ARTICLE

Anatomy of a Successful K–12 Educational Outreach Program in the Health Sciences: Eleven Years Experience at One Medical Sciences Campus

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The Department of Anatomy and Neurobiology, College of Medicine, University of Arkansas for Medical Sciences (UAMS) is the administrative home of a nationally recognized educational outreach program in the health sciences for K–12 teachers (includes school nurses, counselors, etc.) and students. This program is called the Partners in Health Sciences (PIHS) program. It began in the summer of 1991 and is based on an annual needs assessment of the state's teachers. PIHS is a program available to all teachers and students in the state. It has several different components: (1) a cafeteria of 21 days of mini-courses offered in the summer to meet the professional development needs of K–12 biology/health teachers and other school personnel; (2) weekly, interactive telecommunication broadcasts for students during the academic year; (3) intensive, 5-day workshops that train five selected teachers at a time (10 per year) to use an authoring software program to develop grade-appropriate interactive, computer-assisted, instructional (CAI) modules for Internet (http://k14education.uams.edu) use by teachers and students; (4) a monthly science night for students and their parents at a local science magnet high school; (5) field trips to the UAMS campus for teachers and their students; (6) community-requested presentations by program faculty; and (7) availability of earning undergraduate and graduate credit for science education majors in the College of Education, University of Arkansas at Little Rock. The data presented in this report span the period from 1991 through 2001. For all program activities, 14,084 different participants have consumed a total of 50,029 hours of education. ***Anat Rec (New Anat) 269:181–193, 2002.*** **© 2002 Wiley-Liss, Inc.**

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A NATIONAL PROBLEM

Our nation is at risk relative to science and mathematics education at the K–12 level (see Bland and Engler, 1992; O'Sullivan et al., 1997; Moreno, 1999). The problem is well known and serious (AAAS, 1993; NAS, 1996). In a study of 50 countries in the Third International Mathematics and Science Study (TIMSS; see NCES, 1998) twelfth-grade US student performance was among the lowest recorded. The problem may be more severe in rural schools (Stern, 1993). This national problem has a negative impact at a variety of levels.

In the broad sense, our nation needs to (1) increase the overall science literacy for all students/all citizens, and (2) increase health education literacy for all citizens. All citizens need to have the training and mental tools to make informed decisions about the impact science has on the individual and the world (NSRC, 1997; NRC, 1998). In addition, the US Public Health Service publication *Healthy People 2010* (USPHS, 2000; http://www.health.gov/healthypeople/) lists the major, national health concerns: "tobacco use, substance abuse, responsible sexual behavior, injury and violence, cancer, chronic kidney disease, osteoporosis, diabetes, heart disease, stroke, HIV, immunization and infections, blood pressure, nutrition, asthma, sexually transmitted diseases, vision and hearing, maternal, infant, and child health," etc. The theme is that all citizens should have a better understanding of those factors that favor personal and, therefore, national health. In a narrow sense, the problem effects the quantity and quality of students selecting a career in science or medicine. "We must have a society rich in both critical, creative scientific thinkers and enough knowledgeable experts to do today's work" (Maienschein et al., 1998).

Consequently, curricular change and educational reform is upon the land. A popular approach is that inquiry-based methods (the "less is more" theory), which teach students to ask questions, develop thinking/reasoning skills, construct and test hypotheses, communicate ideas to others, etc., will better prepare them for the future (Schmidt et al., 1996; Vogel, 1996; Pratt, 1998) than the older method of covering large amounts of material in the traditional lecture-based session. "The abilities to use scientific information, to think critically, and to solve problems related to the natural and man-made worlds are valuable habits of mind that contribute to both individual and societal well-being" (Moreno, 1999). This thought has fostered the creation of inquiry-based education programs. New inquiry-based science learning programs are being produced by commercial publishers as well as non-profit organizations. Programs emphasizing research-type training for K–12 teachers and/or students in modern laboratories are increasing.

Proponents of the inquiry-based approach offer the criticism that what is laboriously learned in school by way of the lecture approach is forgotten rather quickly (Higbee, 1977; Bahrick, 1979). However, some research has found no evidence that forgetting occurs as rapidly as commonly assumed or described (Semb and Ellis, 1994). Much information learned in the lecture-type educational experience can be useful many years after initial acquisition.

Inquiry-based training for middle and high school life science teachers is offered by the American Physiological Society in its "Frontiers in Physiology" program (APS, 2001). Frequently "inquiry-based or research-type" training concentrates on molecular/cellular biology (see chapters by Alberts, States, Colvin, and Kim in Sussman, 1993). An example would be the hands-on workshop for teachers at "DNA Boot Camp" in the Dolan DNA Learning Center at Cold Spring Harbor Laboratory (Arenson, 2001) and "City Lab" (DeRosa and Phillips, 1999) for students (see also Lewis et al., 2002).

By program design, the "less is more" approach is narrowly focused and, therefore, cannot address the need for literacy for *all* citizens/*all* students in the breadth of health topics listed in *Healthy People 2010*. With the limited resources available for K–12 health science education a legitimate question arises: "Can our nation afford to train teachers and students to have a detailed, in-depth understanding of the scientific process gained from, for example, a mini-research experience involving transgenic organisms-gene therapy, without putting at risk education that will provide *all* students with a basic understanding of the structure/function and major diseases of the organ systems in the human body?"

In the broad sense, our nation needs to increase the overall science literacy for all students/citizens and increase health education literacy for all citizens.

TRAINING TEACHERS VS. TRAINING STUDENTS

A report by the American Association for the Advancement of Science (AAAS, 1989) was entitled "Science for all Americans: A project 2061 report on literacy goals in science, mathematics and technology." *Healthy People 2010* expands this concept to include health science education and literacy for all citizens for basically all human organ systems and their major diseases. This national need for increasing science literacy *and* understanding of health and disease for *all* citizens is too large to be solved by direct teaching of small groups of K–12 students by practicing scientists and/or clinicians.

