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The Crisis in Science Education: Problems and Recommendations: A Summary of the Iowa Academy of Science Symposium at Luther College, Decorah, Iowa, April 22, 1983

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THE CRISIS IN SCIENCE EDUCATION: PROBLEMS AND RECOMMENDATIONS

A Summary of The Iowa Academy of Science Symposium at Luther College, Decorah, Iowa, April 22, 1983

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There is a recognized state and national crisis in securing and maintaining "qualified" science teachers. To date the majority of effort has been expended toward identifying and redefining the problems with few attempts made to resolve them.

The purpose of this symposium was to spend minimal time seeking to inform participants of the problems and then to present some recommendations for resolving them. Each of the presentors was uniquely to address this, to date, intractable problem. The following paper presents a summary of the presentations made by those individuals.

Science and Math Teachers: A National Survey of Supply and Demand

Trevor Howe: Director
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The Problem In Iowa

Total enrollments in Iowa public schools, K-12, have declined. Total enrollments have declined by 130,116 students in ten years. The projected enrollments are expected to drop 31,444 students in the next five years. Obviously the implication is a reduction in the number of teaching positions at both the elementary and secondary levels over the next several years. However, current data indicate that the science and math teacher supply is decreasing more rapidly than student enrollment.

Major findings of the Iowa investigation:

1. Over the 12-year period (1970-81), the supply of secondary math and science teachers who have been certificated has declined 84 percent and 47 percent respectively (Table 1).
2. Competition in hiring from business and industry, especially in 1977, 1978 and 1979 has dramatically changed the job market. Prospective math and science teacher education candidates are being attracted by higher paying jobs in business. Teachers with one to five years of experience are also leaving for higher salaries in the business sector.

Table 1
Comparison of the Number of Fall Vacancies in Mathematics and Science in the Public Schools of Iowa with the Number of Bachelor Degree Graduates Certificated to Teach from the Twenty-seven Iowa Institutions for the Years Indicated

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
MATH												
Vacancies	—	—	196	214	217	189	221	185	189	165	177	102
Graduates	234	218	228	207	166	104	95	75	60	46	49	38
SCIENCE												
Vacancies	—	—	172	261	248	176	217	176	156	159	110	67
Graduates	269	255	190	212	192	185	187	190	155	117	100	128

— data not available

3. There are critical shortages of teachers in the areas of mathematics and science. In the science area, there are shortages in earth science, physics, and chemistry.
4. Long-range consequences of continued critical shortages on the total education system can be extremely serious. Many math and science courses are being taught by less qualified teachers with minimal preparation. This threatens the quality of instruction in these subjects. Many schools will be forced to drop some mathematics and science offerings because of staff shortages.

The prospects for an easy or immediate solution to the mathematics and science teacher shortage in Iowa seems unlikely and will probably worsen in the next few years. In years when the economy remains stable, the competition from business and industry for the service of people with these skills remains high.

The Problem Nationally

A three-year national study by Howe and Gerlovich (1983) indicated a progressively worsening condition in the available supply of physics, chemistry and mathematics teachers. In that study, each state science consultant was asked to secure data covering the state's supply of science and math teachers and rank that supply based on a 5 point Likert scale (1 = surplus, 5 = critical shortage). In 1980 the national average rating for physics teachers was 4.15. By 1982 it had increased to 4.43. In chemistry, the mean rose from 3.71 to 4.16 for the same period. In mathematics the mean rose from 3.92 to 4.37.

Recommendations

The following recommendations were proposed by Dr. Howe to address the above science teachers supply/demand problem (Howe & Gerlovich, 1983).

1. Schools should hire only certified teachers with approval to teach mathematics and science in grades 7-12.
2. Temporary teaching approvals should be eliminated.
3. Certification standards should be enforced.
4. Elementary teachers should be prepared to teach mathematics and science appropriate to those grade levels.
5. Inservice programs should be initiated to upgrade teachers.
6. Scholarships and/or loan incentives should be made available to encourage qualified students to enter science and mathematics teaching.
7. Areas identified as having critical shortages of teachers (i.e. mathematics and science) should be given special salary considerations.
8. Representative advisory committees should be established to avert future crises in mathematics and science teaching.
9. Local school districts should require at least two years of mathematics and two years of science (life and physical sciences, including technology and computer applications) during grades 9-12.

