

FORUM ON EDUCATION SUMMER 2001 NEWSLETTER

Forum News

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Teaching on the Web: Call for papers

The Fall issue will feature discussions of using the Worldwide Web for teaching physics, including online courses, online examinations and problems, video examples online, etc. Please communicate ideas for articles or short notes about Web teaching to Thomas Rossing (rossing@physics.niu.edu) before October 1.

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A Message from the Chair

Jack M. Wilson

Physics forms the foundation for modern society. It has made possible the world's largest industry, Information Technology and it created the tools, techniques, and concepts that have made biotechnology an exciting intellectual adventure. So why do I feel like society undervalues physics? Is it because the funding level for the physical sciences has gone from parity with the life sciences in 1970 to about a third of that today? Is it because I think the best and brightest students today elect computer science or the life sciences instead of physics as my generation did? Is it because several writers have decreed "the end of physics?"



I am not alone in having these thoughts. In this past year the National Research Council finished the most recent decadal survey of physics, led by the committee chair Thomas Appelquist of Yale. (Physics in a New Era: An Overview; Physics Survey Overview Committee, Board on Physics and Astronomy, National Research Council; 208 pages, 7 x 10, 2001. <http://www.nap.edu/catalog/10118.html>). I was a participant on this study. These questions were often discussed during the multi-year process of studying physics and making recommendations for the investment of resources in both physics research and education.

It is a vexing issue. As we examined various fields in turn, we were all excited by the tremendous progress, the promising prospects, and the intellectual excitement. We wanted to prioritize but that proved very hard to do. The opportunities are so enormous, and it was very difficult to compare opportunities in unlike fields. Rather than a strict prioritization, the committee endeavored to identify some of the very exciting prospects.

For the first time, education was a large part of the discussion in the committee. In the beginning, there were hopes for a separate NRC volume on Physics Education, but after two turndowns from NSF, it did not materialize. There was the usual jockeying between the research side of the house (MPS) and the education side (EHR) in which each wanted the other to take a bigger part. There were additional concerns raised over how this study might fit with the many other activities sponsored by AAPT, APS, and AIP. In the end we had to reconcile ourselves to having coverage in the main volume. The committee was broadly constituted with only one person (your Chair) primarily identified with physics education, but with several others who had strong secondary interests there.

The report ranged across the levels of physics education from K-12 through the graduate level. As the committee began its work, a fairly large group of physics educators was convened by Leon Lederman to discuss the issues. In such groups there is always a lot of support for addressing "the K-12 problem." Sometimes I worry that large groups of (primarily) higher education faculty discussing the "K-12 problem" sound a bit like passing the buck. Given the composition of the group, it was both surprising and pleasing

that they also focused very strongly on undergraduate reform efforts and made that the leading, but not sole, priority for the committee. Once the committee was constituted, and then re-constituted after the unfortunate death of the first chair, David Schramm, this issue was debated once again. Among some in the research community, there was a feeling that undergraduate physics was in pretty good shape and that we should instead focus on K-12. This gave us the opportunity to present the work of Hestenes, Halloun, McDermott, Hake, Redish, Mazur, Thornton, Laws, and others. We also identified (with the help of Edward F. "Joe" Redish) a number of promising approaches to undergraduate physics education. Many of these issues were not familiar to the other committee members. In the end, the report does put a lot of weight behind the undergraduate reform efforts. Of course the committee process and the NRC review procedures do "reduce the amplitude" of coverage of any issue, and I think that is especially true of the educational issues. Still the report does give strong encouragement to reform at undergraduate and at the K-12 level.

At the advanced undergraduate level, the report provides the usual strong support for undergraduate research involvement and for connecting physics to the changes in the world.

Nearly every educated American has heard of Moore's Law and knows that it means that computing power doubles in approximately 18 months, but how many know that Moore's Law is a direct result of the physics of creating small structures on silicon? Another doubling law suggests that the bandwidth deployed is doubling in even shorter time periods (sometimes called Gilder's Law). Without the advances in the physics of lasers, optics, detection, and amplification, this could not be happening. As an aside: the first criticisms leveled at the report complain that condensed matter is painted too much as the "handmaiden to technology." The physics community has a hard time taking credit for their own contributions to society!

At the graduate level, the committee struggled with the issues of doctoral supply and demand and with the creation of professional masters degrees. There was also an acknowledgment that PhD's career paths were changing, and that graduate programs need to change to respond to this.

The committee celebrated the "steady increase of the number of women involved in physics at all levels," while lamenting that physics continues to lag chemistry and mathematics in the number of women obtaining PhD's.

For those in APS and AAPT who wrestle with these issues on a day-to-day basis, there will be nothing new or shocking in the NRC report. Many will likely wonder why the committee was not bolder! For those of us who live our daily lives in the research universities, the NRC report can be seen as a welcome gesture of support from our colleagues who do not make their living as physics educators. I think the report does provide both the encouragement toward, and some pointers to, productive directions for physics departments.

I leave the report to you as a reading assignment due for the next newsletter. You will find the research sections to be accessible reading that provides a guide to much of the exciting present and future activity in physics.

In the next newsletter, I will try to take this discussion to the next level. Where will physics education need to go in the next decade? How does physics education fit with the rapidly changing world of higher education? Should the physics societies accredit physics departments the way that Engineering, Chemistry, Business and others accredit their own? Does physics have a role in eLearning or on-line education, or is that the purview of the schools of management and computer science?

See you next newsletter.

Jack Wilson is Chair of the Forum on Education. He is the founding Chief Executive Officer of UMassOnline, the University of Massachusetts Virtual University. Prior to this he was the J. Erik Jonsson '22 Distinguished Professor of Physics, Engineering Science, Information Technology, and Management and was the Co-director of the Severino Center for Technological Entrepreneurship at Rensselaer. At RPI Dr. Wilson led a campus wide process of interactive learning and restructuring of the educational program.

To the Editor of the Forum on Education newsletter:

It has always surprised me that so many of my physics colleagues really do retire from their profession at retirement age. It's so much fun to learn, teach, and do physics! Why would anybody want to stop doing it? However, I wasn't sure that I would still feel this way when I myself actually retired.

Well, retirement time came two years ago, and I can report that physics is in fact more fun than ever. When people ask me how I like retirement, my reply is that I'm having a great time and working harder than ever, it's just that nobody pays me for it. But that is why it's more fun, and more work, now: Since I needn't attend faculty meetings or teach heavy loads, I am free to learn, teach, and do the physics that seems most useful and interesting to me. It's better than a permanent sabbatical.

The point of all this is to invite others, as they approach retirement, to stay active. You have spent a lifetime building, with considerable help from your friends and your country, your knowledge and experience. Don't give it up now! Your profession and your country need your help. Write that article, that textbook, those letters to editors, that you have thought about but haven't had time for. Spread your knowledge by giving talks to local civic organizations, religious groups, and schools. Keep feeding that knowledge-- for example by following new developments in the current mind-boggling "golden age of cosmology." Reach out to local public school science teachers, by involving yourself with the APS or AAPT outreach programs. Talk about physics and related topics on local radio and television programs. Get involved in local, state, or national politics on behalf of science and science education. Bring your knowledge and experience directly to the public by running for political office. The APS and AAPT help form the lifeblood of our profession. Help them to prosper by volunteering for one or more of their various committees, by organizing sessions at meetings, by contributing to their publications, etc.

