furthermore, it didn't belabor the technical stuff, instead providing only exactly what I needed to know. In short, it provided me with plenty of meaty content, and I was willing to learn it, but only because I had a bigger question that I wanted answered, namely: can we reverse paralysis?

When I first started teaching geology, I had a newly-minted graduate student's outlook on teaching, which was something like: I'll show these students what it is *really* like to be a student! By this I meant, of course, what it is really like to be a graduate student. But I wasn't teaching fellow graduate students; I was teaching freshmen. And, unlike me, they weren't even really interested in the subject; they were mostly taking the course to fulfill a lab science requirement. Worse, since I was teaching geology, they were really taking it to avoid having to take physics or chemistry.<sup>10</sup> No matter; I was going to show them what "content" was all about. Geology is chock full of interesting things (like volcanoes, and floods, and evolution)—but they needed to know the basics (like silicate structures, and friction coefficients, and the names of all the delta shapes) before we could get there!

I think also, if I'm to be honest, I was trying to impress the "real" faculty (I was a mere doctoral student at the time) who'd entrusted me with the job. I certainly didn't want them thinking I was some

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<sup>10</sup>I know this because I always polled the students on the first day with the question, "How many of you are in my class only because you are avoiding physics and chemistry?" About thirty to fifty percent of the students usually "fessed up."

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lightweight who was going to be too easy on the students. *My* students were going to know “A Lot of Stuff” if they made it through my class. And that, in turn, would show everybody what a great teacher I was.

I was pretty good at teaching a lot of stuff, in detail. I could probably spend an hour and a half on delta shapes and their names alone. (Luckily for you, delta shapes are outside the parameters of this paper.)

I don’t want to believe I bored my pupils silly, but I think probably (at least sometimes) I did. Looking back, I think, too, that I bored them needlessly. Delta shapes and friction coefficients are important to somebody. They aren’t important to non-science majors. And, as I demonstrated above, once the students left my classroom they didn’t remember that sort of thing anyway.

Old belief systems die hard. Even now, when I hear colleagues say that “fun is all well and good, but I can’t teach the interesting stuff until they learn the basics,” I feel a twinge of guilt for believing that some of those “basics” are overrated. Or if they are not always overrated, then sometimes they are over-taught. To wit, in the magazine article mentioned above, I learned an awful lot of basics about the spinal cord in two short pages that probably took me no more than five minutes to read. Pause for a moment and look back over that list of items and ask yourself how much time we (as scientist/science teachers) might have spent on those basics in the classroom setting before we got to the good stuff. In my olden days, I probably could have milked those topics for a good six hours (pretending, for a moment, that I taught physiology instead of geology). And I could have rationalized every one of those interminable hours by saying, “the students need to know and deeply understand these things before I can talk about paralysis in a meaningful way.”

Let me ask a question here. Are the students interested in myelin, or paralysis? Which one is important to them? Again, these are non-science students we are talking about. (I’m not saying that a science major’s education shouldn’t also be interesting—I’m saying that the content might be different. I want the students going on to be doctors or research biologists to know about myelin in intricate, intimate detail. I want them to *marry* myelin.)

If a magazine article can teach me the necessary basics in two

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pages, why can't I do the equivalent in the classroom so that I can get on to what's really important? Remember, the authors intrigued me enough at the start that I was willing to do the work to get to the payoff. They made me ask the question first. They made me want to know.

All of this leads me back to teaching science labs, the subject of my surveys in the section above. As the coordinator for our Honors College Integrated Science course, I am obsessed with the labs. Labs are where we should be turning them into science fans. Labs are where we should be awakening a life-long interest so that when they walk out of our classrooms and down that long aisle to pick up their diplomas, they do so eager and prepared to investigate Really Important Stuff without us prodding them to do so. If we can do this, we don't have to worry about whether or not they are taught (or remember) all of the "necessary" basics. They will learn the basics as by-products of their curiosity.

Here is the problem: most science labs are boring. For example, take your average physical geology lab manual with the standard cookbook exercises that cover such topics as minerals and mineral identification, igneous rocks, sedimentary rocks, metamorphic rocks, maps and aerial photos, and (my personal favorite in the Most Dull category) mass wasting. I picked one of these exercises—sedimentary rocks—at random out of a typical lab manual. Now, I happen to like sedimentary rocks—a *lot*. Sedimentary rocks are all about my favorite geologic things, like stream and wind processes. Fossils (and lord, I love fossils!) are preserved in sed rocks. So I might be expected to think this lab was interesting.

For the lab exercise, students have to learn the different classifications of sedimentary rocks (for the most part, this is about mineral content and texture) and the origins of the different rocks. They would be given a box of rocks to identify using flow charts and descriptions, and they would probably have to answer some questions at the end of the exercise about the things they'd learned. All of this would take about two hours of their time (learning to use the flow chart and reading the descriptions of the different rocks) and would be as dull as, well, a box of rocks.

Who cares? Who cares if a history major can tell the difference between gypsum and limestone? Especially when the interesting



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stuff *doesn't require them to know it*? Don't get me wrong – if you want to look for reef fossils, you'd better know that limestone is a reef rock whereas gypsum is not. But there, I just told you that. How hard was it to learn that information? And what did it have to do with memorizing mineral content or composition? If a student wants to know where to find reef fossils, we could just tell her: “Here, this is a limestone. Most limestones represent the reef environment. If we were going hiking, where would we look for it? Where do reefs normally occur? How does a reef come to be in the middle of a continent? And now I'll show you how you tell it from other rocks that might look just the same. By the way, did you know that it fizzes in acid? Why do you suppose that is?”

Lead with the question, not the content. Make them want the content to answer the question. You gotta have the itch before you want to scratch.

At the beginning of this essay, I wondered why people watching “Cooking Live” seemed to enjoy learning so much more than our students. Part of the answer, I believe, is the self-selected audience. Students in our labs are not there by choice. But there's probably more to it than that. In the book *Women's Science*, Margaret Eisenhart and Elizabeth Finkel argue that students turn away from science when their education is organized in such a way that it lacks passion, provides no context, and is relentlessly (my wording) rational.<sup>11</sup> My wonderful colleague, Gerald Skoog (who, unlike me, actually *knows* something about educational theory), rightly points out that cooking is “passionate, contextualized, and probably irrational and tied to values!!” whereas memorizing minerals is not.<sup>12</sup>

To be honest, I think a lot of our labs are busywork. I don't think that we intend for them to be that way – I just think that is how it turns out because of the traditional cookbook structure. We labor to teach them the mineral content of gypsum, and they forget it before they're out the door because it is boring and irrelevant.

On the other hand, suppose I lead with a question. Suppose I take my students out to the field and, in between hiking and eating our

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<sup>11</sup> Eisenhart, M.A. and Finkel, E., 1998. *Women's science: learning and succeeding from the margins*. The University of Chicago Press. 272 p.

<sup>12</sup> Personal correspondence.

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peanut butter sandwiches, show them gypsum and say: “Look at this fantastic mineral!<sup>13</sup> What is it? Why is it here and not over there? Somebody give me a hypothesis and we’ll test it. And by the way, did you know that this is the same stuff that’s in sheetrock?”

Suppose I give them, not one three-hour lab, but several weeks to explore this question so that they really could formulate and test a hypothesis. Maybe they would even have to go out into the field on their own! Maybe they would have to build something—like, say, a flume—to test their hypothesis!

Okay, it is true that they wouldn’t get to all that other material in the lab manual. Who cares? They won’t remember it anyway. And it’s BORING. We aren’t going to be turning any of them into junior scientists that way.

Here is what they might learn instead: how to ask a question. What question to ask. Where to look for answers. Along the way, they also learn about gypsum, and restricted basins, and evaporates, and ripple marks, and cutbanks, and....

And—here’s the best part—they might even have some fun.