Programs designed specifically for teaching by active scientists directly to K–12 students are very effective (Thomson et al., 1987; Miller et al., 1989a,b, 1991; Cunningham and Kunselman, 1999; DeRosa and Phillips, 1999). This approach, however, obviously is limited by the unending and annually renewable supply of K–12 students "in need." Offering mini-apprentice programs to small groups of K–12 students has minimal impact on the overall problem of the lack of interest in and/or the understanding of science by *all* students and citizens in the nation.

Hudson (1996) proposed that the goal of national excellence in science for all of our students can only be realized if we have "highly trained, motivated science teachers for all of our students, regardless of the state or community in which they teach." The basic premise is that one teacher impacts thousands of students during her/his professional lifetime. Crosby (in Sussman, 1993) concluded, "the key to any reform of education is the teacher." Training/re-training of teachers has many problems associated with it such as (1) the barriers between schools of education and science on the same or dissimilar campuses (Summerfield, 1996), (2) the low quality of the teaching of science (Weaver, 1984), and (3) the low quantity of well-trained science teachers (Hudson, 1996). Consequently, medical and graduate school faculty have a significant responsibility here (Miller et al., 1989a; Holcomb et al., 1994). Manuals for collaboration between practicing scientists and K–12 teachers have been published (Sussman, 1993; AAAS, 1993).

Training (pre-service) and/or re-training (in-service) of the nation's science teachers is an effective approach to solving this problem. Therefore, in late 1990 when the Dean of the College of Medicine, I. Dodd Wilson, M.D., wanted our medical school to get involved in K–12 health science education, the "train the teacher" instead of the "train the student" approach was selected. All teachers, public and private, in the state would be invited to participate free. The program is called the "Partners in Health Sciences" (PIHS) program.

NEEDS ASSESSMENT OF ARKANSAS SCIENCE TEACHERS

A decision was made to base the functional structure of the PIHS program on the successful community-based public health (CBPH) model (Bruce and McKane, 2000). CBPH promotes

increased capacity of the citizens (teachers in our case) in a community to identify health and/or educational issues and articulate their needs within the context of the local culture and values, i.e., a sense of empowerment in the participants fosters successful engagement/participation and coalition building efforts, which result in viable partnerships.

In an attempt to custom design a retraining program for Arkansas K–12 science teachers that would meet their specific needs and be maximally effective for them and their students, a needs assessment survey of the members of the Arkansas Science Teachers Association teaching life science topics was conducted in the fall of 1990. Only one question was posed: "In your professional role as a teacher, which of the following activities have you/would you find the most educationally beneficial to you and your students? Possible responses were: (A) "An in-depth, hands-on, research-type experience, i.e., depth in one topic is more useful to me as a K–12 teacher than breadth of topic coverage"; or (B) "A program covering a variety of different topics many of which would have accompanying hands-on, mini-laboratory experiences, i.e., breadth of topic coverage is more useful to me as a K–12 teacher than depth within a topic." Only 9.5% selected the "in-depth" approach, whereas 90.5% wanted the "more is better," broader training. The most common comments made by the responding teachers can be summarized as (1) "I need more content training", (2) "I need teaching materials/supplies for direct use in my classroom", and (3) "I would select the summer research program if it provided a handsome stipend".

Because K–12 teachers are (1) professionally trained educators; (2) well-versed in local, state, and national "standards/frameworks"; and (3) trained to design and implement lesson plans in the K–12 classroom, a decision was made that the focus of the medical campus faculty should be on training in correct health science content. No attempt was made to design specific lesson plans for teacher implementation. In addition to the content training, materials and supplies complimenting the content would be provided, empowering teachers to use segments of content in grade-appropriate manners.

INDIVIDUAL COMPONENTS OF THE PROGRAM

Summer Mini-Courses for Teachers

To satisfy the broad content needs of the teachers, a cafeteria of mini-courses (most last for 1 day, others up to a maximum of 3 days) was designed and offered annually in June and July to all (public and private) biology/health science teachers, school nurses, and other school personnel in the state. Names and addresses were obtained from the Arkansas Department of Education, the Arkansas School Nurses Association, etc. During the first summer program and annually thereafter, a needs assessment was conducted of the program participants and used to design the content coverage for the following year. The content requested by the teachers is matched with appropriate (those capable of teaching at the K–12 level) UAMS faculty in the Colleges of Medicine, Nursing, Pharmacy, Health Related Professions, and the Graduate School. One faculty member volunteers to be the course leader and proceeds solo or involves other appropriate faculty members. Each mini-course receives a flexible budget, which with NIH funding consists of an average of approximately $3,000/course day. This funding is used to produce a course syllabus and purchase supplies/materials for the course and for the take-home "tool kits" provided to each participant.

This national need for increasing science literacy *and* understanding of health and disease for *all* citizens is too large to be solved by direct teaching of small groups of K–12 students by practicing scientists and/or clinicians.

Table 1 provides a list of all of the different mini-courses offered in the PIHS summer program from 1991 through 2001. Some have been offered annually, others only once. In most cases the topic was (1) requested during the needs assessment performed the previous year, or (2) was listed in the *Healthy People 2010* report. Because many of the PIHS faculty are productive, NIH funded research scientist/clinician scholars (several have held Research Career Development Awards) many of the mini-courses contain inquiry-based, modern biology training.