The list of possibilities goes on and on. There are enough useful and enjoyable professional activities out there to keep all of us occupied for more than our lifetimes. So when you retire from your "job," please don't retire from physics.

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HASP

Hands-on Activity Science Program

The Hands-on Activity Science Program (HASP) in North Alabama

R. Hugh Comfort

The Hands-on Activity Science Program (HASP) is a collaboration between the Institute for Science Education (ISE) of The University of Alabama in Huntsville (UAH) and eight North Alabama school districts. This partnership involves more than 1300 K-6 teachers and their more than 33,000 students. HASP has focussed on the use of inquiry-based instruction, and the development of a central materials center for sharing curriculum resources among the many schools. A descriptive synopsis of the program is given on our website, <http://www.dcs.edu/HASP>.

Dr. R. Hugh Comfort, a UAH physics professor, is the Director of the Institute for Science Education, which coordinates the program at UAH. Dr. John C. Wright, a retired chemistry professor and former president of UAH, originated the program in 1990 and has guided its evolution through two stages of development, supported by NSF, NASA/Marshall Space Flight Center, Alabama Space Grant Consortium, Eisenhower funding, and local industry. Most recently, HASP was supported by an NSF Local Systemic Change (LSC) grant to implement inquiry-centered science instruction in elementary grades (K-6) in five school districts; this grant was completed during this past school year and is now supported by the partnership districts, with some Eisenhower funding.

The HASP LSC project goals and objectives were:

1. To convert K-6 science programs to activity-inquiry science programs by:
 - Implementing an activity-inquiry curriculum
 - Using appropriate inquiry-based teaching strategies
 - Guiding instruction with authentic assessment methods
2. To secure the support from all five districts for a "Materials Resources Center" that develops these capacities:
 - To provide kits of materials for all modules as needed in the classrooms
 - To facilitate professional development of teachers and principals

- To assist in curriculum planning



Curriculum Implementation

The HASP districts adopted a curriculum based on four standards-based modules selected from [STC](#), [FOSS](#), or [Insights](#) at each grade. Science modules are refurbished and distributed by a materials center that is cooperatively financed by districts and operated by the university. One new module was introduced each year, and teachers participated in professional development addressing science concepts and processes, inquiry-centered teaching strategies, questioning skills, and cooperative learning prior to teaching the module. Inquiry-centered teaching involves students in *doing* science by formulating questions, designing and conducting experiments or observations, and analyzing the results, to determine the answers and to develop additional questions. The teacher's role is then one of facilitating this process rather than being a provider of knowledge.

Infrastructure

Teachers teaching teachers has been a key attribute of the HASP professional development design. Each year all teachers have experienced a minimum of 20 hours of professional development, and professional development quality control has been the responsibility of the UAH co-project director. Approximately 75 percent of school-year professional development was led by a Teacher in Residence (TIR), and approximately 25 percent was led by a district Lead Teacher (LT). With grant support, three TIR's were selected each year from teachers in the grant districts; they were released from teaching responsibilities for the year and worked under the supervision of the UAH co-project Director.

Coordinating a multi-district project such as this has taken special consideration. The HASP organizational structure has promoted shared decision making among the partners. Executive level issues that involve all districts are the purview of a Council of Chief Executives comprised of the school superintendents and the UAH Institute for Science Education (ISE) director. Budgets for instructional materials and professional development through the UAH ISE, and cooperative communication with the state school superintendent were examples of executive level issues. Operating level coordination has been facilitated through monthly meetings of a Design and Implementation Council of district co-project directors and UAH co-project director. Professional development, evaluation findings, and materials distribution have been common concerns of this council. The fact that the partnership has developed communication links among the grant districts and the university helps in the assimilation of new personnel into the project; and this has factored into maintaining stability.

The university has been the contact point for recruiting and guiding scientists for participation in the partnership. Scientists have helped plan and deliver professional development for teachers and principals. Preparation of scientists for this role was aided materially by the American Physical Society through their Teacher-Scientist Alliance program, at the time directed by Dr. Ramon Lopez. HASP was also selected to field test teacher science enhancement modules developed by Dr. Jerry Pine and colleagues at the California Institute of Technology under the Caltech Pre-college Science Initiative (CAPSI). In this program teams of teachers and scientists used the modules to lead classes to both provide science content enhancement for the teacher and model inquiry in the classroom, placing teachers in the roles of students in an inquiry-centered classroom.

Evaluation Findings

The Program and Evaluation Group (PERG) of Lesley College, the project evaluators, found in their midpoint evaluation that a high percentage of students was engaged in hands-on activities, worked in cooperative learning groups, and participated in dialogue with teachers to develop student ideas. The evaluation also provided evidence that teachers felt that they were provided support by colleagues and principals and that teacher and student interest in science was high.

In its final year evaluation, PERG identified four key HASP accomplishments:

- "The five district/university collaboration", with each partner sharing its considerable local strengths with the others.
- "Shared science curriculum; stable and effective materials resource center", with districts sharing "the costs of managing and maintaining a materials delivery system, which has served as a model for other start-up districts across the country."
- "Professional development program," that "has had an enormous impact on partner districts' and teachers' expectations for the design and implementation of professional learning opportunities."
- "Instructional changes; student achievement," with observations providing evidence that teachers' instructional practices were changing, and in districts that have tracked student test results over time, increased scores were noted among elementary-aged students.

PERG also pointed to two important lessons learned:

1. "HASP's extraordinary concept development workshops—the scientist/teacher teams who facilitated them, their structure and design, and the emerging impact on teachers' beliefs and practices—hold enormous promise."
2. "It is important to introduce teachers to effective ways to assess student knowledge and skills from the earliest sessions, and to engage teachers in looking at student work."

In addition to serving as a model to a number of other projects around the nation, HASP was one of eight exemplary programs of 'Inquiry-Centered Science in Practice' described in Science for All Children, prepared by the National Science Resources Center of the National Academy of Science and the Smithsonian Institution (*National Academy Press, Washington, D.C., 1997*).

Changes in Attitudes and Practices

The HASP partners have learned that reform has been facilitated by external stimuli. The presence of the university in the partnership has continued to be regarded as a strong plus by all districts. District co-directors have experienced professional growth through participation in the project and were especially cognizant of this benefit. The program (curriculum and teaching methodology) implemented in elementary grades is highly regarded in all districts and supported by parents and other shareholders.

Current Situation

HASP professional development has now entered a sustaining phase, *supported entirely by the districts*. The HASP district superintendents have agreed to support a full time staff person at UAH and Teacher-in-Residence to plan, develop, and deliver one day of science professional development per year for all teachers, with somewhat more time for lead teachers. Districts continue to provide co-directors in the planning of the professional development program which continues to support teachers at all stages of proficiency in inquiry-centered teaching. In addition, districts continue to support refurbishment of curriculum modules for use by their teachers.