Recently, I’ve tried this approach (what I call a sort of “magazine approach,” but which is properly called an “investigative,” “project,” or “problem-based” lab in the education literature) with my section of Integrated Science lab by switching from exercises that begin and end with each lab period (the “cookbook,” or “verification” approach) to a long project that takes several weeks to complete. This project is one of the students’ choosing, though the choice is strongly guided by the instructor. The first semester I tried this, I wasn’t interested in doing a study on changing students’ attitudes toward labs. I was just messing around in lab trying something new. What caught me by surprise was how much more engaged in their work the students seemed to be. As a scientist, though, it makes me uncomfortable to call this an unqualified success on the basis of the anecdotal evidence that they certainly *seemed* to have fun. So this past spring I began to collect data by doing a pre- and post-semester survey on their attitudes. The results were promising enough that we are switching to

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<sup>13</sup> Selenite and satin spar gypsum are both striking and noticeable in the field. Gypsum is a regular among the rocks and minerals students frequently bring in for me to identify. Of course, often this is after they’ve already “learned” it in the lab.

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project-based labs for all of the labs in Integrated Science.

The projects that I've tried so far include both geology and biology studies. In the geology study, students were taken to the field and shown a sedimentary structure (in this case, pebble imbrication). They described what they saw, and from the information they gathered, they went back to the lab and formed a hypothesis. (They were given enough background information about stream systems to do this, but the instructor did not help them form a hypothesis.) The students then designed an experiment to test the hypothesis, ran the experiment, collected the data, and analyzed the results.

Not one of the groups came up with the correct hypothesis—not unexpected, since pebble imbrication is somewhat peculiar.<sup>14</sup> It didn't *matter*. In science, if we knew what the answer was before we started, we wouldn't bother trying to find out. This was a point the teaching assistant and I made repeatedly to the class. Proving a hypothesis wrong is just as valuable as finding evidence to support it. Data are data; there is no “incorrect” answer (unless you did your experiment incorrectly, which is a different problem). This bothered them at first. Honors students are used to success (and to the notion that there is a “correct” answer). To tell them that they might get something wrong and that it was perfectly okay was a different way of looking at things for them. But, *it is the normal way of doing things in science*.

Interestingly, all of the groups managed (through no planning of mine) to illustrate various things that can occur with a study: getting good data that prove a hypothesis false; designing an experiment that fails to adequately test the hypothesis; and getting the “wrong” hypothesis but the right results from the experiment (i.e., misleading data).

After it was all over, I told them how pebble imbrication occurs. It took all of five minutes and they were happy to have the information, but we all knew it wasn't really the point of the exercise. Maybe I should have spent the semester teaching them a lot of geo-factlets like this. But I think the teaching assistant and I taught them something

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<sup>14</sup> Which is partly why I chose it. I wanted the students to realize that sometimes science is not about curing cancer, but about satisfying your curiosity concerning something peculiar.

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more important than a loose collection of facts. I think they learned something very special about science that they might not have otherwise.

Emboldened by what appeared to be a successful way to teach some of the more intangible things about science, I decided to try a project-based lab again in the spring of 2000. (I also started an assessment program to see if it was really working.) This time the project was a biology experiment. Pigeons are poisoned each year on our campus as part of an eradication campaign, something that the students find quite disturbing. They chose to do a study that would evaluate the effect (if any) of the poison on non-target species of birds.

The hypothesis was this: non-target species are at risk from eating the poisoned corn put out for the pigeons. The students decided to test this by scattering corn in two areas where the poisoned corn was normally placed and monitoring the sites to see whether non-target species were eating it. They set up teams of three to four people, each with different roles in data collection. Each site was monitored by a team for 30 minutes, once a day. There were three teams so this occurred *three times a day for two weeks*. I emphasize this last part for a couple of reasons. The students were the ones who chose to monitor the sites this extensively. This is well above the amount of time that they would normally spend in a lab each week, yet they did this voluntarily. It is a far cry from their asking “Are we going to have to stay the whole period today?”<sup>15</sup>

About halfway through the experiment, I got a message that two students were waiting in front of the Honors offices to see me. When I went to greet them, I found a couple of very excited young women. They’d seen their first spring warbler while they were collecting data and

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<sup>15</sup> And the truth is, they were spending so much outside time during the semester learning to identify birds, researching the nature of the poison that is used, buying cracked corn, monitoring the sites, writing reports, etc., that in the second part of the semester I only required them to show up in lab briefly each week so that I could check their progress. My role was mainly to teach them bird identification and experimental design. Otherwise, the project was almost entirely student-driven.

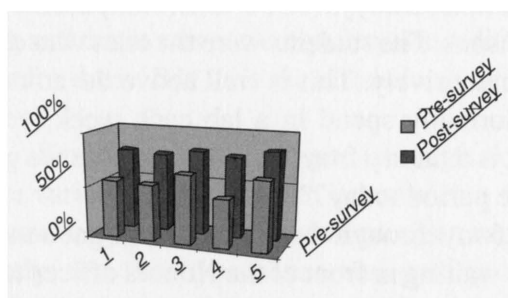
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couldn't wait to tell me.<sup>16</sup> These were students who didn't even know (or care) what a house sparrow was at the start of the semester, much less how to design an experiment and evaluate data.

Aha! Now I get it! Lead with the question. Make them *want* to know the answer to an interesting question, and they'll gather the knowledge you want them to as a by-product of their curiosity.

Aside from anecdotal evidence, survey results seem to indicate the success of this lab (Figure 4):

Post-Survey HONS 2116 H02, Spring 00 Bird Study Project	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I enjoy science labs	2	6	3		
Science labs are fun	1	7	3		
I have learned a lot from science labs	5	3	2	1	
Science labs have increased my interest in science	5	2	2	2	
Science labs have helped me understand the methods of science	4	6	6		



**Figure 4. Pre- and post-semester survey, HONS 2116-H02, Spring 2000.** Numbers 1-5 correspond with questions 1-5 in the chart above. Bar chart reflects a weighted average where Strongly Agree = 5 and Strongly Disagree = 1. See Part One for the pre-survey for the answers to the questions.

The students' written comments were interesting as well, citing the new respect they had for scientific work, a better understanding of the

<sup>16</sup> But, as they hastily assured me, they'd finished the two requisite 30-minute monitoring periods before rushing over to tell me. Besides being thrilled to see their first warbler, they were worried that it might be at risk. I broke one of my rules (pretend I don't know the answer to their hypothesis) and reassured them the warbler would not eat the corn.

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methods of science, an increased awareness of their environment, and *how much fun they had*.

And incidentally, non-target species ate the corn put out in the study.

It's too soon for me to tell how effective using a project-based lab (compared to the traditional cookbook lab) really is. The results from my lab have been encouraging enough for us to try it for both sections of Integrated Science for the entire two-semester sequence this year. We hope we'll be able to gather some definitive data from this tentative experiment in changing our pedagogy. For now, though, the idea of starting with a question that interests the students and going from there appears to have promise. I am encouraged. Maybe, in the Honors Integrated Science class, we are one step closer to teaching students to *want* to know—one step closer to turning our lab into a true “curiosity shop,” where they tinker, and putter, and explore their own way to science knowledge.

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# Creative Approaches to Teaching Science in an Honors Setting

URSULA L. SHEPHERD  
THE UNIVERSITY OF NEW MEXICO

There are many reasons to teach science literacy in a University Honors Program. As our program director, Dr. Rosalie Otero, stated when asked why she has made such a strong commitment to incorporating the teaching of science into our program at the University of New Mexico:

*It is difficult to envision how one will be able to live effectively in the twenty-first century without having achieved scientific literacy. While every educated person will certainly not be a scientist, every educated person must possess sufficient knowledge of the scientific method and of fundamental concepts of the natural sciences to make informed decisions.*

With the growth of the Internet and the biological advances of the genetic revolution, the gap between those citizens who have such mastery of key scientific and technological skills and those who do not will become a critical divide.