The general theme of a mini-course covering an organ or organ system is a mini-medical school curriculum. First, the normal structure and function of the organ/organ system is presented in a highly interactive "lecture/discussion" format with ample time for discussion of questions posed by the participants. This presentation is followed by a hands-on laboratory exercise, which usually includes the dissection of preserved animal organs, (e.g., hearts, brains, eyes, lungs, kidneys, etc.) that the participants take home in sealed buckets/bags. Concurrent demonstration of comparable human organs (normal and diseased) is an important part of this laboratory experience. The hands-on demonstration of functional human organ anatomy is extremely popular with the teachers, because they want to know that they are learning/studying the "real thing." The anatomy component of each mini-course includes the gift of 8 × 10 laminated color photographs of relevant material. Each figure is accompanied by a detailed explanation that serves as a teacher-guide to the content of the illustration. Teachers place these on bulletin boards and/or pass them among the students in the K–12 classroom. The anatomy segment is followed by an appropriate highly interactive physiology lecture/discussion experience that usually is followed by hands-on laboratory exercises such as use of blood pressure cuffs and stethoscopes, electrocardiograph, respirom-

TABLE 1. List of mini-courses offered by course title

A Day at the Cancer Education Center
Adolescent Medicine
Adolescent Risk Taking
Adolescent Sexuality & Reproduction
Adolescent Violence and Aggression
AIDS
Alcohol & Pregnancy
Alcohol: Pharmacology, Abuse and Addiction
Alzheimer's and Down's
Anatomy & Physiology of Kidney
Arkansas Health Careers/UAMS Health Career Enrichment
Attention Deficit Hyperactivity Disorder (ADHD)
Basic Neurobiology of Epilepsy
Biotechnology in Action
Blood and Sickle Cell Anemia
Bone Marrow Transplantation
Brain, Alcohol and Head Trauma
Breast Cancer
Cancer
Cardiovascular Anatomy and Physiology
Cell Cycle and Cancer Chemotherapy
Chronobiology
Common Pediatric Problems
Computer Simulation of Science
Continue the Connection—Workshop for Teachers: Statewide Science Initiative Training
Depression
Developing and Publishing Health Science Education Materials on the Internet
Diabetes
DNA and Human Identification
Domestic Violence
Educational Technology
Embryology
End of Life Issues
Ethics
Exercise Physiology
Eye & Ear
Heart
Heart Embryology
Human Body Workshop (Dental Hygiene, Nervous System, Teratology, and Cardiovascular Physiology)
Hypertension
Immunization Overview/Communicable Diseases in Pediatrics
Immunology
Integument
Internet, Virtual Reality & Health Science Education
Kidney
Kids & Drugs
Kids and Depression
Lifestyle: Role in Health Promotion & Disease Prevention
Lymphatic System
Managing Stress
Medical Genetics
Microbiology
Molecular Biology
Nervous System
Neurobiology of Learning
Neuroimmunology of Disease: Multiple Sclerosis, Alzheimer's Disease, AIDS Dementia and Beyond
Normal Muscle Function & Muscular Dystrophy
Nutrition
Parkinson's Disease
Pediatric Asthma
Physiology of Fitness
Placenta, Early Embryology and Teratology
Post Traumatic Stress Disorder (PTSD) and Adolescents
Radiation Biology—Clinical Applications
Reproductive Biology/Fertilization
Respiratory Anatomy & Physiology
Role of Diet in the Prevention of Cancer and Other Diseases
Sex, Pain and the Brain
Sex, Relationships, Cyber-porn, and Surfing in the Dot Com World
Sexually Transmitted Diseases
Structure and Function of the Endocrine System
Successful Aging
The Breast: Anatomy and Pathology
The Human Genome Project and Mammalian Cloning: Two Biological Milestones That May Shape the Future of Medicine
Tobacco in Modern Society
Transgenic Organisms and Human Gene Therapy
Trauma of the Central Nervous System: Spinal Injury and Neurological Diseases
Viruses and Viral Diseases
Women's Health Issues

eter, etc. The typical organ/organ system mini-course ends with a presentation by a clinician and a question-answer/discussion session. Each participant exits a mini-course with a "tool kit," which contains (1) a detailed course syllabus with illustrated chapters written by each faculty presenter, and (2) a variety of appropriate teaching materials/supplies such as buckets of preserved animal organs, items of laboratory equipment (power supply, electrophoresis apparatus), copies of videotapes/CDs, stethoscopes, and blood pressure cuffs, etc.

"Interest hooks" for both teachers and students are (1) any disease entity such as cancer, hypertension, diabetes, sickle cell anemia, sexually transmitted diseases, glaucoma, Alzheimer's, Parkinson's, etc., and (2) anything "fetal" or "reproductive." For example, in the heart course, the participants not only learn about the adult anatomy and physiology but also the fetal circulatory patterns and some of the major congenital heart defects, some of which are known to be caused by drug intake during pregnancy. In addition to dissecting preserved cow hearts (and taking them home) and performing electrocardiograms, heart sounds and blood pres-

Box 1: Examples of research-based "modern" biology courses for teachers

Normal Muscle Function and Muscular Dystrophy: a 1-day course directed by Charlotte Peterson, Ph.D., Department of Geriatrics, UAMS, contained the following hands-on laboratory training:

1) Use of light microscope to examine the differences between normal skeletal muscle and skeletal muscle from a patient with muscular dystrophy
2) Restriction enzyme digestion of dystrophin DNA
3) Gel electrophoresis to identify the dystrophin gene.

Viruses and Viral Diseases: a 2-day mini-course directed by Wayne Gray, Ph.D., Department of Microbiology and Immunology, UAMS, contained the following hands-on laboratory training:

1) Viral cytopathic effect
2) Viral quantification phage plaque assay
3) Laboratory diagnosis of viral diseases – check lab results from previous day
4) Use of serological kits (monospot test) to test unknown blood samples for infectious mononucleosis
5) Discussion: teaching virology in the K–12 classroom.

Microbiology: a 3-day mini-course directed by David Wennerstrom, Ph.D., Department of Microbiology and Immunology, UAMS, contained the following hands-on laboratory training:

1) Aseptic transfer of organisms
2) Isolation of organisms in pure culture
3) Microorganisms in the environment
4) Staining and observation of microorganisms
5) Genetic transformation
6) Plasmid isolation and electrophoretic analysis
7) Discussion: role of microorganisms in biotechnology.

sure determinations, participants learn about normal and abnormal heart sounds, see and receive copies of audio-visual tapes of coronary artery by-pass surgery, angioplasty, etc. These organ structure-function-disease based mini-courses specifically respond to the *Healthy People 2010* report (USPHS, 2000).