After two years of planning and proposal submission, NSF has awarded funding for a new LSC project, "Middle Grades Hands-on Activity Program (MGHASP)" to implement inquiry-based science in grades 6-8 in seven of the partnership districts. This project serves 160 teachers and approximately 11,500 students. The boundary conditions and circumstances of the middle grades are very different from the elementary grades so many new approaches must be explored. But the potential pay-off for science in reaching students in these critical years and making science a positive rather than a negative learning experience makes it an essential next step. The experience of this and similar projects around the country has shown that all children are capable of learning science and enjoying it when facilitated effectively; one of our roles as scientists is to work with teachers appropriately to make that happen.

R. Hugh Comfort is Professor of Physics and Director of the Institute for Science Education at the University of Alabama in Huntsville. He is the Project Investigator for the HASP program.

A Model Physics Teacher Education Program

At Illinois State University

Carl J. Wenning

The Illinois State University Department of Physics has been working since 1994 to develop and implement a model bachelors-level physics teacher education program. During this past academic year, the final pieces of the program were put into place. Seven years ago the ISU Physics Department had one established pedagogically-oriented physics education course, and had just introduced a second. There were only four majors in the physics teacher education sequence at that time. Now, in 2001, there are six pedagogically-oriented physics education courses, with 22 physics teacher education majors and 6 minors. Next year's graduating class of physics teacher education majors will total five; two minors will also graduate after taking the full sequence of physics teacher education courses. This compares quite favorably with most physics teacher education programs.

The Physics Teacher Education program at Illinois State University prepares students to teach physics and at least one other subject at the high school level. This program provides a thorough study of representative fields of physics, plus training in astronomy, chemistry, and mathematics. The required program of study integrates a minimum physical science concentration of 48 semester hours with a professional education sequence of 22 semester hours and the University's general education requirement of 45 semester hours. All physics teacher education majors are required by state law to complete requirements for a second area of endorsement. Students are advised to take courses adequate to ensure broad-field preparation in science. To this end they are encouraged to take an eight-semester-hour, two-course sequence in biology. If students do not take this sequence, they most typically satisfy the requirement by taking an organic chemistry course. Using the broad-field preparation approach, students earn 56 semester hours in science; using the dual endorsement route, students earn 53 semester hours in science. A total of 115 clock hours of clinical experiences in area high schools are associated with required professional studies and pedagogically-oriented physics courses. Teacher education majors must complete not less than ten full weeks of student teaching in physics.

The program of study for physics teacher education majors at Illinois State University calls for two full academic years of preparation. Six courses constituting twelve semester hours of course work serve as the basis for preparation. Each of the courses may be described briefly as follows:

PHY 209 – Introduction to Teaching High School Physics (1 semester hour) This course provides 25 clock hours of pre-professional observations and activities within area high schools. It is structured as a weekly seminar in which students exchange information and share reflections derived from their clinical observations that are based upon professional teaching standards. Students take this course during the autumn semester of the junior year.

PHY 302 – Computer Applications in High School Physics (1 semester hour) This laboratory course assists prospective physics teachers to develop a working familiarity with the large number of computer applications and devices that might be encountered in secondary school physics classrooms. Students complete projects associated with generic instructional hardware and software, physics simulations, and CBL and MBL technology. Students learn detailed procedures for experimentation, and complete a capstone experimental project. This course may be taken during the autumn of the junior or senior years.

PHY 310 – Readings for Teaching High School Physics (3 semester hours) This course provides essential preparation for teaching high school physics that centers around developing scientific literacy in students. It provides students with philosophical and pedagogical background in the teaching of physics. Students learn physics and about the nature of science by participation in model inquiry-oriented lessons. Students take this course during the spring semester of the junior year.

PHY 311 – *Teaching High School Physics* (3 semester hours) This course is designed to bridge the gap between educational theory and practice. It provides students with a chance to apply their knowledge of physics, adolescent psychology, and pedagogical theory to teaching high school physics. Students continue to learn basic physics through participation in inquiry-oriented lessons. Students also learn about resources and special considerations relating to physics teaching. Students take this course during the autumn of the senior year.

PHY 312 – *Physics Teaching from the Historical Perspective* (3 semester hours) This course provides an overview of the development of classical scientific thought relating to physical phenomena with applications to pedagogy. Intense focus is placed on historically-oriented inquiry teaching, demonstrations, laboratory activities, and discussion leadership. Students take this course prior to but during the same semester as student teaching that occurs during the spring semester of the senior year.

PHY 353 – *Student Teaching Seminar* (1 semester hour) This seminar course begins by providing pre-student-teaching clinical experiences at future student teaching sites thereby ensuring a smooth transition as students become student teachers. Biweekly meetings during student teaching provide candidates with an opportunity to share experiences and reflections. Activities culminate in the creation of professional teaching portfolios. Students take this course during the spring semester of the senior year.

All physics education courses in the program of study tend to be student-centered, and are closely aligned with local, state, and national teaching and science teacher preparation standards. All assessments are performance-based. Illinois State University is fully accredited by NCATE as a teacher education institution. The physics teacher education program is fully accredited under NSTA guidelines for the preparation of science teachers. INTASC standards as well as teacher education's conceptual framework – *Realizing the Democratic Ideal* – form the basis of much of the program's clinical experience work.

Illinois State University's physics teaching sequence is coordinated by one staff member who is dedicated full-time to developing and teaching physics education courses, supervising student teachers, and advising majors. A program overview including teaching philosophy, student knowledge base, plans of study, course syllabi, assignments, performance-based assessments, grading rubrics, and clinical experiences are available online at www.phy.ilstu.edu. It is expected that physics teacher education faculty everywhere will find the resources available through this web site quite useful. Specific questions about the program or its materials may be addressed to Carl J. Wenning, program coordinator, at wenning@phy.ilstu.edu.

Carl J. Wenning is Lecturer in Physics and Coordinator of the Physics Teacher Education Program at Illinois State University. He can be reached at Campus Box 4560, Normal, IL 61790-4560.

K-8 Science Education through the Eyes of a Physicist

Ted Schultz

As a theoretical physicist who now devotes full time to promoting the systemic reform of K-8 science education to a hands-on, inquiry-centered approach, and to involving scientists in this process, I have found the environment and challenges in the worlds of physics and education, and the effects they have on physicists and educators, to be entirely different. Any physicist working in both worlds, or wishing to make a transition from one to the other, will have to learn about the differences. The observations presented here are intended to help that process along.

A few definitions: By "physicist", I shall mean someone whose perspective comes from doing pure and applied physics research. Physicists may also be engaged in education and administration, from which they might develop quite different perspectives, but I shall not consider these. By "educator", I mean anyone involved professionally in the science education of children. This includes teachers, school administrators, school-system administrators, state and national figures of all kinds, national standards writers, instructional materials developers and publishers, cognitive science researchers, college of education faculties, and even some scientists. The list is almost endless.