A scientifically literate populace will also be important to our future as a nation. As a country we are already confronted with political and social decisions that require that the body politic have the ability to identify the difference between competent science and junk science. These skills are imperative if we are to make informed decisions in both our personal and our public lives. E.O. Wilson has warned:

*Already half the legislation coming before the United States Congress contains important scientific and technological components. Most of the issues that vex*



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*humanity daily—ethnic conflict, arms escalation, overpopulation, abortion, environment, endemic poverty, to cite several most persistently before us—cannot be solved without integrating knowledge from the natural sciences with that of the social sciences and the humanities. Only fluency across boundaries will provide a clear view of the world as it really is, not as seen through the lens of ideologies and religious dogmas or commanded by myopic response to immediate need. Yet the vast majority of our political leaders are trained exclusively in the social sciences and the humanities, and have little or no knowledge of the natural sciences. The same is true of the public intellectuals, the columnists, the media interrogators, and the think-tank gurus. The best of their analyses are careful and responsible, and sometimes correct, but the substantial base of their wisdom is fragmented and lopsided. (Wilson, 1999)*

If Honors Programs do not accept the challenges outlined by Otero and by Wilson, who can and will? In 1998, the University Honors Program at University of New Mexico demonstrated its awareness of, and its commitment to, addressing these issues. It did so by hiring a full-time faculty member whose background is in the biological sciences. The two years since that time have been both exciting and challenging for myself, as that new faculty member, and for the Honors Program. We have experienced some great successes and still have much to achieve. To help you understand the setting and so that you can evaluate how well this experience can inform your own, I will begin by describing how our program fits in with the rest of the university community.

The University of New Mexico is a large research institution with over 24,000 students. There are excellent science departments—biology, geology, chemistry, etc.—but the Honors Program has focused primarily, as most seem to, on the humanities. In 1996, the university moved to a tenure-track system for Honors faculty, and all hires since then have been hired at the rank of Assistant Professor.

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At UNM, honors are awarded in each department. In Biology, for example, there are no specific honors classes, but a biology student can graduate with Biology Honors by conducting research and writing an undergraduate research thesis. This student may well be one who does not especially like the humanities and would prefer to avoid classes outside his/her field. This student may elect to be a part of the University Honors Program because it offers some specific advantages. He/she will take 21 hours in the Honors Program. These units can satisfy several of the student's general education requirements (i.e., humanities, social science, and arts requirements) without him or her having to attend the very large lectures offered through these departments. Biology, chemistry, and math majors are also often looking for elective classes that will allow them to delve more deeply into some aspect of their major or to investigate an interdisciplinary approach to some topic. For example, the opportunity to discuss the historical, ethical, or political implications of their work is often lacking in the science curriculum, and, as an interdisciplinary program, Honors Program classes offer this opportunity.

Another Honors student is one we might identify as well-rounded. This student likes a wide range of topics, and the Honors Program allows him/her to pursue interests across a broad spectrum. Often, such a student liked science in high school but decided to follow another career path. Many such students are heading to law school or to MBA programs. They are interested in topic courses that allow them to satisfy their broad interests or that infuse their primary major with very different skills and proficiencies.

The third student group is made up of those who are anxious to take science in an Honors setting because they need one course to fulfill their lab science requirement for graduation. These are the science-averse students who have done well in school but who never liked science and would avoid it if at all possible. Because they write and read well, they are comfortable with the Honors format and they hope the experience won't be too painful in the Honors Program.

Such diversity of student needs means there are diverse curriculum needs as well. This reality places great demands on curriculum development but also provides for some especially rich rewards.

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### CURRICULUM DEVELOPMENT

#### LABS

One of the first things I did was to apply for lab credit hours for the Honors Program. Within the first year, lab credits were approved by the university, and we are now able to satisfy the needs of those science-averse Honors students. They can now tackle science in a small seminar setting rather than the large lecture format so familiar at big universities. The lab format fits the Honors teaching method very well. Historically, labs are hands-on and interactive. The least successful aspect of many traditional science labs is that students experience them not as experiments of discovery but as lab demonstrations that are failures if they don't come out as outlined in the lab manual. The small setting and the participation of the faculty member rather than a first- or second-year graduate student allow greater flexibility in an honors lab, and our students can experience the lab as a dynamic and exciting class rather than a highly structured exercise.

The major challenge to presenting good labs is one of gathering instrumentation and proper facilities for the class itself. During our recent move to a new facility we made some gains in this area. We designed one classroom that has the basics: a sink, running water, fans, cabinets for equipment, and a small refrigerator. While these are important strides, for now we work with very limited equipment. We still have important needs such as a hood, more appropriate lab tables and stools, and better microscopes. While these limitations are at times frustrating, we have worked to make our lack of equipment a strength rather than a weakness. We have been able to succeed in part because of the generosity of members of the Biology Department, who often provide space or short-term loans, and in part because Honors students are very good at devising things.

In the first lab class I offered, students were required to propose and then design the experiments they would do. They were required to secure any needed equipment and to carry out the experiment. Finally, they had to present the experiment and its results to members of the seminar who had not elected to participate in the lab. The students needed a centrifuge and were unable to borrow one. They also decided that future classes should have a centrifuge. So, they

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decided that their first assignment was to build a functional piece of equipment from a kitchen blender. The students learned a great deal about the design and manufacture of scientific instrumentation. While our new centrifuge looks a bit unusual, it is perfectly balanced and has been a great hit in class. After its fabrication, these same students used it to carry out their first experiment: the extraction of DNA from several fruits and meats.

### COURSE TOPICS

Probably the most challenging aspect of curriculum development in this setting is the need to design courses appropriate to the diverse student population we serve. Since our students differ so much in their knowledge and understanding of scientific material, I have designed and taught several courses that range in focus from minimal science to complex biological topics and in-depth scientific concepts. These topics are then coupled with an investigation of the ethical and political consequences associated with them. These courses are:

***Writing the Earth*** (200 level, writing and reading nature writing from North America). This course introduces biological thinking as well as creative writing and teaches basic field observation techniques. Several basic biological concepts are incorporated. Students learn about taxonomy, use of field guides, and some evolutionary thought while they are learning to write and are reading about the American landscape.

***Natural History of the Southwest*** (300 level, includes a lab and field work). This course teaches a variety of biological concepts and skills while focusing on the Southwest region in which our students live. Students are required to keep field notes and to learn observational skills. They learn about regional biomes and habitats and about particular organisms as diverse as biotic crusts, beetles, birds and plants. They complete the course by presenting a symposium on local conservation issues to the university community.

***Biodiversity, Our Natural Heritage*** (300 level, no lab at present, but this may change). This course presents the fundamentals of ecology and conservation biology and

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incorporates political and social issues. Students read and analyze two books—*Diversity of Life* by E.O. Wilson and *The End of Evolution* by Peter Ward— as they discuss evolution and the third great extinction in process now. We discuss the development of an environmental ethic, and each student becomes an expert on one group of endangered organisms, presenting the social, cultural, and political issues as well as the biological issues surrounding that group's endangerment.

***Biodiversity and Natural History of Tropical Australia*** (300 level, a field course offered in Australia in alternate summers). This course introduces the unique fauna and flora of Australia as it teaches the fundamentals of ecology and the discipline of scientific research. Students learn to conduct individual scientific inquiries. (Shepherd, 1999; Also, visit our web site: <http://www.unm.edu/~austral>.)

***Cloning and Genetic Engineering*** (300 level, lab available to students willing to be self-directed). This class strives to teach the biological fundamentals of genetics to a broad range of students, not just biology majors, and it explores the ethical and moral issues that modern genetics and embryology bring to the table for both modern scientists and modern citizens.