Other mini-courses are more "research orientated" such as the 3-day "Molecular Biology," the 3-day "Microbiology," the 2-day "Viruses and Viral Diseases," and the 1-day "Sickle Cell Anemia" courses. These courses have significant hands-on laboratory exercises, involving the use of relatively sophisticated equipment and techniques such as electrophoresis, bacterial plating, plaque assays, DNA restriction enzymes, serological test kits, etc. In every case where a hands-on laboratory exercise is offered to the participants, they are given enough of the instruments and supplies in their "tool kits" so they can replicate the laboratory experiments in their home classroom. To compare an organ-based, structure-function-disease type of course (see above) with "modern" biology, research-based courses, summaries of examples of 1-, 2-, and 3-day "research" courses are presented in Box 1.

An example of a mini-course that was custom-designed in direct response to requests by teachers when the O. J. Simpson trial was in the news was the "DNA and Human Identification" course directed by Gary Bannon, Ph.D., Department of Biochemistry and Molecular Biology. This course did not have any wet lab hands-on activities but did contain several inquiry based ("minds-on") exercises in which DNA banding patterns of child, mother, and several possible fathers were used to select the genetic paternal parent. Teacher training occurred in the following topic areas: (1) forensic biology—is recombinant DNA technology in its future?; (2) repetitive deoxyribonucleic acid (DNA) and human genome variation—relative to forensic biology; (3) application of DNA probes in parentage testing; (4) polymerase chain reaction–based DNA identification: a transition in forensic science; (5) population genetics issues in disputed parentage; (6) population genetics as it relates to human identification; (7) calculation of probability of paternity by using DNA sequences; (8) DNA and the courts.

A summary of the mini-course program is as follows: 79 different health science topics were taught by 143 different UAMS faculty in 184 mini-course days to 1,052 different teacher-participants who consumed a total of 30,459 hours of continuing education (CE). CE calculated as 7 h/course day per course participant (note that some teachers took only one course, whereas others may have taken 20 or more days of coursework).

All UAMS faculty and all K–12 teachers, school nurses, and other school personnel participating in the mini-course program volunteer their time and effort. The UAMS faculty involved list this activity as part of their community service obligation. The school personnel participating are given CE credit, which is officially honored by the Arkansas Department of Education (ADE) as satisfying part or all of the hours of "in-service" professional development required of teachers annually to maintain certification. In addition to the faculty volunteers, UAMS provides as "in kind" support (Office of Academic Services) the use of lecture and laboratory teaching facilities, AV media support, and a part-time technician for all PIHS laboratory exercises. For all 1,052 different participants 86% were women and 14% were men; 85% were white and 13% were African American (25% African American teachers attended the "Blood and Sickle Cell Anemia" course) and 2% were other. For all participants, 91% came from middle or high schools (grades 7–12) and 9% came from elementary schools (grades K–6).

Telecommunication Outreach for Students

Wittson et al. (1961) have been credited as the first to use telehealth for medical purposes when, in 1959, they established telepsychiatry consulta-

TABLE 2. List of interactive television (ITV) outreach program topics

A Day in the Life of a Genetic Counselor
Alcohol and Head Trauma
Anatomy and Pathology of the Skin
Anatomy of the Human Brain
Anatomy of the Human Heart
Asthma: A Major Allergic Emergency
Behavior of Cancer Cells—Can It Be Changed?
Cancer
Cardiac Physiology
Cell Cycle and Mitosis
Chemistry of Some Anti-Cancer Drugs
Clinical Chemotherapy of Cancer
Club and Recreational Drugs: Information You Need to Know
Depression in the Classroom
Diseases of the Close Kind (STDs)
Gametogenesis, Fertilization, and Cancer Biology
Genes and Cancer
Genetic Engineering (Insects)
Inside the Darkside of the Tobacco Industry
Interview of Course Faculty by ASMS Students
Keeping the Beat: How to Treat Heart Disease
Kids & Drugs: How Much Do You Really Know?
Kids and Depression
Making Cancer Cells Behave
Medical Biology of the Skin
Molecular Biology of Muscular Dystrophy
Muscular Dystrophy: Can We Repair Muscle Defects with Gene Therapy?
Return of the Swallows and Other Hard to Stomach Tales
TB or not TB: A Biotech Question
Testing Anti-Cancer Drugs in Vitro
The Crooked Cell: Sickle Cell Anemia
The Functional and Dysfunctional Brain
Uncle Joe Wants You: The Tobacco Industry and Teens

tions between two sites 112 miles apart. Telehealth-telemedicine has grown tremendously since then (Perednia and Allen, 1995; Mair and Whitten, 2000). This "interactive television" (ITV) technology has even brought health care into the elementary school setting (Whitten et al., 2000). This technology is two-way audio/two-way video in real time and, if used properly, can be highly interactive. All participating teachers receive a videotape of the program they and their students attended. Many times the teacher replays the tape and goes over the content again.

UAMS has a telemedicine network connecting the main campus in Little Rock with approximately 50 distant sites in rural hospitals, Area Health Education Centers, and community colleges in all geographic locations in the state. The PIHS program uses this network to offer weekly 1.5-h highly interactive broadcasts to teachers who are alumni of the mini-course program and their students. Teachers sign up on a first-come/first-serve basis and then field trip their students to an ITV studio close to their school. UAMS faculty presenters are usually the same faculty that taught in the mini-course the teacher attended previously. Connectivity between the UAMS statewide telemedicine network and other telecommunication networks in the nation and the world is a technical reality.

Table 2 lists the titles of the different ITV programs offered. Each program usually is duplicated three to five additional times to keep the number of classes or sites participating to no more than five. This method fosters interactivity between students and the faculty presenter. Interactivity is the most important feature of this educational technology. The absence of interactivity between the presenter and the participants using this medium is the equivalent of watching a one-way, "talking head" videotape.