1. Complexity and Size. The educational system is far more complex and, in effect, far larger than are physical systems, and in at least four ways:

First, although a physical system may have several organizational levels (e.g., elementary particles, nuclei, atoms, etc.), it is usually possible to focus on one or two in any single investigation and ignore the rest. By contrast, although the educational system may also have several organizational levels (classroom, school, school district, state, nation), each with a different set of players, these interact so strongly that it is difficult if not impossible to ignore all but one or two levels. Thus, while there may be many physical systems, there is really only one mammoth U.S. educational system, although many educators may be involved with only a small part of that system.

Second, while physical systems may be coupled to external systems (e.g. the sources of applied fields, heat, and pressure and any measuring apparatus), these external systems are relatively few and their effects can usually be determined and controlled with some precision. The educational system is coupled to numerous external systems that play such important roles that they really must be considered a part of the system itself (e.g. teacher training institutions and departments, science departments at colleges and universities, educational research organizations, educational testing organizations, educational materials developers and publishers, educational advocacy organizations devoted to a wide and often conflicting range of issues, funding organizations, and political figures and organizations).

Third, in physics, although systems may be extremely large (of order 10^{23} particles in typical condensed-matter systems), the number of truly different kinds of subsystems, and especially of those in a given system (e.g. kinds of atoms in a particular solid), is very small, and subsystems of like kind obey identical laws. By contrast, the U.S. elementary education system, because of its great heterogeneity, seems far larger. It has 51 "state" jurisdictions, 16,000 school districts, 100,000 elementary schools, 1,400,000 elementary school teachers (most of whom have had little education in science, almost none of which was the kind we would hope they'd emulate in their own teaching), and about 24,000,000 elementary school pupils, and *in some important ways, all of these districts, schools, teachers, and pupils are different.*

Finally, physical systems don't have stakeholders (until particles like electrons, atoms, or molecules develop wills of their own). However, in the educational system, there may be many conflicting stakeholders: pupils, parents, teachers, school administrators, school boards, state departments of education, national administrators, advocates and lobbyists, higher-level educational institutions, teachers of education, educational researchers, and politicians at all levels. The contentions among these create problems for which physical systems, fortunately, have no analogue.

2. Measurability and Predictability. In physics, the fundamental quantities are all measurable, some with great precision. Furthermore, because the rules governing the behavior of various subsystems are usually known, the behavior of the systems is in some sense predictable, sometimes only in principle but sometimes with surprising precision. This ability of physicists to measure and predict breeds confidence that sometimes borders on arrogance (at least when viewed from the vantage point of a non-scientist).

In education, nothing comes close to being as measurable as things are in physics. The most interesting quantities, like the knowledge of science, ability to do science, long-term effects of education, ability of teachers to teach science, etc. can be "assessed" (the jargon word) only crudely, and since there are usually so many variables that can't be held fixed, reliable experiments are very hard to do. Furthermore, there are no sharp rules, much less laws, that characterize the behavior of any education subsystems or their interactions. Thus, the results of teaching in a certain way, of using certain instructional materials, or of instituting a certain educational program, are very hard to measure and are predictable only crudely, if at all. This inability in education to say with confidence that this is better than that, and certainly to say by how much, leads, I think, to insecurity and defensiveness..

These differences also produce notable differences between the way physicists and educators interact. Physicists are constantly disagreeing and questioning; tell some physicist you believe something and they immediately try to find a counterexample. The arguments get rather hot, but the end result is usually a defensible conclusion, or at least an agreed strategy for testing different contentions. Among educators, because defending conclusions is much more difficult, disagreement and questioning are often seen as more personal and threatening, so educators seek to avoid confrontation. Differences, if

resolved at all, are often resolved by appeals to authority or political maneuvering on a scale that is quite foreign to physicists.

This difference in approaches may account for the phenomenon noted by the renowned physicist Melba Phillips: the difference between science and education is that in the former, problems that are solved stay solved. Thus, while there are fashions in physics, they are fashions of what is considered interesting, not of what is believed to be true. Our understanding of the physical world progresses in one direction; rarely do we revert to a position held and abandoned long before. In education, where what is "true" is much harder to agree on and even harder to measure, fashions in what is valued are more common, and old views do return.

3. Relevant Time Scales. In physics, the interesting results of an experiment usually occur within days, sometimes within microseconds; in education, the ultimate effects may not occur for many years. This difference makes meaningful experiments in education far more difficult. One wants to know the effect of instruction not only on the student's understanding of science and his/her development of scientific skills and habits of thinking each day and by the end of a module, but also on the student's choices and behaviors in middle school, high school, college, and beyond. These are all important effects, and all essentially unmeasurable.

4. Inanimates vs. Humans. Physicists deal with particles and fields; science educators deal with human beings. This difference affects not only the predictability of their systems but also the way they operate. For example, feelings play little if any role in what physicists do but a very important role in what science educators, especially teachers, do (and don't do). When I first entered the world of science education, I was astounded at the number of greeting cards, gifts, and celebrations of personal events (not to mention baby showers!). In the world of physicists, only weddings, deaths, the commemoration of major work anniversaries, and the winning of major prizes receive that kind of attention.

The different role of feelings is also reflected in their choice of words. For example, physicists "tell", and the reactions of the person being told are usually ignored. Educators "share", and the reactions of the person with whom one is sharing are sensitively felt.

5. Substance vs. Mode. For physicists, what they communicate is far more important than how they communicate it; for science educators, the balance is very different. The differences are seen both in the way the two groups communicate and the extent to which they evaluate their communication processes.

For physicists, their discoveries are almost all that matters. Papers are often badly written; talks at meetings are often compressions into 10 minutes from what should take 3 hours; and the pervasive attitude in oral presentations, which are almost never read from a prepared text, is "here it is, come and get it". Some real care may be taken by some physicists, some of the time (e.g. in writing review papers and books), but little is expended on how research results are first communicated.

For science educators, how they communicate (which is really a form of education) is extremely important. At a conference, reading a prepared paper, with its carefully crafted prose and many well-turned phrases, is common. Also, educators' concern about communication extends well beyond the preparation of presentations. At several kinds of events evaluation sheets are distributed, something that occasions no surprise. If evaluation sheets were handed out after a physics seminar or colloquium, it would shock the speakers and audience beyond belief.

6. Questions vs. Answers. For physicists, asking the right question is most important; for elementary-school teachers, having the right answer often is. This statement is of course an oversimplification, but there's more truth than might first appear.

For the research physicist, good questions are the crux of the enterprise; research is a continual quest. The answers, when found, are certainly interesting, especially when they allow the quest to go on, and they are what gets published. But it is the unknown, not the known, that is most intriguing.

For many science teachers, questions are threatening, especially if from students. It is answers that make teachers more comfortable and that they are used to dispensing. This is not to say that physicists, when asked a question by almost anyone, don't just dump a lot of facts; they usually do. Or that undergraduate science education is inquiry-centered; it usually isn't. But it's changing, because many physicists know that they do their best teaching when they are working together with their graduate students, near the frontier where they themselves don't know the answers.