***Senior Option*** (400 level, senior capstone experience). Students may complete a senior thesis or a community science-based project. Either option is based in science research or science teaching. Students pursuing the thesis option must submit their thesis in the format of an appropriate refereed journal. They are strongly encouraged to consider publication of this work. As with other students completing a thesis in Honors, they must present a professional oral defense of that work. Students choosing community service are encouraged to do substantive work such as volunteering at the museum of natural history or developing a science course for local high school or primary school children. These students must also present an oral report of the results of this work. (Examples of student work and additional information about any of these classes can be found on my web site: <http://www.unm.edu/~microart>.)

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### STUDENT DIVERSITY BUILDS COMMITMENT AND ENRICHES COURSE CONTENT

I would argue that the diversity of needs and skills of our students is one of the great strengths of Honors science classes if they are well designed. Special attention must be given to assure that assignments and readings are developed and assessed with the idea of making use of each student's strengths and interests. This makes the first several class meetings especially important.

As an example, in "Biodiversity: Our Natural Heritage," we read and discuss Wilson's *Diversity of Life*. Several chapters are quite advanced for the average student so I am careful to choose more advanced students to tackle the discussion of these readings. I begin the semester with a brief writing assignment in which I ask all the students to tell me what biology courses they have had, and I ask several basic questions that allow me to assess their competence. In the biodiversity class, I might ask questions about the species-area curve and the Hardy-Weinberg Principle. Papers are not graded, but I read them before I assign students to lead discussions on particular chapters. For a chapter as difficult as that dealing with population genetics, I lead the discussion if there is no qualified student in the class. Students who are not proficient in the topics are required to provide specific questions that can form the basis for the discussion.

Final oral and written projects also differ markedly depending on student interests and strengths. How projects are graded differs as a result. In my first class on cloning and genetic engineering, one student was particularly interested in law and intellectual property rights. He wanted to explore the implications of the genetic revolution for this area of law. My expectations for his final assignment were therefore different from those arrived at with another student, who focused on dealing with the applications of genetic engineering technology on third world farming practices. While each student was required to demonstrate a firm understanding of the science involved, each also became an expert in a very different literature. In so doing, each added a vital perspective to the overall class discussion.

Another context in which diverse student backgrounds and interests can prove beneficial is team projects. I always pair students

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with different skill levels, and students with a higher level of mastery are expected to mentor their less trained teammates. I emphasize that the lead student will learn a great deal in the process of teaching, and I acknowledge that I expect more from him/her in overall mastery. As a result of this practice I have been able to identify important holes in more advanced students' understanding of complex topics and have been able to assist them in closing those gaps, thus providing a useful service to those students preparing to take the MCAT or GRE. Students generally become quite committed to this format because of these perceived benefits.

Although I was initially concerned students might see the small differences in expectations as unfair, to date they have been quite comfortable with those differences. They are quite aware that a biology major can be expected to bring a greater depth to a biology topic. Also, many of the students who did not have a background in biology have proven quite able and have surprised and pleased their fellow classmates with the degree to which they gained proficiency. Overall, students have reported in their evaluations that the courses have been quite successful, and I have truly enjoyed teaching them. Beyond that, in a university with an overall retention rate of approximately 80% for its best undergraduates, Honors students complete their undergraduate degree at the rate of 98%, and many of the students in these classes are continuing on to graduate school.

## CONCLUSION

There are several major goals that confront science educators in the twenty-first century. The first, and undoubtedly most recognized, is that we “need to teach more students more science” (Tobias, 1990). The second is that we must ensure that those students who will be future science practitioners achieve a real fluency in their chosen fields. At the same time, future scientists must not complete their undergraduate careers unaware of or unprepared to face the political and ethical issues associated with their work. The last goal, as recently defined by Wilson (1999), is for science faculty to join with faculty from other branches of academia to establish formats that allow students to engage in the quest for the unification of knowledge.

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University Honors Programs are especially well suited to address these challenges if we are willing to push the envelope of interdisciplinary studies to include substantive science topics. In doing so, we will also enliven our existing programs as we welcome a greater diversity of students. It is in Honors that the gifted non-scientist is lurking. It is in Honors that science majors can stretch to embrace other modes of thought, and it is uniquely in Honors that we are able to encourage dialogues between diverse intellectual cultures—dialogues that we can only hope will continue throughout the lifetimes of our students.

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# **FUNDING FOR SCIENCE IN HONORS**



# **Grant Support from the National Science Foundation to Improve Undergraduate Education for All Students in Science and Mathematics, Engineering and Technology**

**HERBERT LEVITAN**  
NATIONAL SCIENCE FOUNDATION

The articles in this special issue of the *Journal of the National Collegiate Honors Council* focus on honors courses and programs that include science, mathematics and/or technology education in an innovative way. My objective is to describe a program offered by the National Science Foundation's (NSF) Division of Undergraduate Education that supports the development of such courses and programs. In addition, I will indicate several reasons why faculty associated with honors programs may be particularly well positioned to submit competitive proposals to this program, as well as particular challenges that proposals from honors programs may face.

Many of the current programs and leadership efforts of NSF's Division of Undergraduate Education (DUE) reflect the recommendations made in *Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering and Technology* (NSF Publication 96-139), in the National Research Council report *From Analysis to Action: Undergraduate Education in Science, Mathematics, Engineering, and Technology* (NRC, 1996), and in the National Research Council Report *Transforming Undergraduate Education in Science, Mathematics, Engineering and Technology* (NRC, 1999). These reports and follow-on activities have had broad-based input from faculty from the relevant disciplines, presidents and

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other administrators at academic institutions, representatives from business and industry, students, and parents. These activities highlighted the importance of an undergraduate education in science and mathematics for students with diverse aspirations, including:

- Students majoring in science, mathematics, engineering and technology;
- Prospective pre-Kindergarten through grade 12 teachers;
- Students preparing for the technological workplace; and
- All students, as citizens in a society increasingly dependent upon science and technology.

### **CHARACTERISTICS OF NSF'S COURSE, CURRICULUM AND LABORATORY IMPROVEMENT PROGRAM**

The Course, Curriculum, and Laboratory Improvement (CCLI) program seeks to improve the quality of science, mathematics, engineering, and technological education for all students, and it targets activities affecting learning environments, course content, curricula, and educational practices. The program has three tracks that emphasize, respectively, the development of new educational materials and practices for a national audience, the adaptation and implementation into an institution of previously developed exemplary materials and practices, and the national dissemination of exemplary materials and/or practices. Projects may address the needs of a single discipline or cut across disciplinary bounds.

#### **TRACK 1: EDUCATIONAL MATERIALS DEVELOPMENT (CCLI-EMD)**

The objective of the CCLI-EMD track is to support the development of educational materials that incorporate practices that are effective in improving learning of science, mathematics, engineering, or technology (SMET) by undergraduates with diverse backgrounds and career aspirations. Projects are expected to address national needs or opportunities in undergraduate SMET education and to produce innovative materials of a quality and significance appropriate for national distribution, adoption, adaptation, and implementation.

The CCLI-EMD track invites two types of proposals that aim to achieve these goals: a) those that intend to establish a “proof of

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concept” or a prototype that would be responsive to a national need, and b) those that intend to fully develop a product or practice for national dissemination.

### PROOF OF CONCEPT

A “proof of concept” project is expected to demonstrate the scientific and the educational feasibility of an idea. If development of the prototype proves successful, the project would be expected to move to full-scale development of the materials. Such a proposal for full development could be submitted to NSF for peer review and possible funding, or to other sources of potential support.

The outcomes expected of a CCLI-EMD Proof-of-Concept project include all of the following:

- A prototype that addresses a nationally recognized need and is based upon sound, effective pedagogy;
- A pilot test that provides a credible evaluation of the prototype; and
- Dissemination to the professional community about the prototype, and the results of the evaluation.