The ITV program has grown from the first broadcast in the fall of 1996 to 16 students at only one distant site (Arkansas School for Mathematics and Science, Hot Springs) to weekly broadcasts during the regular academic year. Because of the interstate connectivity between telecommunication networks, some of the UAMS telecommunication outreach broadcasts have involved not only Arkansas students, but simultaneously, students in the following states: Montana (three high schools), West Virginia (four high schools), Florida (students in a program at a science museum), California (one high school), and Louisiana (one high school). In all of these ITV broadcasts, the presenters were faculty from UAMS. In the fall of 2001, a special event occurred when, for the first time in the history of the UAMS K–12 telecommunication program, a non-UAMS faculty member presented to students in Arkansas as well as to students in his own community. In this way, Samuel Shacks, M.D., Ph.D., at King-Drew Medical Center, Charles R. Drew University of Medicine and Science, Los Angeles, CA, held interactive sessions for Arkansas as well as California high school students on "Asthma: A Major Allergic Emergency." On February 20, 2002, PIHS-ITV held its first international ITV program to students in Kaoshiung, Taiwan. On July 8, 9, and 10, 2002, an entire PIHS mini-course on "Cancer" was taught from UAMS by ITV to high school teachers attending "The Howard Hughes Medical Institute Pre-College Summer Research Program" at the University of Louisiana at Monroe, LA.

Perhaps more important than the content covered in an ITV educational session is the direct, hands-on student experience with this sophisticated technology. Students learn they can interact with different groups at different geographical locations simultaneously in real time without the need for travel.

Our experience with ITV outreach to students is summarized as follows: 12,414 h of education have been consumed by 8,276 students in 33 different topics presented by 29 different faculty in 119 sessions lasting 90 minutes each. For all participants, 61% were female and 37% were males (2% no response); 70% were white and 22% were African American (7% NR, 1% other), and 91% were 18 years old or younger.

TABLE 3. List of computer-assisted instruction titles

A Mole in Chemistry?
A Problem with Nerve Conduction
Alcohol and It's Effects on Body Organs
Analyzing Graphics and Visuals: Using the OPTIC Strategy
Articulations: Anatomy & Physiology
Basic Chemical Reactions
Biological Weapons: An Overview
Blood Pressure
Cell Organelles
Cellular Respiration
Chemistry Lab Equipment: Names & Uses
Chronobiology
Classification: Three Domain System
Common Sense? Technology in Medical Diagnosis
Data Confusing? Then Record It and Graph It!
Depression in the Classroom
DNA: Basic Replication
DNA: Morse Code for Life
Energy Transfer and Fertilization
Flowers, Fruits and Seeds
Genetics: Chromosomes and Karyotyping
Genetics: Punett Squares
Handwashing for Health
Heart Smart: A General Heart and Blood Tutorial
Histology: General
Histology: Muscle Tissue
Hormones and the Endocrine System
Human Pedigree Analysis
Inherited What? (Pedigree Study)
Ionic Compounds: Naming and Writing Formulas
Lighthouses: Then and Now
Meal Worm Respiration
Osmoregulation & Excretion in Mammals
Osmosis
Osmotic Solutions
Parts of the Brain and Brain Disorders
Protein Structure
Recombinant DNA Technology
Science Fair Projects
So Let the Sun—Shine In? (Skin Cancer)
Test Your Lifestyle
The Cell Cycle
The Earth Around Us
The Knee: Anatomy and Injuries
The Six Kingdom System of Classification
Trashing of America
U.S. Space Program
Viral Diseases of the Skin
Welcome to the Mysterious World of Germs

CAI Authoring Workshops for Teachers

The mini-course program coupled K–12 teachers as education experts with UAMS faculty members as content experts to address the content needs of the state's health science teachers. To obtain maximal educational impact of the best of the PIHS-retrained teachers on the largest number of K–12 students, a decision was made to use the Internet as a major dissemination medium. In addition, instead of asking UAMS faculty to attempt to produce instructional materials for use by grade 7–12 students, we elected to use the education training and expertise of selected PIHS alumni to author grade-appropriate CAI modules. To accomplish this goal we trained selected, highly motivated, K–12 teacher-alumni of the PIHS program how to author a CAI program on a topic of their choice that would be appropriate for the grade 7–12 student. Five highly motivated teachers were selected and offered the opportunity to participate in a 5-day workshop to learn how to use authoring software (Authorware). For this intensive training the teachers were paid a stipend for attending the workshop and producing a finished CAI module. Many of the CAI modules produced have been placed on our Web site [http://k14education.uams.edu]. Two such workshops are usually held annually. Table 3 lists the different CAI modules authored by teachers completing the workshop. (Note: each workshop participant was asked to develop a CAI module "on their favorite topic." We assumed that would be interpreted as a "health science topic." All participants responded accordingly except one who produced a CAI module on her favorite topic, "Lighthouses: Then and Now."

In summary, the CAI workshop program involved 2 faculty, mentoring 53 different teachers, who consumed 1,855 h of instruction in 265 workshop days. For all workshop participants, 86% were women, 14% were men, 94% were white, and 6% were African Americans.

Science Night at a Science Magnet High School

The UAMS College of Medicine "adopted" a local science magnet high school (Parkview High School-PVHS) approximately 15 years ago, providing the high school students with tours of the medical sciences campus, some shadowing opportunities and UAMS faculty participation in PVHS career day. The PIHS program expanded this commitment by adding a monthly science night for students and their parents during the school year. A presentation is made by a UAMS faculty member at the high school. On purpose, not all of the presenters are M.D. or Ph.D. level faculty: nurses, radiology technicians, social workers, etc., are included. Each presenter first introduces himself/herself in detail, providing the students with a look at the different academic paths taken by different health professionals. After this self-introduction, which begins when the speaker was a senior in high school, the speaker talks about his/her job responsibilities and/or an appropriate health science topic. In this way, the high school students realize that careers in the health sciences are available at a variety of levels of educational accomplishment. The topics presented in this program are listed in