This difference has important implications for the nature of experiments in inquiry-centered teaching and the nature of inquiry itself. Where possible, experiments should provide answers to unanswered questions, not simply confirmation of known results. Physicists know this, although they often ignore it in educating undergraduates. For traditional teachers, for whom experiments, when they occur, are often just demonstrations and are rarely to answer questions, this principle is novel, and was almost certainly not followed in their own science education. Thus, for physicists, inquiry is natural, at least when they are in their research mode. For many teachers, inquiry is unnatural. Given how hard it probably was for the physicist to learn to be a true inquirer, it is not surprising how difficult it is for a teacher who is learning to teach children in an inquiry-centered way.

7. Collaboration vs. Solo Performances. For physicists, research is most often collaborative, because that way it is synergistic; an obstacle that is difficult for one member of a team, may be easily hurdled by another. In a recent issue of *The Physical Review B*, 95% of the papers have more than one author, and the joint authors are usually close collaborators at a single research institution. But the collaboration among physicists is not just within the same discipline or at the same institution. Collaborations among physicists have led to both the automated electronic exchange of preprints and more recently to the invention of the World Wide Web.

For most teachers, teaching is usually a solo performance, because the time, flexibility, and administrative support needed to make real collaboration the norm are all scarce. Their schedules are tight and non-meshing; they often have neither Internet access nor even a telephone; and financial support for attending meetings or even observing other colleagues is usually not there. There is an increasing recognition of the need of teachers to collaborate but, to a large extent, teachers are isolated; what they give are solo performances. To me as a physicist, this was one of my biggest shocks when I first became exposed to the education world.

8. Collaboration among Students. Physicists know from much experience that effective collaboration while efficient is not easy to learn. To us, the idea of encouraging it among children is obvious and natural: the sooner we encourage it rather than inhibit it, the better.

In the *traditional* education of children, where it has been thought important to be able to evaluate each pupil individually, collaboration among children has often been discouraged, and sometimes even punished. This, fortunately, is changing.

9. World Stage vs. Single Classroom. Not unrelated to their very different opportunities to collaborate are the very different stages on which physicists and educators "perform." Physicists who are able to publish the results of their research perform on a world stage. What they publish in an American journal (or even more, the preprint they circulate electronically from a server in Los Alamos or Trieste) is read by other physicists in Moscow, Madras, Madrid, and Montevideo. It will be discussed at national conferences in a few months, and perhaps at international conferences not long after. Real collaborations will start among people who have never even met one another.

For the school teacher, a discovery may never go beyond his/her own classroom, certainly not beyond his/her school. If there are 10,000 teachers attending the annual meeting of the National Science Teachers Association, there are at least 1.4 million teachers who are not there, most of whom are not even members of the NSTA and will never be at such a meeting.

10. Teamwork vs. Hierarchy. For physicists, the leader of a research group or team is often like a playing coach. It is in this position that he/she gets the best feel for what the research program is doing and the best opportunity to make his/her own scientific contribution. This cooperation is also a great leveler, strongly opposing any tendencies toward a hierarchical structure.

For teachers, to lead is to be out in front, set the agenda, determine what is taught and how, provide the necessary information and even materials. In this sense, some teachers do lead, but more often they are led, these decisions being made for them. The result is a hierarchical structure that pervades much of education and that can be very inhibiting to teachers' initiative and creativity.

11. Teachers' Professional Development — Physicists' and Teachers' Views.

Physicists are, by the very nature of their jobs, undergoing continual "professional development," i.e. they are always learning new things — from their own investigations, from their study of others' work, and from others directly. But what about teachers?

The physicists' view of what elementary-school teachers are is usually based on a few images from their own youth or from their children's teachers of previous years. These images, snapshots in time, give no sense of how teachers grow over the years. In this view, teachers just are, they don't become.

The teacher's view is that his or her growth comes from experience, inservice courses, summer institutes, advanced credits, and trying hard to get better — a complex but often successful progression that, unfortunately, often ends in burnout. A teacher picks up many things from many places, and then proceeds pragmatically: try them, and if they work, use them. In this view, research journals, whether on cognitive development, how children learn, or the effects of different instructional strategies, are for the research community, not for the practicing day-to-day teacher.

In Conclusion. Physicists (and other scientists, engineers, and other technical professionals) can make important contributions to science education in many ways. But to do so, they must enter a very different culture. To make their involvement useful in any real sense, they must understand the underlying features of that culture and not assume those features are similar to those of their own culture. Educators will say that physicists will really understand this only when they have *constructed their own understanding* of the differences. The observations offered here are intended to aid in that constructivist process.

Ted Schultz was a theoretical condensed-matter physicist at the IBM Thomas J. Watson Research Center for 34 years, with sabbaticals at New York University and the University of Munich. He started a second career in science education in 1992. After working at the National Science Resources Center in Washington, DC, for three years, he helped create the website of Project RISE (Resources for Involving Scientists in Education) at the National Research Council (<http://www.nas.edu/rise>) and worked on, and now directs, the Teacher-Scientist Alliance program at the APS.

Teachers as Professionals

Stan Jones

In an article in the last FEd newsletter, Ken Heller called for the professionalization of teaching at the K-12 level. His article focussed almost entirely on salaries. There is no doubt that low salaries are the main evidence for the low professional status of teachers, and I completely agree that raising salaries is the most important step we can make in attracting more competent teachers to the schools. However, there are many aspects to being a professional, and the teaching "profession" today lacks most of these. If we as a society truly value education, we should be putting our money into not only the salaries of our teachers, but into the entire educational structure, including the working conditions of these teachers. Teachers are given one of the greatest responsibilities we can give to another person, that of educating our children. We have the obligation to treat them, and to expect them to behave, as professionals.

I was involved a few years back with an organization known as the Holmes Group. This consortium of research universities "dedicated to improving teacher education and the profession of teaching" published a landmark white paper called *Tomorrow's Teachers* which was, in fact, a call for the professionalization of teaching. Here is a summary of the goals of the Holmes Group as stated in this monograph:

- 1. To make the education of teachers intellectually more solid.** Teachers must have a greater command of academic subjects, and of the skills to teach them. They also need to become more thoughtful students of teaching, and its improvement.
- 2. To recognize differences in teachers' knowledge, skill, and commitment, in their education, certification, and work.** If teachers are to become more effective professionals, we must distinguish between novices, competent members of the profession, and high-level professional leaders.
- 3. To create standards of entry to the profession--examinations and educational requirements--that are professionally relevant and intellectually defensible.** America cannot afford any more teachers who fail a twelfth grade competency test. Neither can we afford to let people into teaching just because they have passed such simple, and often simpleminded exams.
- 4. To connect our own institutions to schools.** If university faculties are to become more expert educators of teachers, they must make better use of expert teachers in the education of other teachers, and in research on teaching. In addition, schools must become places where both teachers and university faculty can systematically inquire into practice and improve it.

5. To make schools better places for teachers to work, and to learn. This will require less bureaucracy, more professional autonomy, and more leadership for teachers. But schools where teachers can learn from each other, and from other professionals, will be schools where good teachers will want to work. They also will be schools in which students learn more.

In examining these goals, it might be illuminating to make a comparison between the status of, say, professors and K-12 teachers. I'll focus primarily on the 2nd and 5th goals.