### FULL DEVELOPMENT

A full development project is expected to produce and evaluate significant new educational materials and pedagogical practices, and to promote their dissemination and effective implementation nationally. The outcomes expected of the funded projects include all of the following:

- The full development of innovative materials that incorporate effective teaching and learning strategies and that are based upon prior experience with a prototype;
- A credible evaluation of the effectiveness of the materials or practices at different types of institutions serving students with diverse backgrounds and career goals;
- Preparation of faculty at test sites and other potential users to use the materials or practice;
- Dissemination of information about the developed materials; and
- Commercial or other self-sustaining national distribution (for

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example, distribution through a commercial publisher or discipline-based professional society).

### **TRACK 2: ADAPTATION & IMPLEMENTATION (CCLI-A&I)**

This track promotes the improvement of SMET education in the funded institution through adaptation and implementation of specific exemplary materials, laboratory experiences, or educational practices that have been developed and tested at other institutions. CCLI-A&I projects should effect change within or across departments or other institutional units by having broad faculty and administrative support.

Projects to adapt and implement high quality SMET curricula, materials, and/or techniques might include, for example:

- The incorporation of laboratory experiments or field experiences that effectively engage students in scientific processes and exploration of scientific concepts;
- The adaptation and testing of exemplary materials for use by a student audience significantly different from the one for which they were originally developed;
- The enhancement of teaching and learning through the use of resources, particularly instructional and information technologies, demonstrated to be of high quality;
- The development and use of collaborative learning, learning communities, and other innovations that aim to improve pedagogy in courses; or
- The integration of the study of pedagogy and content in science and mathematics core courses for prospective preK-12 teachers.

The scope of a project may range from an individual course or laboratory to a more comprehensive effort that impacts entire curricula or programs. The funds may be requested in any budget category normally supported by NSF or may be entirely for instrumentation.

Proposers of CCLI-A&I projects are expected to adapt and implement high-quality materials and effective educational practices developed elsewhere by individuals supported by NSF or by others. Adaptations that integrate significant advances from the research

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field into the undergraduate curriculum are also appropriate. Materials for adaptation may be drawn from more than one source.

Information about the results of projects funded through the Department of Undergraduate Education (DUE) programs can be obtained via the DUE Project Information Resource System <http://www.ehr.nsf.gov/PIRSWeb/Search/>. Many of these previously funded projects are in progress, and proposers may wish to contact the principal investigators for further information.

The outcomes expected of funded A&I projects include all of the following:

- Adaptation and implementation of exemplary practices and/or materials for course, curriculum, or laboratory improvements in innovative ways;
- An evaluation that informs the institution and others of the effectiveness of the implemented materials and practices, and also informs development of the project;
- Faculty professional development as needed in support of curricular adaptation and implementation;
- Efforts to build on the project and to broaden its impact at the institution, within the discipline or across disciplines; and
- Effective dissemination of project results to the broader community.

### **TRACK 3: NATIONAL DISSEMINATION (CCLI-ND)**

This track supports the national dissemination of exemplary materials and practices by providing faculty with professional development activities. Eligible activities are not restricted to the dissemination of results from NSF-funded projects. Projects are invited from organizations that propose to provide faculty professional development opportunities on a national scale. Such organizations should be able to provide efficient administrative support to manage the logistics of these activities at multiple sites. Although it is expected that the primary mechanisms will be workshops, short courses, and distance learning opportunities, other means of dissemination are also encouraged.

These professional development opportunities are expected to enable faculty to introduce new content into undergraduate courses



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and laboratories, and to explore effective educational practices, thereby improving the effectiveness of their teaching. The new content may be scientific and technical knowledge, laboratory practices, or reformatted and synthesized content that supports new modes of learning. It is expected that the format will provide interaction with experts at a level deep enough to promote and achieve significant gains by participating faculty.

Successful proposals must aim to provide faculty professional development in a variety of disciplines or broadly within one of the following disciplines: behavioral sciences; biological sciences; chemistry; computer and information sciences; engineering; earth sciences; mathematical sciences; physics and astronomy; social sciences.

The outcomes expected of funded CCLI-ND projects include all of the following:

- Sets of materials for use by attending faculty that are appropriate for their needs;
- Participation by faculty representative of the national demographic and institutional diversity within the included disciplines;
- Follow-up activities to sustain faculty who participated in the professional development activities;
- A network of faculty actively using the disseminated best practices in their courses and classrooms;
- Evaluation protocols to assess the effectiveness of professional development activities and to improve their effectiveness.

Proposals submitted to each track should clearly indicate in the main body of the proposal how the objectives of the proposed project correspond to the outcomes expected, and describe in detail the plans to achieve these objectives and outcomes.

Consider, for example, the expected outcome that projects evaluate the impact of the effort on student learning. The objective is to determine what difference NSF's investment and the Principal Investigator's (PI) efforts have made. In spite of faculty familiarity with testing students to determine the students' level of achievement,

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faculty often have difficulty presenting a credible plan to determine how well they have succeeded in achieving the learning objectives they have set. A deficiency common to many assessment plans is that the project's objectives have not been defined with sufficient specificity. Skilled evaluators brought into the project from the start can be of great assistance in this respect. Individuals trained in assessment can and should be consulted to help with this task, and the cost of their time may be included in the budget for the project. In addition, there is a rich literature and other resources on assessment that can and should be consulted (see references below).

However, it may also be appropriate for prospective principal investigators to learn to design credible assessment schemes on their own, without becoming experts in assessment. For example, a PI could describe his/her project's learning objectives in terms of the knowledge and skills students should acquire by the end of the experience. An assessment plan would include the various ways in which students could demonstrate to an independent, objective observer that they have acquired these skills and knowledge. This would not include self-reported satisfaction of the outcomes by either students or the PI. To demonstrate that progress had been achieved as a result of the experiences and opportunities provided by the project, the students' knowledge and skills could be assessed before and after they engaged in the project. Indicators of success or progress toward success could include a demonstration that students are able to do things with the knowledge and skills they have acquired that they couldn't do before. An example might be to determine a student's ability to create an "ideal" exam question on a relevant topic, and to constructively critique a colleague's response to the exam question.

### **THE HONORS "ADVANTAGE" AND CHALLENGES**

Proposals from honors programs may be stereotyped by reviewers, and while such expectations and stereotyping of students and faculty associated with honors may bestow some advantages, they also pose unique challenges. An applicant should be aware of and be prepared to address both the advantages and the challenges. Just as faculty teaching honors classes may have stereotypical expectations of the students enrolled, reviewers may expect projects

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associated with honors programs to be more likely to succeed because of the attributes of the faculty and students associated with them and because of the special status they have within an institution. Some of these attributes are real advantages, others are burdens.

Some of the reasons why the honors community might be in an especially good position to submit a competitive proposal to the CCLI program include:

- Experience in using the environment as resource (one example is the NCHC's perennial use of City as Text©; others include science-rich institutions in an urban area or the natural resources in any area);
- Incorporating students as collaborators, partners and even leaders of course or program-related activities;
- Forming alliances and partnerships with non-academic resources, such as people from the surrounding community in industry, business, community service organizations and local government;
- Attracting students with diverse interests and aspirations, who are capable and competent in science and mathematics but may not be majoring in science, to engage in interdisciplinary studies;
- Incorporating multicultural perspectives by making explicit use of the diverse backgrounds and experiences of students in the honors program;
- Using writing, or more generally communication, as a means to learn science and mathematics;
- Teaching to learn by engaging students as teaching assistants and peer tutors;
- Learning communities which engage faculty from different disciplines in cooperative ventures;
- Experimenting with innovative styles of learning and giving students responsibility for their own learning;
- Readily available venues for communicating/disseminating experiences, such as JNCHC and the NCHC national meeting.

Although faculty associated with honors programs may have some competitive advantages, they also face distinct challenges.