TABLE 4. List of topics—Parkview High School Health Sciences Lecture Series

A Cancer Cell, A Mouse Embryo and a Zebra
A Day in the Life of A Genetic Counselor
Accidents and Brain Injuries
Beavis and Butthead: Human Models for ADHD? Hyperactive Rats: Rodent Models for ADHD?
Can't We All Just Get Along? Anger, Aggression, Violence and Depression in Teenagers
Choices, Choices and More Life Choices
Club & Recreational Drugs: Information You Need to Know
Diabetes 101 Plus
Diet, Oral Hygiene and Dental Disease Prevention
How Scientists Test for New Anti-Cancer Drugs
I've Fallen and I Can't Get Up: Falls in the Elderly
Kids and Drugs—What's the Connection?
Mammalian Cloning: A Sheep in Wolf's Clothing
Pain and the Brain: Does Everyone Feel It The Same Way?
Perform Better: Nutrition as the Key
Putting Humpty-Dumpty Back Together Again: The State of the Art in Reconstructive Surgery for Cancer of the Head and Neck
Radiology: The Inside Story
Stop the World I Want to Get Off—Teen Stress
The Beat Goes On—Cardiology for Kids
The Human Genome Project
To Date or Not To Date, This Should be the Question: Dating Violence
When I Am Old, I Shall Wear Purple, The Art and Science of Aging
X-rays, A-Bombs and Cancer—The Good News about Radiation

Table 4. A summary of the PIHS science lecture series at PVHS is as follows: 23 different faculty presented 23 different topics to 2,150 student-parent contacts for 2,150 h of education consumed. For all participants, 49% were males, 61% were females, and 63% were African-Americans.

Student Field Trips to the UAMS Campus

It is known that student recollections of field trips are engendered from (1) personal involvement (positive or negative) of the student, and (2) links between the topic covered in the field trip with the same topic coverage in the K–12 classroom (Wolins et al., 1992). Therefore, it is valuable for medical science campuses to host meaningful field trips for students and their teachers. Exposing the visiting students to more than a "tour" experience has more educational benefit. Therefore, PIHS designed field trip experiences to the main campus to include special lectures on important topics. In this way, a PIHS field trip consumed approximately 3 h on campus and usually included feeding lunch to a large number of high school students. Table 5 lists the different topics presented in the PIHS Field trip program. Approximately 60% of these are presented by non-UAMS faculty such as the presenters in the Howard Hughes Medical Institute's Holiday Lecture series. In summary, 12 different faculty presented 16 different topics to 976 student contacts for a total of 1,527 h of education consumed.

Community-Requested Presentations by Program Faculty

Physically moving program faculty from the medical sciences campus to schools thoughout the state consumes a significant amount of faculty time for round-trip travel as well as program presentation. The most efficient way to deal with this situation is to use telecommunication technology (see earlier). However, sometimes the needs of the local school/community cannot be adequately met using telecommunication technology and the physical presence of a faculty presenter is necessary, especially when parents are involved as well as the teacher and her/his students and the topic is "sensitive." To satisfy this special need, program faculty have presented the following topics to students at their schools and to parents and teachers at PTA meetings: "Aspects of Managing Life—Threatening Illness and Its Impact on the Family," "Club and Recreational Drugs—Information You Need to Know," and "Safety for Kids and Porn on the Internet." The special nature of the community need for these "in person" presentations can be appreciated by the topics presented. Note: two tragic events in Arkansas brought forth the special need for "on site" visitation/presentation by program faculty: (1) a high school student died of a "club" drug overdose at a "rave party," and (2) the school shootings in Jonesboro. In summary, four different faculty presented three different topics in three sessions to 1,577 students who consumed 1,624 h of education.

College Credit for Participating Pre-Service and In-Service Teachers

In an attempt to get more science content into the teacher-in-training curriculum in the College of Education (COE), University of Arkansas at Little

TABLE 5. List of topics: Student field trips to UAMS*

Kids and Drugs: How Much Do You Really Know?
Kids and Depression: How Much Do You Really Know?
Inside the Darkside—Inside the Tobacco Industry
2000 and Beyond: Confronting the Microbe Menace (HHMI* Lecture)
Clockwork Genes: Discoveries in Biological Time (HHMI Lecture)
Molecular Biology and Cancer Research (Visit to UAMS by High School Students in a HHMI Sponsored Program, University of Louisiana, Monroe, LA)

*HHMI, Howard Hughes Medical Institute Holiday Lecture Series; UAMS, University of Arkansas for Medical Sciences.

TABLE 6. Results of questionnaire sent to 302 alumni (1991–1995) of PIHS mini courses

Question	Response[a]
The PIHS program should continue.	4.90 ± 0.04
My PIHS experience, in general, was professionally beneficial to me as a teacher.	4.70 ± 0.05
My PIHS experience, in general, was beneficial, through me, to my students.	4.56 ± 0.06
I learned at least some new information related to the health sciences in the PIHS program.	4.78 ± 0.04
The syllabus and/or other handouts or booklets or copies of computer programs or video tapes provided by the faculty was (were) helpful/useful.	4.52 ± 0.06
The PIHS course(s) I attended were well taught.	4.77 ± 0.05
The PIHS course(s) I attended had a positive motivational impact on me.	4.61 ± 0.06
I felt a collegial connection between myself and the PIHS faculty.	4.31 ± 0.07
I repackaged at least some of the material I learned in the program and presented it to my students.	4.25 ± 0.08
I have done some new demonstrations and/or laboratory type exercises for my students as a direct result of my PIHS experience.	3.89 ± 0.09
The letter I received from the PIHS program director at the end of the program listing the total number of contact hours I consumed is useful and important to me.	4.53 ± 0.07
My school district gives me staff development credit for the contact hours of instruction I consume in the PIHS program.	4.43 ± 0.14
I would like to be able to get graduate credit for the work I do in the PIHS program.	4.59 ± 0.10
I would like to see some UAMS-PIHS faculty visit or interact with my students using two-way interactive video technology.	3.81 ± 0.10
When I leave each PIHS course I have taken I would like to leave with even more take home supplies, materials and inexpensive items of equipment.	4.47 ± 0.08
One of my biggest problems in teaching what I consider to be essential information to my students is the lack of sufficient supplies, materials and/or equipment.	3.86 ± 0.11
The material given to me in the PIHS program was useful for my students, e.g. slides, tapes, computer simulations, handouts, reprints of articles, etc.?	4.42 ± 0.07
The facilities at UAMS encouraged you to encourage your students to think about attending UAMS if they were interested in a career in any of the Health Sciences.	4.16 ± 0.10
In general, my experience in the PIHS program was one of the most beneficial/useful events in my continuing education.	4.48 ± 0.07

[a]5 = strongly agree; 4 = agree; 3 = not applicable/do not know; 2 = disagree; 1 = strongly disagree. N = 99 (33% response).