Goal 2. We professors have ranks we can aspire to, ranks which afford higher salaries and prestige and stand as incentives to encourage achievement. For the vast majority of K-12 teachers, this is not the case. How can a teacher then justify the tremendous amount of energy required to continually upgrade his or her teaching skills? What incentive is there to keep abreast of new research on teaching and learning? What incentive is there to experiment and be a part of the generation of new knowledge? Instead, what our current system encourages is a strategy of survival, and there is a serious burnout problem that causes teachers, especially good ones, to leave the profession at an early age.

Goal 5. There are many ways in which the schools today are *not* good places to work, and in which teachers are treated more like assembly line workers than professionals. Think first about the profession of being a university faculty member (a professor...the epitome of a professional!). University faculty have secretaries to handle routine tasks such as communication with others, preparation of written materials, photocopying, etc. We have (most of us!) travel budgets and are encouraged to be active in professional organizations. We have time to prepare our classes and reflect on the teaching process. We have a budget for teaching materials, and time to learn how to use them. And many of us have assistants to help with grading, running labs, etc. Most of us have a private telephone line! And most of us do NOT have the legislature or the board of education telling us just what we must teach and which standardized test our students must be able to pass.

Contrast this with the K-12 teacher who generally does not have an assistant or a phone, who must handle all student/parent communications herself, and who may or may not have a preparation period built into her schedule. It is especially rare for elementary teachers to have such preparation times. On the contrary, many of them are required to spend their lunch hours supervising children, and may also have to supervise children both before and after school hours. It is common for K-12 teachers to spend long hours at home preparing lessons and grading papers, and to spend significant amounts of their own money on supplies. Finally, many teachers must deal with serious discipline problems on a daily basis. This is not a professional working environment.

Goals 1 and 3: Our college and university employers and constituents have high expectations of us as professionals. We have earned advanced degrees and are presumed to be experts in our fields. We are expected to remain current in our fields and to be "professionally active," whether through research or innovation in teaching. We are, in other words, expected to be "scholars." We need to have similar expectations of those given the responsibility of educating our children.

University faculty are not, interestingly, required to have significant training in the art of teaching and it must be said that the expectations placed upon us as teachers vary widely from institution to institution. Perhaps we need to work some more on developing our own professional standards.

Goal 4: Science faculty must play an important role in preparing these teachers. It is paramount that university faculty recognize the importance of teaching, and of training teachers. Our disciplines must include as one of their high priorities the training of K-12 teachers; how else will they gain the "command of academic subjects" that professional teachers need?

I agree, in other words, that teachers need to be treated, and they need to act, like professionals. In my mind, we will have approached that stage when teachers are paid professional salaries, when they all have paraprofessional aides, when they have time set aside during the work day for preparation, grading, and reflection, and for meeting individually with students. Support personnel will make arrangements for such things as conferences with parents and field trips, and parents will understand that education is so important that it should start in the home, at birth. Teacher professionals will have travel funds to attend national meetings in their fields, where they will learn the latest research findings, will present papers to communicate their own ideas and findings, and (most important) talk in the hallways with other professionals about the new exciting experiments they are trying out. These teaching professionals will be so valued that they will be able to compete for numerous summer grants for research and training, and for summer appointments in corporations and businesses.

I'd like to see our public school systems take some steps in this direction.

Stan Jones is Professor and Chair of the Department of Physics and Astronomy at the University of Alabama. He is editor of the summer issue of this newsletter.

Alabama Science in Motion

Jill Shearin Driver

Introduction

Alabama Science in Motion (ASIM) is a visionary educational program established in 1994 by the Alabama Legislature to address problems Alabama teachers face in teaching high school science. As a discipline rooted in experimentation, science requires an understanding of the scientific method that is acquired through "hands-on, minds-on" laboratory activity.

Equipment, supplies, lab preparation time, and knowledge of science are essential elements of an effective laboratory program. Many, if not all, of these qualities are often lacking in science classrooms in Alabama. Few schools have the equipment and supplies needed to run an effective laboratory program and high percentages of science teachers, particularly in chemistry and physics, are teaching outside their major field of study.

Science teachers, like most other teachers, teach multiple subjects during the day. Running a laboratory component for each different subject requires preparation time that most teachers do not have. Moreover, without appropriate equipment and supplies, teachers are not motivated to prepare lab activities.

ASIM is a network of resources designed to provide equipment, supplies, training, and preparation support so that secondary science teachers may run an effective science laboratory program.

Structure

ASIM currently consists of eleven regional sites in Alabama; every high school in the state is served by one of the eleven sites, thereby giving equal access to all of Alabama's teachers and students regardless of their schools' economic status. Each of the eleven sites has two vans (one for each of two disciplines chosen from chemistry, biology, or physics), as well as a master's-level teacher for each of the two disciplines.

The ASIM program has two primary components: (1) providing teacher training, and (2) providing equipment and supplies to the participating teachers and their students.

The teacher component provides 15 days of training per year--10 in the summer and 5 throughout the academic year. Training is designed to update and strengthen teacher content knowledge, to familiarize teachers with the operation of ASIM equipment and labs, and to model effective teaching strategies. Labs are designed to align with objectives of the state's course of study for science and with teachers' needs.

The master's level "van driver" delivers equipment and prepared labs to participating teachers based on scheduled requests. The "van driver" typically stays with ASIM beginning teachers and team teaches the lab until the classroom teacher feels confident in using the equipment and conducting the lab alone. Veteran ASIM teachers just have the requested equipment and supplies for a lab dropped off. Typical equipment used in physics experiments is given in the table below.*

<i>Physics Equipment</i>	<i>Physics Experiments</i>
16 - Laptop Computers	Match the Graph
12 - PASCO Interfaces with Sensors	Newton's Second Law
12 - Dynamics Cart and Track Systems	Conservation of Momentum and Energy
12 - Projectile Launchers	Projectile Velocity and Range <i>vs.</i> Angle
6 - Rotational Motion Apparatus	Central Force and Rotational Motion
10 - Oscilloscopes	Resonance
12 - Electrical Circuit Boards with Meters	Ohm's Law
12 - Optics Kits	Reflection, Refraction, and Lenses
12 - Emission Spectra Power Supplies	Spectra

*Table provided by Paul Helminger, Department of Physics, University of South Alabama

Many of the Physics experiments are based on the use of laptop computers equipped with "works" and plotting programs. PASCO computer interfaces are used to automate data taking and analysis. The Physics vans also carry a good selection of other laboratory equipment for experiments in sound, electricity, and light. A number of the Physics laboratory experiments written for *ASIM* are in discovery-based "exploratory" format with follow up questions included to lead students to form their own conclusions about the data.

Impact: School Sites

The information below details the number of individual school districts, schools, teachers, and students that ASIM impacted during 1999-00:

School Districts: 118 (of 128 in the state)

Schools: 278

Teachers: 548

Students: 47,870

On average during the 1999-00 academic year:

ASIM equipment was used by 41 teachers per day;

Teachers used the equipment 13.4 days;

Students used the equipment 9 hours.