It is often assumed that honors programs are given special resources to accomplish their goals, which might not be available to

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others. For example, it may be assumed that honors programs have the best or at least the most highly motivated students, that their student-faculty ratio is low, and that they have access to special resources such as space, scholarships, resource people and equipment. Thus reviewers express skepticism about the generalizability of honors projects to the broader population, where the needs, numbers, problems and opportunities are greater.

Thus, applicants need to address in detail:

- the generalizability of their projects to students and faculty not associated with honors programs, and their institution's commitment to extending what is learned beyond the honors community;
- how the innovations that are successful will be sustained and institutionalized;
- how they will credibly assess the impact of the innovations introduced on student learning.

These challenges and others might be directly addressed if projects conceived by honors programs include on their planning teams and as their test sites those who are not members of the honors community.

In addition to serving as a principal investigator on a project, faculty and administrators with science and mathematics backgrounds can contribute to the improvement of undergraduate education for all students in the sciences by serving as a member of a team on a project conceived by others, being a member of a coalition or consortium, serving on an advisory board for a funded project, or serving as a beta tester of materials and methods developed by others. Faculty can also serve as reviewers of proposals submitted to the CCLI program, and can make their interest in doing this known by filling out and submitting NSF Form 428A, which is available on the Web at <http://www.nsf.gov/cgi-bin/getpub?form428a>. This form should be mailed to DUE along with a resume, or the information e-mailed to "undergrad@nsf.gov."

Disclaimer: The views expressed in this article are those of the author, and do not necessarily reflect those of the National Science Foundation.

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- 2 *Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology* (NSF Publication 96-139), <http://www.ehr.nsf.gov/ehr/du/outreach/stf/publications.asp>
- 3 *From Analysis to Action: Undergraduate Education in Science, Mathematics, Engineering, and Technology*. National Research Council Report (1996), <http://www.nap.edu/catalog/9128.html>.
- 4 *Transforming Undergraduate Education in Science, Mathematics, Engineering and Technology*. National Research Council Report (1999), <http://www.nap.edu/catalog/6453.html>.

The following references may be helpful in designing an evaluation plan:

- *User Friendly Handbook for Project Evaluation: Science, Mathematics, Engineering and Technology Education* (NSF 93-152, revised 2/96). See: <http://www.ehr.nsf.gov/EHR/RED/EVAL/Handbook/handbook.htm>
- *User Friendly Handbook for Mixed Method Evaluations* (NSF 97-153). See: <http://www.ehr.nsf.gov/EHR/REC/pubs/NSF97-153/start.htm>
- Online Evaluation Resource Library. See <http://oerl.sri.com>.
- *Field-tested Learning Assessment Guide* (FLAG). See: <http://www.wcer.wisc.edu/nise/CL1/flag/>

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# **An NIH- and NSF-Funded Program in Biological Research for Community College Students**

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## **ABSTRACT**

In a program supported by grants from the National Institutes of Health and the National Science Foundation, selected students in biology courses at Valencia Community College actively pursue the scientific method in a series of laboratory exercises. Results are then published as reports written in the format of a scientific paper. Faculty from the disciplines of biology and English composition evaluate students' work. Students are required to collaborate and present findings as if they are researchers. Students interested in science careers can subsequently enroll in a research training course, upon completion of which they are eligible for a summer internship at a partnering research university. Summer interns are required to present their findings to faculty of both the host and the parent institutions in accepted formats.

## **BACKGROUND**

Biology faculty, like colleagues in other disciplines, must adapt to the rapid growth in information related to the field. Students in biology face an even more difficult struggle filtering through the mass of information which will confront them in their studies and beyond.

Faculty face a challenging dilemma in creating curricula for

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courses that serve both as prerequisites for science majors and as science electives for students not majoring in the sciences. While Honors Biology courses are designed to prepare science majors for further advanced study, the lecture component of the course, with its requisite theory and extensive content, may occasionally overwhelm them without piquing their intellectual interest. Recent trends suggest ways to arouse student interest through innovative forms of engagement.<sup>1</sup> Incorporating elements of other successful curricula and underwriting them with grant support, Valencia is in its third year of offering students a research-based biology experience.

If each student in freshman Honors Biology were to declare early his/her commitment to pursue biology through graduate school, then faculty could begin and end with the basics of biology, letting students' critical skills develop over the course of their higher education. However, the typical "Biology-1 Honors" student at this institution may not be planning a career in the sciences. The question is, how can students of varied interests experience in two semesters enough scientific practice to make informed judgments in the future concerning issues related to science?

Our goal is to provide students with experiences that demonstrate science as an active process necessitating the exchange of ideas. As a community college, we are committed to the goal of our students continuing their education at the university level. Through internships and workplace learning, students observe the process and practice of science. As a result of these experiences, they can make more informed decisions about their career paths. While many students may not apply to graduate programs in science, all students are shown that it is an option. Even if they choose to go no further, the students are now sufficiently literate to make better decisions when confronted with issues impacted by science. For those interested in pursuing further studies in science, this path leads to a bridge that extends to faculty mentors at a partnering research university.

### METHODS

Drawing on the resources of multiple departments, Valencia Community College has established a three-level approach to encouraging scientific understanding and literacy in our students. First, students in first-year Honors biology are challenged to practice

the scientific method by emulating research scientists. Using reprints of journal articles provided by potential mentors, students learn the structure and format of peer-reviewed journal articles. From these articles students learn to extract techniques and emulate state-of-the-art laboratories featuring but not limited to techniques utilized in biochemistry and molecular biology.<sup>2</sup> Working in groups, students collaborate and peer-review laboratory reports which are modeled after relevant journal articles. A faculty mentor in Honors English Composition, with whom the students have previously studied, participates as a consultant, assisting students in structure and style. Logic and critical thinking skills are strengthened as students familiarize themselves with the subtle persuasion inherent in scientific writing. By mid-semester, students are designing their own experiments, often amid spirited debates involving how best to apply the scientific method. At this point the class examines contemporary articles in various mass media and scrutinizes them for scientific accuracy and integrity.

Upon completion of a minimum of one year of biology course work (chemistry was added in 1998) and with expressed interest in a career in the sciences, students can enroll in a special topics course of experimental research methods. This course is funded through grants from the National Institutes of Health (NIH) (1997-1999) and the National Science Foundation (NSF) (1999-2000). Admission is selective and requires an interview and a written goals statement. In fifteen laboratory sessions, students learn by hands-on practice research techniques often encountered only in university laboratories. This curriculum, developed by Valencia faculty in consultation with university faculty, requires students to keep a detailed lab notebook (like those used by graduate students). Grading is by competency exams involving mastery of fundamental techniques as demonstrated by carrying out a series of unassisted determinations using only their own notebooks. Topics include practice of the scientific method, biochemical techniques, advanced microscopy, bio-medical techniques and data presentation.<sup>3</sup>

Partnering institutions include the University of Florida, the University of South Florida and the University of Central Florida. Faculty mentors are selected to accept these students as summer interns upon completion of research training. The internships are paid by grant funding and last 5-8 weeks. Mentors are contacted to provide input on laboratory skills desired. Many provide reprints of their



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recently published journal articles, which are analyzed by the class prior to leaving Valencia for the universities. Student interests are matched closely with prospective mentors.

While interning at the universities, students continue to be mentored by Valencia faculty. Each student, in consultation with his/her university mentor, develops a project which will be completed in the allotted time. Students are required to function autonomously and to keep detailed notes. At the completion of the Internship, students must present their project results to the faculty and other students. Presentations are in one of three appropriate formats. Student interns at the University of Florida participate in a mock symposium where each student presents his/her results in a 15-minute seminar to the faculty mentors and a panel of graduate students. Students at the other institutions (USF and UCF) can choose to present in a similar symposium upon return to Valencia or to compete in the annual undergraduate research symposium's poster session. In addition, interns can submit their project findings in the form of a journal-format manuscript to their faculty mentors.