Rock (UALR), the COE and the PIHS program entered into the following partnership: Pre-service teachers would receive undergraduate or graduate credit toward their education degree requirements by attending 5 days of mini-courses of their choice in the PIHS summer program. A faculty member in the COE (Cheryl Grable, Ed.D.) monitors this program and sets academic requirements that involve the writing of lesson plans, evaluation of the various teaching methods used or not used by the UAMS-PIHS faculty, etc. This program began in the summer of 2000. Since then, 13 master's level and 14 bachelor's level students in science education in the COE/UALR have earned college credit for attending PIHS mini-courses. For all of the education majors participating in the PIHS program 68% were females, 32% males; 32% were African Americans, 59% were white with 9% other.

EVALUATION

Two types of program evaluation have been performed. Each program event is evaluated according to "satisfaction" criteria such as good speakers, good use of audiovisuals, effective laboratory, enough time for questions, topics you would like to see presented in next year's program, etc. The program was modified annually in response to the data generated by this evaluation tool.

Two outcomes studies have been performed: one at the 5-year mark and one at the 11-year mark. After 5 years experience in the PIHS program, a questionnaire was sent to 302 alumni of the program with a 33%

TABLE 7. Results of survey completed by 300 alumni (1991–2001) of PIHS mini courses*

Question	Yes (%)	No (%)	Not applicable or not yet (%)
Have you participated in more than one summer PIHS mini-courses prior to 2001?	77	23	0
Are you a teacher?	50	50	0
Are you a school nurse or counselor or other school personnel?	48	50	2
In regard to your personal, professional development was your PIHS training a positive experience for you?	99	0	1
In your opinion was this training experience valuable, through you, for any (one or more) of your colleagues?	97	2	1
Was this training experience valuable, through you, for your students ("patients" if school nurse or counselor)?	94	1	5
Did you share some of the information you learned in the course(s) and/or the course syllabus(i) with your colleagues?	93	3	4
Did you share some of the information you learned in the course(s) and/or the course syllabus(i) with your students ("patients" if a school nurse or counselor)?	83	5	12
Did you perform any new laboratory-type exercises or demonstrations with your students as a result of your PIHS training?	36	46	18
Did you use any of the supplies or materials such as color laminated photos, videotapes, preserved organs, reprints, texts, charts, etc. with your students/patients?	76	10	14

*PIHS, Partners in Health Sciences program.

response rate. Some of the descriptors dealt with topics not applicable to this study (e.g., "if you stayed in the student dorm were the accommodations acceptable?") and are not included in this report. The results of this survey appear in Table 6 and are self-explanatory. The highest ranked item was the 4.90 rating for "the PIHS program should continue." Noteworthy was a rating of 4.25 associated with "I repackaged at least some of the material I learned in the program and presented it to my students."

In the fall of 2001, another survey was conducted of all 1,052 different alumni of the PIHS program of mini-courses, with a return rate of 30% (n = 300). The results of this survey appear in Table 7. The data accumulated were entered into an Excel spreadsheet and subjected to analysis by using SPSS (Statistical Program for the Social Sciences) version 10.1 software for Windows. For comparison, variables were grouped into areas of specific interest and then analyzed at a descriptive statistical level. All incomplete surveys were included in the analyses, therefore, the percentage data do not always total to 100%. No inferential statistics were performed, as the main focus of analysis was limited to a descriptive review of the survey data. This strategy allows the data obtained to be examined in a variety of ways.

Of the respondents to the survey, only 36% reported that they performed new laboratory-type exercises/demonstrations with their students and 46% answered "no"; however, 48% of the overall respondents were nurses and might be expected to say "no" to this question. By using SPSS to select out the responses of only the teachers and compare this with non-teacher respondents, it was discovered that 54% of the teachers reported that they performed new laboratory-type classroom experiments or demonstrations for their students as a direct result of their participation in the PIHS program. Interestingly, 17% of the non-teachers stated that they too performed a new experiment or demonstration with their "patients."

Seventy-six percent of all respondents stated that they used the supplies/materials provided in the "tool kits" with their students/patients. As expected, participants who previously attended the program before 2001, i.e., were not attending the program for the first time in 2001, accounted for more PIHS-based, classroom activity than the first-time participants: 97.0% vs. 84.3% for "valuable experience for students/patients"; 86.5% vs. 82.9% for "share with colleagues"; 87.5% vs. 44.3% for "use supplies"; and 40.9% vs. 18.6% for "lab/demo with students". The largest discrepancy between the new and prior alumni was for conducting a laboratory experiment or demonstration. This finding was expected, because the survey was performed only a few

months after the completion of the summer program and most of the participants probably did not have enough time to design and offer a new lab exercise or demonstration for their students. The data indicate that, with time, the first time attendees will increase the number of laboratory experiences and/or demonstrations they perform for/with their students. No differences were found between rural- vs. urban-based participants for all categories: 93.6% vs. 94.9% for "share with colleagues", 85.5% vs. 85.3% for "share with students", etc.

Arkansas is a rural state. Teachers and students in cities have access to more educational interaction than do those living in smaller communities. Therefore, it becomes important to determine whether the needs of the rural-based teachers and students were being met by our program activities. A study of the registration data for all 1,052 different alumni of the summer mini-course program indicated that 56% were rural-based vs. 44% urban-based.