Impact: Teacher Development

The following summarizes the ASIM teacher training conducted during 1999-00:

574 teachers participated;

400 teacher training days were offered.

On average, each of eleven sites held 36.4 teacher development days with 10.1 teachers present each day.

Closing

Alabama Science in Motion is a nationally recognized model for secondary science outreach which provides services to students and teachers on a cost-effective basis. Funding from the Alabama legislature currently provides \$125,000 per van per year; cost-sharing is provided, in addition, by the universities at which each ASIM program is housed. Funds pay for the following costs: master's-level "van driver;" equipment and supplies; substitutes, mileage, and per diem for teachers on training days; consultant costs for providing training; technical support to assist "van drivers" in lab preparations; part-time clerical support; professional development for the "van drivers."

ASIM provides the opportunity for instruction and laboratory experiences that few students, especially in rural and poor school districts, could ever hope to receive without such a program. Additionally, the program fosters cooperation between high school teachers and university faculty who typically lead the training sessions. Moreover, ASIM impacts pre-service teachers at the university who, as part of their methods course in teaching science, work with "van drivers" to learn about laboratory safety and

management, lab preparation, lesson planning, and effective instructional strategies using technology.

Dr. Jill Shearin Driver is Director of the University of Alabama Inservice Center as well as Director of the Alabama Science in Motion program at UA.

Promoting Diversity in Physics

Ramon Lopez

Ask most people to draw a physicist and they will likely draw an Albert Einstein-like figure - elderly, male, and white. In fact, for most of history this picture of the physicist was not far from the truth. While the physics community has been changing and becoming more diverse in recent years, Hispanics, African Americans, and Native Americans are still very much underrepresented in physics and in science as a whole.

Diversity in science is an issue with which we should all be concerned if we want healthy programs that can reverse recent enrollment trends. Physics departments all across the country are worried about the lack of majors. There were 3646 Bachelor's degrees conferred in the class of 1999, which is a forty year low [1]. And despite a 4% increase in 1999 in graduate enrollments, the 1262 Ph.D. degrees conferred in 1999 represent the fifth consecutive year of enrollment declines [1], despite the fact that more students are going to college.

Total enrollments in all post-secondary education institutions rose from 10,985,000 in 1976 to 14,345,000 in 1997, however a disproportionate amount of the growth came from increases in minority groups [2]. While white, non-Hispanics enrollment went from 9,076,000 in 1976 to 10,161,000 in 1997, enrollments of Hispanics, African Americans, and Native Americans went from 1,493,000 to 2,872,000 [2].

So if a large part of the enrollment growth is coming from minorities, how is physics doing in recruiting and retaining these students? In 1997, African Americans earned only 5% of Bachelor's degrees and 1% of Ph.D. degrees [1]. The numbers for Hispanics were 2% and 1%, respectively [1]. On the one hand, these are miserable numbers. On the other hand, the situation represents an opportunity to tap into a pool of students that can help keep physics departments afloat.

When considering how to attract these students into physics we have to consider several items. First, almost half of them start in 2-yr schools. They may have a very limited exposure to physics, and the idea of pursuing a degree in physics is likely to be a thought that not many of these students have ever had. This means that physics departments should establish closer relationships with 2-yr schools so as to expose students to possible careers in physics and recruit prospective students.

Secondly, more women than men are going to college (among whites as well, but especially among minorities), and, despite recent gains, physics has not done too well in attracting women into the field [1]. Physics departments should take advantage of resources provided by the APS Committee on the Status of Women in Physics (site visits, on-line reports, special APS sessions) to make their programs more accessible to women.

Third, the Hispanic community is geographically concentrated in the southwest, as well as a few other places (such as the Cuban community in south Florida). The southwest

Hispanic community is overwhelmingly Mexican American with strong family ties that influence young people to stay in their communities. These students tend to think about going to college where they grew up. For example, about 80% of students attending the University of Texas at El Paso (UTEP) are Hispanic and from El Paso county. Similarly, many African Americans still elect to attend historically black colleges and universities. The APS Bouchet Award provides funds for the awardee to visit such institutions, but a broader effort by the physics community to partner with such institutions could help establish more opportunities for students interested in graduate school. And in fact many research programs (such as the NSF Science and Technology Centers) require minority-serving partners as a means to broaden the research enterprise and increase minority student participation in science.

Another pathway to these underrepresented students is through professional societies such as the National Society of Black Physicists (NSBP), the National Conference of Black Physics Students (NCBPS), and the recently formed National Society of Hispanic Physicists (NSHP). Other groups that are broader than just physics, such as the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) or the American Indian Society of Engineers and Scientists (AISES) hold considerable promise. SACNAS, which is primarily biological in orientation, holds an annual conference attended by close to a thousand undergraduate students. The SACNAS meeting is a great forum for providing information about opportunities in physics to students.

Despite knowing these facts, significantly increasing minority enrollment in physics (or science in general) has proved very elusive. Recently, both NASA and the Geosciences Directorate of the NSF have launched diversity initiatives. The NSF/GEO initiative is particularly interesting because of the nature of the problem. The geosciences do not get their "fair share" of minority students, a situation that is similar in physics. A committee formed by NSF to examine the issue recommended undergraduate research as its highest priority as a means for encouraging students to pursue geoscience careers, and for retaining students in a science track.

Another NSF program that is trying to raise minority enrollments in science (and engineering) has also recognized the role of undergraduate research. The Model Institutions of Excellence program has provided significant opportunities and funds for students to get involved in research. At UTEP (which is part of the MIE program) this support for undergraduate research has proven very effective. This should come as no surprise given that more and more physics departments recognize the need for increased undergraduate research for all students.

The basic point is that the individual attention that students get when they do research has a lot to do with their attitudes about physics, aside from the excitement of doing research. For over a decade the APS has had a minority scholarship program that aims to keep bright students in physics. In addition to a very modest stipend (\$2000), each student is assigned a faculty mentor and the department chair gets a \$500 check to be used to benefit students. The attention that the APS awardees get from their department chair and the mentor has a lot to do with the success of the program (over 10 years more than 80%

of awardees got a degree in physics). And so, while the physics community may try to do a better job understanding where our minority students come from, improving diversity in physics is still going to be done one student at a time.

Selected Websites

National Society of Black Physicists – <http://nsbp.org/>

Society for the Advancement of Chicanos and Native Americans in Science – www.sacnas.org

American Indian Society of Engineers and Scientists - <http://www.aises.org/>

NSF/GEO diversity initiative - <http://www.geo.nsf.gov/geo/diversity/>

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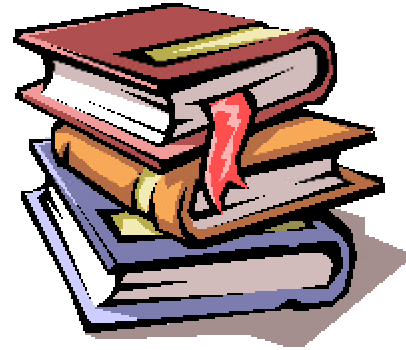
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Browsing Through the Journals

Thomas D. Rossing



•Women hold a disproportionately small share of senior faculty positions in Japan's universities. According to a story in the 20 April issue of *Science*, 35 Japanese women scientists met to draw up a list of obstacles they face in obtaining grants and to plan a lobbying effort to create a better working environment. At present, most grants for new investigators are restricted to scientists of age 37 or younger. With more women wanting to resume their research careers after starting a family, a ceiling based on years in the field rather than age would be more equitable, the participants argued. An even greater problem is the rise in the number of part-time and nonpermanent university faculty and staff positions, a trend fueled by the sagging economy. Although the squeeze on tenured positions applies to both men and women, men are more likely to be appointed to permanent posts when they are offered.