### RESULTS

Since 1997, 54 students have completed all three components of this program culminating in a successful research internship. As part of our commitments to granting organizations, each student is tracked until a terminal degree is awarded or contact is lost.

For the years 1997-1998 and 1998-1999, support for the research methods course and the student internships was provided by the NIH. During the year 1999-2000 support was provided by the NSF. Under the NIH Bridges program, enrollment was limited to 25 students. Under the NSF grant, enrollment was limited to 15 students. Enrollment in the research methods course was open to all students at the college meeting the criteria. Honors Program students represented greater than 40% of each class. Minority students comprised greater than 60% of each class.

In the Research Methods course, Honors students having previous experience with our techniques were joined with other students to form collaborative groups. The more experienced students, acting as mentors, provided instruction, guidance, and support to the less experienced members of the group. This see-do-

teach approach is based on instructional and training strategies used in medical and graduate schools.

Many students have established contacts at the universities which resulted in employment after transfer. Most significantly, several have published and presented their work. Honors and awards for these students' work include institutional honors (The University of South Florida Student Research Symposium; Undergraduate Research Awards 1998, 1999) and national honors (The American Society of Biochemistry and Molecular Biology Annual Meetings; Undergraduate Student Research Awards 1999, 2000).<sup>4</sup> Within two years of completing his associate of arts degree at Valencia, one student is beginning graduate course work at the Massachusetts Institute of Technology with a full fellowship.

<b>Student Results 1997-2000</b>	<b>1997-1998</b>	<b>1998-1999</b>	<b>1999-2000</b>
Qualified Applicants	28	30	26
Enrolled in Research Methods	25	25	15
Completed Research Methods	18	23	15
Research Internship	16	23	15
Transferred to a University	13	15	11
Returned to Valencia	5	8	4

## DISCUSSION

These practices in student self-development of scientific understanding were implemented primarily outside the traditional lecture format. The emphasis on direct reading of scientific literature, active practice of the scientific method and communication by writing and presenting were all laboratory-based. Recent trends in undergraduate science education emphasize student inquiry.<sup>5</sup> This curricular approach can augment text-based learning with computer-accessible resources such as CD-ROMs and web sites.<sup>6</sup> We have chosen to follow this course at Valencia in Honors Biology. Laboratory curricula and instructional materials were developed mainly by our own faculty.

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As many institutions have done, Valencia has invested heavily in student-accessible computer laboratories and electronic classrooms. Utilizing these resources, students can explore a range of prepared tutorials and simulations in addition to accessing resources on the world wide web. In an effort to merge the components of lecture, laboratory and computer laboratory, eight computer stations in a network are located in an adjoining room to our Honors laboratory facility. A full-time laboratory instructor is available during normal class hours to assist students with computer-based assignments, CD-ROM tutorials, and any word processing, graphics or spread sheet construction. Honors students and students enrolled in the research methods course are expected to follow up on experiments in the laboratory after hours. An Honors resource facility is also available with similar support after hours.

### CONCLUSIONS

Valencia has adopted as its core competencies four simple measures: How does what we do better prepare students to think, value, act and communicate? In science, thinking needs to be more than memorization, and three hours of laboratory a week is not enough time to act on the ideas we cultivate. Perhaps if we educate students on how to communicate matters of science, these students will be better equipped to think, value, and act in life. Additionally, understanding the process and practice of science by experiencing it during an internship can consolidate interest in further studies. Our partnerships with three major state universities have greatly enhanced our students' opportunities and provided a near seamless academic transition for them. The students complete Honors Biology during the first year at Valencia, the research methods training course in their second year, followed by the summer research internship at the partner institution. With planning, these students enroll as transfer students at the chosen university in the third year. In the third year of our program we are now beginning to see our former students accepted into science programs at these and other graduate and professional schools.

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# **An NSF-Funded Opportunity for Pre-Service Science Teachers**

**LILLIAN F. MAYBERRY**

**JACK BRISTOL**

**UNIVERSITY OF TEXAS AT EL PASO**

During the fall semester of 1995, a unique partnership opportunity was presented to the Colleges of Science and Education at the University of Texas at El Paso (UTEP). A National Science Foundation Request for Proposals was received from the Division of Undergraduate Education (DUE). It required Colleges of Arts and Sciences and Education to form collaboratives involving the improvement in the preparation of K-12 science and mathematics teachers: A Collaborative for Excellence in Teacher Preparation (CETP). Although unknown at the time, this would result in Honors education opportunities for students seeking teacher certification.

The Deans of the Colleges of Science (Jack Bristol) and Education (Arturo Pacheco) wrote a successful five year, five million dollar proposal (El Paso CETP, DUE NSF-9453612), recruited one math and two science educators in the College of Science, and formed a very successful partnership known locally as the Partnership for Excellence in Teacher Education (PETE). This program has resulted in a major revision in the requirements leading to K-12 certification in mathematics and science and provides significant stipends to students with a 3.0 or better GPA who wish to pursue certification.

One of the numerous components of the PETE grant includes field experiences (experiential learning) for the pre-service participants. Two courses used by students in this capacity are Desert Ecology and Marine Biology (taught by Honors Director, Lillian Mayberry); these are senior-level elective courses. Each of the courses involves an intense one-week field experience at either the 37,000 acre Indio Mountains Research Station (IRMS) owned by

## AN NSF-FUNDED OPPORTUNITY

UTEP or the Intercultural Center for the Study of Deserts and Oceans (CEDO) on the Gulf of California in Sonora, Mexico, which has been utilized by the University for the past 16 years. PETE pays the field fees associated with the courses.

Students seeking elementary certification and those majoring in science or mathematics and seeking certification at the secondary level have enrolled and used their projects/experiences to develop modules for use in teaching. (Texas requires a major in the discipline for secondary certification.) Those PETE students who qualify for the Honors Program receive honors credit on a contract basis. One group of students conducted a study of tide differentials in relation to the position of the moon and developed a cooperative learning teaching module to be used at the secondary level to explain how the moon affects the tide movements on earth. At the end of the semester, they were required to make a public presentation using the module they developed.

At the IMRS, another group examined arthropod diversity under fallen Yucca logs. A PETE student in this group developed a teaching unit on arthropods for elementary students in grades 3-4. The module was written so students would learn about the arthropods' structure and about some of their habits. Basic taxonomy and characteristics were included and some examples studied were spiders, beetles, grasshoppers, butterflies, houseflies, centipedes, and lobsters. To make the unit cross-curricular, and at the same time more interactive, the students were to help write a story about an arthropod. As a model, the class read Eric Carle's *The Very Hungry Caterpillar*. The unit was designed to be completed in four days with a quiz on the third day and a collaborative writing activity on the final day.

Students in these field courses receive multiple benefits. Not only can they earn Honors credit for development of teaching modules that they can use in a classroom setting, but they participate in an experiential and cooperative learning activity as well. Other opportunities for students to earn Honors credit while participating in the PETE Program have included developing teaching modules based on their experiences while interning at the El Paso Zoo, The Centennial Museum on the University campus (a museum of cultural and natural history that has supported pre- and in-service K-12

## MAYBERRY AND BRISTOL

teacher workshops) and the Franklin Mountains State Park (the largest urban park in the United States).

At a large public institution such as UTEP, where Honors courses *per se* are mostly limited to general requirements like English, history, political science, etc., capitalizing on the opportunities provided by the PETE Program has allowed Honors students seeking teacher certification to participate fully in the Honors Program and, through contracting, earn required credits towards the University Honors Degree or Certificate.