DISCUSSION

One of the most successful components of the program is the annual needs assessment, in which the participants request the content they believe they need. When these data are analyzed, the program director then seeks out the appropriate course leader from the UAMS faculty and in many cases the requested topic is presented during the following year. During the needs assessment performed in 2001, the following topics were frequently requested: (1) stem cells and stem cell research, and (2) bio-terrorism (anthrax and smallpox). For PIHS 2002, therefore, we plan to offer a mini-course specifically dealing with each of these topics. We can also predict topics that are important to present and will be well attended. For example, in the 2002 program, there will be a 1-day course entitled "Making Educational Technology Work For Teachers." This mini-course will be the program's direct response to a new certification requirement announced by the Arkansas Department of Education in its Rules and Regulations Governing Professional Development, requiring a minimum of 6 h of in-service training in "educational technology." In this way, the PIHS program has customized its offerings to match the needs of the participants or the needs of the time.

In general, participation in the PIHS mini-courses dealing with behavioral science topics such as depression, attention deficit hyperactivity disorder, managing stress, posttraumatic stress disorder, etc., was higher than the rate of participation in the mini-courses dealing with non-behavioral health science topics such as cardiovascular anatomy and physiology, cancer, cell division and chemotherapy, molecular biology, genetics, etc. Unfortunately, it appears as if teachers are spending significant amounts of time trying to understand and deal with these behavioral issues in the classroom (Kirchner et al., 2000) and, therefore, are in need of training in these areas. This finding has to have a negative impact on the amount of science content that is being taught in the K–12 classroom.

One retrained, better equipped, motivated teacher will directly impact thousands of students during a teaching career.

The demand (annual needs assessment) for training in behavioral science topics was so intense that a replicate program called Partners in Behavioral Health Sciences (PIBHS) was funded for 5 years by an additional, separate Science Education Partnership Award in October of 2000. The PIBHS program is codirected by a psychiatrist and a clinical psychologist in the Department of Psychiatry. Receipt of the second SEPA grant from the National Center for Research Resources-NIH in 2000 gave the UAMS College of Medicine the national distinction of being the only medical school in the nation to have two simultaneously active SEPA grants. Furthermore, of the 57 active SEPA grants in the nation in 2000–2001, the only one to focus exclusively on behavioral science/mental health issues was awarded to the UAMS College of Medicine.

All children (*all* citizens) should have excellent and equivalent science and health education even though only a small fraction of them will ever pursue a career in science (Rutherford and Ahlgren, 1989; NSRC, 1997; NRC, 1998). The problem is so large that excellent programs which directly train students instead of teachers cannot have as great an impact on the national problem as programs which train/retrain teachers. The most cost-effective approach seems to be the "train and equip the teacher" model. One retrained, better equipped, motivated teacher will directly impact thousands of students during a teaching career.

Propagating the PIHS Concept

For those readers interested in replicating or modifying the PIHS concept at their institutions, 11 years of experience has indicated several features that play key roles in fostering the success of the PIHS program:

1. A high level of administrative support is essential for maximal success. In our case, the initial idea was seeded by the Dean of Medicine (current UAMS Chancellor), I. Dodd Wilson, M.D. His continued interest and support has elevated the program to a campus-wide activity involving "in kind" use of appropriate campus teaching facilities and faculty volunteers from the colleges of Medicine, Nursing, Pharmacy, Health Related Professions, and the Graduate School.
2. Committed faculty volunteers who are capable of teaching at the K–12 level is essential. Not all well-meaning faculty members can teach at the K–12 level, which is an especially challenging and rewarding experience. Long-term knowledge of the teaching ability of medical sciences campus faculty permits the most talented to be selected for the K–12 program (ERB, the PIHS director, has been at UAMS since 1968 and knows most of the faculty who can and cannot teach at the K–12 teacher/student level). All UAMS-PIHS teaching faculty volunteer their service; no salary off-

set is provided. Most of the PIHS faculty volunteers are parents and/or grandparents, and this fact sponsors effective volunteerism in addition to the university requirement that faculty perform some service role on campus and/or in the community.

3. Funding certainly helps produce an effective educational program, especially for the gift of supplies and materials to the participants. The larger the amount of funding, the more plentiful and sophisticated the course supplies and the take-home "tool kits" become. However, large sums of money are not essential. A relatively small level of funding from the discretionary pool that administrators control can support an effective program, as was the case for the first several years of the PIHS program. Without a high level of funding, a program could be offered that would provide participants with excellent, useful, needed, content retraining. If a school, college, or university makes the administrative decision and commitment to help solve this national problem, an effective program can be implemented without dependence on large sums of extramural funding. The private sector can also be encouraged to be involved. In our case, we use an "adopt-the-course" approach. In the 2002 version of the PIHS program of mini-courses, two private sector sponsors (The Bank of America and The Arkansas Cancer Coalition) have adopted (underwritten) one mini-course each.

A cadre of K–12 education "leaders" exists within Departments of Anatomy throughout the nation.

The Anatomist's Role in K–12 Education

In general, anatomists not only carry a larger than average teaching load for basic scientists, but they are some of the best teachers on campus (for example, see Drake (2002) and articles cited therein, which comprised a special issue on modern anatomy education; online at http://www.wiley.com/anatomy/education.html). In addition, most anatomy faculty members also are research scientists and, therefore, are very capable of incorporating inquiry-based teaching methods into the teaching of organ-based and/or more targeted research topics. Anatomy faculty members probably also know who among their colleagues in other departments are teachers capable of teaching at the K–12 level. Thus, a cadre of K–12 education "leaders" exists within Departments of Anatomy throughout the nation. Coupling this fact with the highly visual nature of organ-based functional human anatomy that is frequently requested by K–12 teachers and their students perfectly positions anatomy faculty to be leaders in helping the nation solve its problem relative to K–12 education reform in science.

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