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The Honorable Lee Hamilton, Frank McCloskey, Tim Roemer and Legislative Assistant
Molly J. Moran
U.S. House of Representatives
Washington, D.C. 20515

Dear Representatives Hamilton, McCloskey, Roemer and Assistant Moran:

You may recall that I visited your offices on 21 April 1994, at the time of the Washington meeting of the American Physical Society, to discuss education in Indiana and the United States. The present letter is a somewhat expanded version of the handwritten summary that I left with you.

I have been a member of the physics faculty at Indiana University for 24 years, a research physicist at North American Aviation and then Rockwell for 15 years, and have been working¹ for about eight years to improve the large-enrollment introductory physics courses at Indiana University and nationwide, recently under a grant from the NSF's Division of Undergraduate Education and the Division of Materials, Research, and Development (DUE/MDR 9253965). I am a Fellow of the American Physical Society.

Having met some 2000 students entering General Physics I, P201-2 over the course of the past two decades, I am seriously concerned about their rapidly deteriorating preparation for any substantive introductory physics course. On average, present day students are sadly deficient in mathematics, science, English, drawing, problem solving, and the ability to think critically. Such inability of K - 12 students has been amply documented by an avalanche of recent studies^{2,3} which strongly suggest that *the United States has become a nation of science-math illiterates*,⁴⁻⁸ with a dwindling supply of first-rate scientists and engineers,⁹⁻¹¹ an uneducated work force,¹¹ an inability to compete economically in world markets,¹¹ and, by far the most critical, a diminishing capability to overcome the economic-political-scientific problems which beset us.¹²⁻¹⁸ The National Science Board Task Committee on Undergraduate Science and Engineering reported¹⁵ "*...the deterioration of collegiate science, mathematics and engineering education is a grave long-term threat to the nation's scientific and technological capacity, its industrial and economic competitiveness, and the strength of its national defense.*" According to the National Commission on Excellence in Education¹⁶ "*lack of scientific literacy threatens the efficient, or even adequate, functioning of our democracy in this scientific age.*"

Unfortunately, the above report avalanche has failed to produce any important overall national improvement in the U.S. educational system.^{6,18,19} One might hope that the much heralded *Goals 2000: Educate America Act*, approved by Congress and signed in late March by President Clinton with its \$647 million authorization for this year might finally place us on the right path. But the laudable goal of making "United States students first in the world in mathematics and science achievement " by the year 2000 now seems little more than a pipe dream.^{6,18,19} According to the 1991 International Assessment of Educational Progress in mathematics, our 13-year-olds ranked fourteenth out of fifteen nations, higher only than Jordan. In science they ranked thirteenth out of fifteen with Ireland and Jordan trailing. Perhaps the governors could explain how, in six years, these students, exposed to the present disastrous K - 12 systems in their states, are to be first in the world in mathematics and science.

As repeatedly emphasized for over 30 years by physicist Arnold Arons,⁷ and more recently by educator John Goodlad,²⁰ and physics Nobel Laureate Kenneth Wilson²¹, the crucial need is for the proper education and professional development of all teachers over long time periods extending from their early education on into their professional years. In my opinion, such bolstering of the teaching profession must at least proceed in parallel with programs such as *Goals 2000*, the AAAS *Project 2061: Science for All Americans*, and the National Science Teachers Association *Scope, Sequence, and Coordination* (SSC). It might be thought that the dire need²⁻²¹ to improve the quality of teacher education and education generally at all levels would finally become a high priority matter for research universities. Twenty years ago physicist Fred Reif,²² then at Berkeley, wrote:

"Universities must be willing to face the challenge, worthy of the role of a university, of devoting to education the kind of searching thought commonly bestowed on scientific and engineering fields, and of promoting the translation of new ideas into practice."

Unfortunately, *research universities throughout the country have almost totally ignored this challenge*. Lamenting this failure, Richard M. Cyert, former president of Carnegie Mellon University wrote:

"The academic area is one of the most difficult areas to change in our society. We continue to use the same methods of instruction, particularly lectures, that have been used for hundreds of years. Little scientific research is done to test new approaches, and little systematic attention is given to the development of new methods. Universities that study many aspects of the world ignore the educational function in which they are engaging and from which a large part of their revenues are earned."

I have heard that Representative Lee Hamilton once asked Indiana University (IU) administrators "But what can you do for the rural schools in my district?" I think that IU could do a lot, especially with funding now becoming available for systemic improvement in education from the NSF's Directorate of Education and Human Resources (EHR). In Ohio, Kenneth Wilson was in part responsible for the award of a ten-million-dollar NSF *Statewide Systemic Initiative* grant over 5 years. With like matching funds from the state, Wilson is now engaged in *Project Discovery*, a program to improve the science/math teaching effectiveness of Ohio middle-school teachers. This program makes use of the research-based materials of physicist Lillian McDermott at the University of Washington. Unfortunately, little or even negative value is placed on the educational activities of people such as Wilson and McDermott in most research university physics departments, including those in Indiana.

In my opinion, some way must be found to impress upon research university administrators and faculty outside of Ohio and a handful of other states that the science/math illiteracy of the general population is a crucial social problem⁸⁻²² which *they* should help to alleviate. In the words of Representative George Brown,¹² "Scientists must seek to share the privilege of their enrichment with others, not by promising more, faster, stronger machines but by sharing what they know and how they feel. This demands a renewed commitment to education as the ultimate mechanism for individual empowerment, and a critical prerequisite for social justice. This is a commitment that all scientists can make, in their own backyards, starting now."

In view of all the above, I hope that you will support:

- (a) expanded funding for the NSF's EHR Directorate, above that specified by the Clinton budget,
- (b) the NSF's systemic improvement projects in education, such as the *Statewide Systemic Initiative* and the *Institute for Science Education*.

I also hope that you will ask administrators and faculty of Indiana research universities a Lee-Hamilton-type question "What are you doing to help K - 12 education in Indiana and to diminish the science/math illiteracy of the general population?"

Sincerely,

Richard R. Hake
Professor of Physics

cc: Hans Andersen, Professor of Science Education, Indiana University
Thomas Ehrlich, President, Indiana University
William Farquhar, Director, Contract and Grant Administration, Indiana University
Joseph A. Franklin, Director, Federal Relations, Indiana University
Tim Londergan, Chair, Physics Department, Indiana University
Morton Lowengrub, Dean, College of Arts and Sciences, Indiana University
Howard Mehlinger, Director, Center for Excellence in Education, Indiana University
George Walker, Dean of the Graduate School and Vice President for Research, Indiana University
Donald Warren, Dean of the School of Education, Indiana University

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18. A retrospective analysis of the lack of any substantive reform after the "Nation At Risk" report has been given by one of the report's authors, Harvard physicist-philosopher Gerald Holton: "A Nation at Risk Revisited," in *The Advancement of Science and its Burdens* (Univ. of Cambridge Press, Cambridge, England, 1986). Holton writes: "If the Constitution and the Tenth Amendment are interpreted narrowly, as is now the fashion, one cannot be surprised by the movement to phase out most or all of the federal responsibility for education.....Thomas Jefferson, in asking Congress for a remedy, said 'An amendment of our Constitution must here come in aid of the public education. The influence on government must be shared by all the people.'.....Without a device that encourages cumulative improvement over the long haul, without a built-in mandate to identify and promote the national interest in education as well as to 'help fund and support efforts to protect and promote that interest'we shall go to sleep again between the challenges of a Sputnik and a Honda."
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