•The changes facing university physics departments in the UK were the subject of two days of discussion at the Institute of Physics annual congress, according to the May 2001 issue of *Physics World*. Two of the major subjects discussed were the decline in the mathematical capability of students starting physics degrees and how the four-year Mphys and Msci physics degrees would fit into the Quality Assurance Agency's new qualifications framework. Under this framework there will be five levels of university qualifications from 2003: higher education certificates; ordinary degrees; honours degrees and graduate certificates and diplomas; masters degrees and postgraduate certificates and diplomas; and doctoral degrees.

•John Hubisz reports on a study of middle school physical science texts in the May issue of *The Physics Teacher*. The study, supported by the David and Lucile Packard Foundation, aimed to determine whether there might be a link between the quality of textbooks used in middle school (grades 6, 7, and 8) and the students' poor performance on TIMSS tests. A previous study had looked at high school physics texts (see *Phys. Teach.* **37**, 283-308, 1999).

The reviewers found a very large number of errors, many irrelevant photographs, complicated illustrations, experiments that could not possibly work, and diagrams and drawings that represent impossible situations. They noted that a lot of the material had little to do with science. Unlike college-level textbooks, and some high school texts, middle school textbooks are seldom written by a single author or even a team of authors. Rather, they are produced by committees, and it is very difficult to find anyone with the authority to make corrections. While none of the books reached a level that could be called "scientifically accurate," the reviewers noted that most of the books were beautifully done with plenty of color diagrams and photographs. Hubisz, who is president of AAPT, feels that physics teachers have to become more active in schools. If

good materials are going to be used, they must be brought to the attention of teachers and administrators. The full report can be downloaded at <http://psrc-online.org/curriculum/book.html>

- There has never been a better time for physicists to set up their own firms, according to the April 2001 issue of *Physics World*, devoted to physicists in business. The opportunities in lasers and optics are enormous, and so-called photonic band-gap materials could be the next big thing. Without a doubt, the biggest spinoff from physics has been the World Wide Web, which was developed at CERN. Nanotechnology is beginning to develop. The special issue includes advice for would-be entrepreneurs. Rule number one: recruit experienced managers who can help you to grow the business. Founding entrepreneurs often become chief technical officers, leaving the day-to-day running of the firm to specialists, even if it means sharing the business. It's better to own 10% of a large company than 100% of a small one is one person's advice.

- India's physics community is spearheading a campaign to prevent the introduction of astrology into the country's universities, according to a story in the July issue of *Physics World*. Astronomers and physicists have been joined by other scientists in asking the Indian University Grants Commission to reconsider its decision taken earlier this year to introduce optional science courses in "Vedic astrology." So far their objections have had little effect. The Grants Commission has invited universities to set up departments of Vedic astrology that would offer bachelors, masters, and doctoral study programs, and has offered grants to set up an observatory, a library, and a "horoscope bank." Each department can also recruit a professor, a reader, and two lecturers of astrology. "It would be okay to introduce astrology as a subject in ancient Indian studies of anthropology or philosophy," according to Ganesan Srinivasan, president of the Astronomical Society of India, but what the Indian scientists are protesting is the projection of astrology as an applied science.

- "Should I pay attention to the output from physics education R&D?" is the title of a guest comment by Donald Holcomb (based on his talk given at the Centennial Meeting of APS in Atlanta) in the April issue of *American Journal of Physics*. In Holcomb's view, the most useful result from physics education R&D has come from organized and carefully documented listening to students through interviews and questionnaires. Such interviews tend to show that mathematical derivations in the classroom, use of computer programs in real time in the laboratory, and asynchronization of classroom and lab work are typically ineffective. In assessing the usefulness of a particular project in physics education R&D, a good question to ask is whether the researchers have selected an important question to study. The author urges nonpractitioners of physics education research to beware of the often unrecognized barrier to productive change: "I learned physics in a certain way, so I'll teach it the way I learned it. If today's students work hard, they can learn it in the same way I did!"

- Noting a shift away from the study of physics in schools, the Scottish branch of the Institute of Physics has taken steps to strengthen physics teaching in Scotland, according to a note in the July issue of *Physics World*. One project is producing a video and

possibly a CD-ROM or Web-based materials aimed at pupils aged 13-14 before they choose their subjects for Standard Grade. Physics education is generally healthy because all physics teachers hold a physics qualification. However the profession is aging, and there could soon be a shortage of young physics teachers, the Scottish branch wishes to help prevent.

- The world's first degree course in science and science fiction at the University of Glamorgan is described by course tutor Mark Brake in the January issue of *Physics World*. Science fiction exists not just as a rich genre of film and text but also as a living cultural phenomenon that influences the way we see the world, Brake explains. The science fiction element of the course focuses on the relationship between science, culture, and society. The course aims to produce graduates "who not only have a dynamic and pluralistic understanding of the nature and evolution of science but can also critically develop and communicate ideas about science and its cultural context."

- A laboratory-based nonlinear dynamics course with an interdisciplinary content for science and engineering students is described in the May issue of *American Journal of Physics*. The course, taught jointly by the physics and mathematics departments at California Polytechnic State University in San Luis Obispo, includes 7 weeks of prescribed experiments plus a 3-week project. The prerequisite is one year of calculus plus a junior-level course in the student's major.

- Currently, 28 percent of our nation's high school students take at least one course in physics, Frederick Stein, APS director of education and outreach, reminds us in a guest editorial "Modeling Effective Teacher Preparation" in the May issue of *Journal of College Science Teaching*. Although this is a significant improvement over the last decade, many courses do not develop good conceptual understanding. The ongoing and overwhelming need for inservice teacher enhancement programs in physics points to the failure of programs in our colleges and universities to prepare students adequately for teaching. PhysTEC, the Physics Teacher Preparation Coalition, was set up as a partnership of APS, AAPT, and AID to augment the role of physics departments to better prepare future teachers. PhysTEC inverts the strategy of university-based projects involving all science departments to that of a nationally recognized coalition with a single discipline aimed at a large number of colleges and universities linked through professional societies.

- For centuries telling stories has been a valuable way of imparting a message, and it is possible to communicate physics through story, an article in the January issue of *Physics Education* reminds us. This approach may be more useful for children who are concrete thinkers than formal methods of teaching physics. Back in the 1940s, George Gamow created the mild-mannered bank clerk Mr. Tompkins to tell stories about relativity, quantum physics, and a variety of physical phenomena.