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# Editor's Note

ADA LONG

UNIVERSITY OF ALABAMA AT BIRMINGHAM

Mistakes are sometimes gifts in disguise. We made a humdinger of a mistake in our inaugural issue of JNCHC, omitting an entire essay. Paul Homan's reflection on Catherine Cater's life in Honors was meant to be the cornerstone of our celebratory festschrift for Dr. Cater, but somehow—much to our surprise—it vanished on the way to the printer. This unhappy disappearance provides now an opportunity for a happy reappearance and a reprise of our festival-writings in honor of Catherine Cater. It also allows us to balance the two stories of scientists' lives in Honors that begin this issue with the storied life of a humanist in Honors. So we present here Homan's tribute to the life of Dr. Cater with combined apologies and gratitude for our mistake in omitting it from the previous issue of JNCHC.

# **A Humanist in Honors: Another Look at Catherine Cater**

**PAUL HOMAN  
NORTH DAKOTA STATE UNIVERSITY**

In 2000 Catherine Cater marks her 55th year of teaching, a career which began in 1945 upon completion of her Ph.D. in English at the University of Michigan. Since 1962 she has taught at North Dakota State University, and although she officially retired from the faculty in 1982, she has continued to teach philosophy, direct humanities tutorials, and advise students on a volunteer basis. When the faculty at NDSU recognized her with the university's most prestigious teaching award, they made note of her role as the embodiment of the teacher-scholar "who has kept alive the tradition of liberal studies at NDSU; for her, the best that has been thought and said is appropriate for all students, and she has made that tradition accessible to all." The grace of her own scholarship has dignified that tradition, while her graciousness and perceptive guidance have encouraged generations of students, and colleagues alike, to see dignity in their own work.

She arrived at NDSU by way of Moorhead State University, Olivet College, Ann Arbor, and Talladega College in Alabama, where her family moved in 1918, a year after she was born in New Orleans. Set in the foothills of the Blue Ridge, Talladega was a town she describes as having had a Faulknerian courthouse square which witnessed the regular passage of wagons loaded with cotton bales. Her father, a progressive administrator with close connections to Robert Hutchins and the University of Chicago, had become dean at Talladega. Under his guidance, an exchange of personnel and ideas developed between Chicago and this southern inter-racial college, where she received her B.A. in 1938.

In 1939 she obtained an M.A. in English from the University of Michigan. However, with so few positions in higher education

## A HUMANIST IN HONORS

available to women, and needing to find a job, she returned to school for a degree in library science and was subsequently hired to head the circulation department at Fisk University in Nashville. Three restless years later she returned to Ann Arbor on a fellowship, “a young person in a great hurry” who began to work on Platonism in Milton, but soon published an article on southern poets, and this led to a dissertation on Faulkner.

Her first teaching position was at Olivet College in Michigan. Those who know Catherine Cater know how naturally she associates experimental, interdisciplinary, and experiential with teaching. The opportunity to teach at Olivet was ideal. In 1945 it was a highly experimental institution with a cosmopolitan student body. Guided by the idea that the greater difficulty lies in learning how to “include oneself in the world,” its curriculum focused on areas of human endeavor rather than academic disciplines, and the emphasis was on a tutorial system which favored primary experiences: doing rather than studying sculpture, for example, especially if it was not one’s own field. Olivet was, for four years, the high point of her teaching experience. But it coincided with the rise of Senator McCarthy, and Olivet’s unconventional approach attracted attention. She and others resigned in protest when four faculty members were dismissed on political grounds. Although financial difficulties ultimately intervened, they developed plans to open a new experimental college in New York, even obtaining the federal government’s promise of a former army barracks as a campus.

In 1949, when Catherine again began looking for a job, the placement director at Michigan predicted that as a woman she had “as much chance of being placed as a person without arms.” So she simply began writing letters, all with northern addresses. All but one of the replies were negative; many said that although her credentials were attractive, their institutions simply were not ready for someone with her background. The positive response came from Moorhead State University in Minnesota; it offered a one-year replacement position teaching English and, of course, library duties. However, the absent faculty member failed to return, the library dropped out of the job description after a year, and in the next 13 years (1949-1962) she taught English and humanities courses, set up a campus radio station, founded

## PAUL HOMAN

a student-faculty group called the “Concentrics,” who gathered to talk and exchange ideas, and gradually came into contact with colleagues in English at North Dakota State University across the river in Fargo. Most importantly, she met Delsie Holmquist, who also taught in Moorhead’s English department. Together they experimented with the general education curriculum: “a chance to be creative with courses in critical thought, anthropology, and philosophy.”

Catherine resigned from Moorhead State in 1962 and went to North Dakota State, followed by Delsie Holmquist two years later. In addition to her duties in the English curriculum, she soon developed a course which would become legendary at NDSU. “Approach to the Humanities” was a year-long interdisciplinary survey of the arts and humanities which attracted students from every corner of the campus, and for which she and Delsie literally traveled the world collecting course materials. In the early 1970’s she participated in the Tri-College Humanities Forum, an experimental, intensive humanities program which drew on the resources of three institutions in the community. In 1968 she founded the honors (Scholars) program at North Dakota State, directed it for many years, and continued to teach in it until 1998. Along the way, she did post-doctoral studies at Kenyon, Columbia, Berkeley, and Cambridge; directed countless tutorials in philosophy, literature, aesthetics, and the arts; was recognized with every major teaching award offered at North Dakota State; chaired the graduate program in English; inspired and guided the development of the first university-wide interdisciplinary courses at North Dakota State; advised the student government on the acquisition of a significant collection of modern art; and, most recently, has been teaching a full range of philosophy courses for NDSU.

Catherine attended her first NCHC conference in 1968 and has had an active role in all but one annual meeting since. She was elected president of NCHC in 1974 and, over the years, has served on virtually all of its major committees, chairing the publications board and taking a special interest in the honors semesters. She has never ceased to be active at the grassroots level as well, organizing many workshops and special sessions, encouraging and inspiring new members of the honors community.

## A HUMANIST IN HONORS

Generations of students keep in touch with Catherine Cater, still drawn, as they were in tutorials and large classes alike, to a teacher who is herself so evidently and joyfully a learner. Students sense that she is willing to take a chance: on them, on their ability to grapple with even the biggest philosophical questions, and on the likelihood of conversation leading to discovery. To be in Catherine's classes, or sometimes even in casual conversation, is to risk being surprised at the unaccountable engagement one begins to feel in the subject. A graduate student who assisted her in "Approach to the Humanities" recalls that once, on a lark, Catherine, Delsie Holmquist and he set out on a drive to Canada with no purpose other than being in the countryside with good company. The changing scenery led to a discussion of the work of abstract expressionist painters as a form of landscape, while farm trucks loaded with freshly harvested potatoes sped along in the opposite direction. They slowed down and parked on the side of the road and began picking up potatoes that had fallen from the trucks into the ditches. Back in the car, with the trunk full, Catherine's comment was, "Now when I eat potatoes I will have a greater understanding of Van Gogh's painting *Potato Eaters*."

The persistent questioner, seeking connections rather than answers, she draws one in with the simplest and greatest traits of a teacher: human, wide-ranging, curious and, perhaps above all, generous. It is to such a teacher, colleague, and friend that these essays are dedicated.

# **ABOUT THE CONTRIBUTORS**

**Thomas P. Arnold** is a Professor of Biology in the Honors Program at Valencia Community College in Orlando, Florida. Tom received his A.A. from Palm Beach Community College, his B.S. in Zoology and Chemistry from the University of Florida, and his Ph.D. in Biochemistry and Molecular Biology from the University of South Florida, College of Medicine. Tom is Co-Principal Investigator with Frances Frierson on the NSF (CCLI) grant and Program Director for the NIH bridges grant.

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**Susan Tomlinson** is a geologist and paleontologist with a strong interest in science education for non-majors. She is currently working for the Texas Tech University Honors College as the science coordinator.

**Len Zane** is a professor in the Physics Department at UNLV. He started UNLV's Honors Program in 1985, helped the program become a college in 1997, became dean of the Honors College in 1998, and stepped down to return to the classroom in the summer of 2000. He is also a past president of NCHC.



# NOTES

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