Analysis of the Problems in Science Education and Recommendations for Resolution

George Burnet
Commission on Precollege Education in Mathematics, Science, and Technology

The Problem

The quality of precollege mathematics and science education in our schools and the implications for all sectors of American society have been articulated in the Commission on Precollege Education in Mathematics, Science, and Technology's report, *Today's Problems, Tomorrow's Crises* (1982) and in numerous other reports, articles, publications and public fora. Since July 1982 the Commission has been collecting information and suggested solutions from a broad base of institutions, organizations, and expert observers.

Recommendations

The charge to the Commission is to develop a national action plan to remedy the discouraging state of the teaching of science and mathematics in our schools. The plan is to assist our precollege educational system to meet the following equally important goals:

1. To continue to develop and to broaden the pool of students who are well prepared and highly motivated for advanced careers in mathematics, science and engineering.
2. To widen the range of high quality educational offerings in mathematics, science and technology at all grade levels, so that more students would be prepared for, and thus, have greater options to choose among technically oriented careers and professions.
3. To increase the general mathematics, science and technology literacy of all citizens for life, work and full participation in the society of the future.

Governor's Task Force Report on High Technology in Iowa: Results and Applications to the Crisis in Science Education

David H. Swanson: Chair
Iowa High Technology Commission

The Problem

Governor Robert Ray, on May 18, 1982, directed a High Technology Task Force to examine the feasibility of the development of high technology industries in Iowa. This task force after 5½ months of study, made its report to the governor. The report found that 75 percent of the new U.S. manufacturing jobs created during the past 25 years were in seven basic industry groups. These industries were generally described as high technology. The report also concluded that in the future manufacturing employment increases were most likely to occur in high technology industries.

Considered major among the locational factors of high technology industries were characteristics which focused upon advanced research and industries which produce a high value product, proximity to major scientific research and technological universities, good vocational/technical schools, available air transportation and a supportive environment for scientists. The attractiveness of centers of excellence in research was perceived as a major attraction for most companies utilizing advanced technologies.

Recommendations

The High Technology Task Force recommended:

1. That research and development efforts in high technologies be concentrated in biotechnology, microelectronics, productivity enhancement/process controls, and energy alternatives.

2. The mechanisms to transfer information on research, technology, and other scientific endeavors among universities, laboratories, governments, and the public be greatly improved.
3. The energies and resources of Iowa be directed to the long term development, attraction, expansion and utilization of advanced technologies.
4. A permanent High Technology Commission be established to pursue, guide and coordinate Iowa's efforts in high technology.
5. Specific legislative incentives be provided that would encourage the location and expansion of high technology companies.
6. Special efforts be undertaken to insure the necessary training and development so that Iowans could be employed in high technology industries, research, and its applications.
7. Venture capital mechanisms be encouraged which would foster the development of high technology operations and research.
8. Research and development centers be established near research universities in order to facilitate research, product development, innovation and the practical application of research.
9. Promotional efforts of the state be expanded so as to attract high technology companies to Iowa.

The Task Force, and the subsequent Commission, felt the development of high technology employment opportunities and the effective adoption of existing technologies was heavily dependent upon specific educational capabilities. Human resource development, the strength of technology based industries and research, required improvement in the public and private educational delivery systems. These improvements included (a) expansion of advanced technical skills in the area college curriculum, (b) greater emphasis upon competencies in mathematics, science, communication skills, computer literacy, problem solving skills, entrepreneurship, and other technology instruction programs in grades K-16, (c) partnerships between business/industry and educational systems so as to strengthen the technical competency of teachers and students, (d) incentives to encourage teacher preparation and retention in science, mathematics, and high technology programs, (e) the expansion of continuing education opportunities for adults seeking opportunities in high technology. (f) the identification of high technology job opportunities (g) the creation of new instructional programs at the secondary and college levels, (h) incentives to encourage business/education to share high technology equipment and facilities, and (i) the use of telecommunication and advanced educational technology in teaching.

The criticality of science and mathematics in the development of high technology industries and centers of excellence in educational institutions were strongly underscored by the task force. The decline in competencies in these fields was seen as a deterrent, not only to the development of industry and employment in Iowa, but to the development of technology in the United States. Iowa's excellent educational system was seen as an advantage, but only if additional investment and coordination assure improvement in the understanding and utilization of scientific knowledge.

The Search for Excellence in Science Education

John E. Penick
University of Iowa

The Problem

In 1976 several NSF funded studies revealed the current state of science education in the United States. In 1978, a synthesis of the more than 2,000 pages of information from those three NSF reports and the NAEP data was begun by twenty-three science educators throughout the U.S.

The synthesis researchers worked independently in small teams, each focusing on one aspect of science education: elementary science, biology, physical science, science/technology/society, or inquiry. A critical part of the synthesis analysis was developing a description of an ideal or desired state for a focus area and then comparing the actual to the desired state.

Goals arising from the synthesis desired state for each of the five focus areas were used as criteria for defining excellence in a school science program.

Recommendations

1. Fund large, regional centers for mathematics and science education which would:
   A. Develop and implement intensive and flexible inservice efforts focusing on teaching strategy, rationale, and curriculum revision.
   B. Provide a source of support for teachers, schools, or districts wishing to improve their abilities or programs.
   C. Develop model preservice science and mathematics teacher education programs.
   D. Help schools develop model science and mathematics programs.
   E. Help schools develop locally relevant curricula.
2. Sponsor research efforts aimed at answering such questions as:
   A. What are appropriate materials and strategies for achieving desired state goals?
   B. How effective are preservice and inservice programs in developing teachers who can meet these goals?
   C. What school or district organizational plans best facilitate excellence in science and mathematics teaching?

Applying Technology to Alleviate the Problems Created by the Shortage of Qualified Math and Science Teachers

Jack A. Gerlovich
Iowa Department of Public Instruction

The Problem

In November, 1982, a report (Gerlovich *et al.*, Note 1) was delivered to then Governor Robert D. Ray outlining the problems in science education in Iowa and recommendations for addressing them. Among the major needs outlined were:

1. Salaries of teachers in short supply must be made competitive with those in the private sector.
2. Preservice scholarship and loan forgiveness programs must be initiated for science teaching.
3. Cost effective, continuous, inservice programs for upgrading current science teachers should be initiated.
4. Prospective science teachers should complete coursework for the DPI "all sciences" approval to improve their employability.
5. Local schools should require 2 years (units) of science (1 biological, 1 physical science) for graduation; 3 units for those students who are college bound (Gerlovich & Unruh, Note 2).

Recommendations

Based upon the Governor's report, the Department of Public Instruction felt that the state science consultant should identify or establish programs which would begin to address the needs of that report. It was felt that physics was the subject in greatest need of immediate assistance. In September 1982, a task force was identified to prioritize needs and to begin pilot programs.

A teacher's guide was developed which would provide physics teachers with basic physics content, student application activities, and teacher's notes. Videotapes of unusual demonstrations and student activities which would be difficult to replicate and computer software activities were compiled. Six pilot schools in Southern Prairie AEA assisted in refining the materials during the 1982-83 school year. An interactive telephone system was established to communicate the materials to the teachers. Each school was provided with a telephone, telephone amplifier, teacher's guide, videotapes, and computer software. Teachers received a one hour call at the beginning of each of 10 units to upgrade them in physics content, walk them through physics activities, and familiarize them with video and computer materials.

The program is unique in that it upgrades teachers in physics content, provides student activities which emphasize "application" of physics content, incorporates contemporary technology, is cost effective, on-going, and has been found to be very effective by the teachers in the pilot schools.

Funding has been provided by the Iowa legislature to expand the pilot to 45 centers during the 1983-84 academic year.

Summary

Crisis is a time for change — not for trepidation! With the talented, concerned and dynamic scientists and science educators we have in Iowa, it is merely a matter of focusing direction to resolve this crisis. We look forward to progressive change, tempered with stability.

If you have questions concerning these projects, please contact any of the symposium presentors.

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Reference Notes

1. Gerlovich, *et al.* 1982. The crisis in science education: problems and recommendations. Iowa Academy of Science report to Governor Robert D. Ray.
2. Gerlovich, J. and R. Unruh. Applying technology to alleviate the problems created by the shortage of qualified science teachers. Publication pending.