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Introduction

A recent National Science Foundation report warns that the United States faces immediate shortages of engineers and computer professionals; it also sees a trend "toward virtual scientific and technological illiteracy in the population at large." (12)

Science News reported that the nation's commitment to excellence and international primacy in science and mathematics has waned markedly over the past 15 years. Not only the scientific community, but the nation as a whole, will suffer if drastic changes aren't made quickly. In an age when scientific and technical literacy is becoming increasingly necessary to function in our society, increasing numbers of students are electing not to enroll in science and mathematics courses beyond the 10th grade. Only 17% of all high school students enroll in 11th or 12th grade science and math courses, and these are primarily students planning on science-related careers. (18)

U.S. News and World Report recently reported that America appears to be losing its struggle to stay ahead in science. Three decades of unprecedented scientific growth and development in the U.S. since World War II may have come to an end, and many analysts think that such a productive period is not likely to be repeated in the forseeable future. (19)

In a recent *Science News* post-election analysis, Roloff reported that with President Reagan's "plan to cut government spending, a major source of basic research funds and jobs, the science community will be especially vulnerable relative to many other sectors of the economy." (13)

As a result of school consolidation, shifting demographics, economic fluctuations, war and the baby boom, the number of school districts in the U.S. had declined from 127,000 in 1932 to about 70,000 by the mid-1950s. (4) Consolidation resulted in further reduction to the number of school districts to 35,000 by 1962. In October, 1957, the Soviet

Union launched Sputnik I, and the U.S. found itself number two in science application. Schools were found to be the major problem; specifically, small schools with limited staff, budget and curriculum offerings. Emphasis was placed upon curriculum change. The most significant beneficiaries were the natural sciences: chemistry, physics and biology. Curriculum, a long neglected educational field, came into its own. The national emphasis placed upon science, resulted in increased science enrollments, increased production of scientists and significant ensuing strides in scientific and technological achievement. Curricular emphasis was placed upon content knowledge and developing junior scientists of all capable students.

In the wake of this curriculum movement of the 1960s, one would think that most science education objectives had been accomplished. Unfortunately, the schism between ideal and reality remains significant. Mayer reported, "Enrollment in science courses has dropped, perhaps as a protest against the perceived evils of science and technology. Science, as a process, is not well understood and antiscientism results from frustrated expectations. Antiintellectualism, in general, has been on the rise, and increased interest in the occult, membership in cults, and the following of those who promise simple, easy solutions to personal and world problems, is on the increase. This changing climate and these pressures have caused many teachers to realign their teaching in order to introduce no perturbations in the system." (9)

Miller reported that today's science has little or no value to students. "As organized science is not an important topic to most Americans, science information is a low priority item with them. In the high school population sampled, Miller found interest in science and technology a minority activity and noted that high school appears to have little or no impact on the stimulation of interest in organized science. His study found less than five percent of non-college bound high school students able to qualify as informed about science, and he noted no pattern of growth in attentiveness to organized science during the high school years. His conclusion was that present high school curricula provide minimal increases in information for the college-bound, but that the high school experience fails to stimulate any significant growth in interest in organized science. A major task, then, of science education in the '80s is to interest students in, and inform students about, science; neither to proselytize them into more courses in science to build an academic empire, nor to cause more to undertake careers in science, but rather to give them the tools necessary to understand the role science plays in their lives and how science can best be used to contribute to society and its goals." (10)

Helgeson reports that although the goals for science in the elementary school tend to be stable, it is apparent that the goals for secondary science are in a period of significant transition. Curricular emphasis is shifting toward environmental concerns, societal issues, world problems, decision-making and interdisciplinary efforts. Implementing such goals is much easier than verbalizing them. (7) Traditional components of science programs are being questioned, such as: the necessity for laboratories for physics classes, (14) or the need to offer physics courses in high school at all.

Yager reported that science education, at the graduate level, is in a state of crisis. "In the 1970s the number of state (and also city and county) science supervisors declined dramatically; neither Stanford or Harvard replaced their eminent science educators when they retired; New York University's science and mathematics doctoral program is in limbo; the Department of Science at Florida State University was abolished as such; and the faculty of the University of Maryland Science Teaching Center was cut from twelve to seven members." (17)

Paul DeH. Hurd states in the same report that "much of the present crisis in science teaching results from a neglect of professional responsibilities. He says further that issues and dilemmas in science education suggest a need for the reconstruction of science education as a discipline." (17)

Perceptions of Problems

As evidenced in a report by Gerlovich and Yager, it appears that the most significant problem facing science education at all levels of science, is the uncertainty of directional goals. Other commonly perceived problems (Table 1) include: public apathy, or negative attitude toward science; poor quality of teacher education programs; and diminishing financial support. (6)

On the national level, there is evidence that elementary teachers do not feel that they are well qualified to teach science. (16) While nearly two-thirds of all elementary teachers feel very well qualified to teach reading, only 22 percent feel very well qualified to teach science. Similarly, at the other end of the spectrum, only 16 percent of elementary teachers feel they are *not* well qualified to teach science, compared to only 3 percent feeling *not* well qualified to teach reading.

In addition, elementary teachers' perceptions about their qualifications for teaching various subjects are consistent with the amount of time that is generally spent in these areas. That is to say, that elementary teachers spend the bulk of each day in the teaching of reading and mathematics, with very little time allotted for instruction in science.

Nationally, the emphasis on the "basics" apparently leaves little time for instruction in science. Students in grades K-3 spend an average of approximately 18 minutes per day on science. In grades 4-6, the

Table 1
Perceptions of Current Problems in Science Education (6)

A. Problems as Perceived by Members of the Iowa Council of Science Supervisors.	%	B. Problems as Perceived by 150 Faculty Members at Major Graduate Centers.	%	C. Problems as Perceived by Teachers, In-Service Supervisors, Workshop Supervisors/Department Chairs, Graduate Students, and College Science Educators.	%
1. *Lack of agreement about goals and objectives*	76	1. *Uncertainty about goals and objectives of science education*	75	1. *Confusion and uncertainty concerning goals and objectives*	71
2. *General lack of public support for science and understanding of it as a discipline*	60	2. *Declining enrollments in science and science education*	60	2. *Lack of vision and leadership in schools and universities*	43
3. *Lack of vision and proper leadership among professional science educators*	40	3. *General anti-science tenor of society*	55	3. *Public and parental apathy towards misunderstanding of science and science education*	40
4. *Poor quality of teacher education efforts – pre- and inservice*	32	4. *Diminishing financial support for science education*	45	4. *Limited budgets and facilities*	36
5. *Limited financial support for science in schools and teacher education*	28	5. *Lack of leadership in science education*	40	5. *Poor quality and low standards of teacher education programs*	30
6. *Lack of opportunity for professional dialogue and sustained inservice*	24	6. *Lack of theoretical base to guide research and practice*	30	6. *Limited scholarly dialogue between researchers and practitioners*	30
7. *Too many varied teaching assignments; too many reassignments for teachers*	20	7. *Poor quality of teacher education programs*	25	7. *Declining enrollments generally*	26
8. *Too few new programs for dealing with societal issues; too few examples of "new" science*	20	8. *Inappropriate programs (curricula) for all persons*	25	8. *Lack of a theoretical base for science education*	25

average number of minutes spent on science increases to approximately 32 minutes per day. (16)

It can be seen from Fig. 1 that at the K-3 level, the ratio of time spent on reading compared to time spent on science is just over 5 to 1, and drops to just over 2 to 1 in grades 4-6.

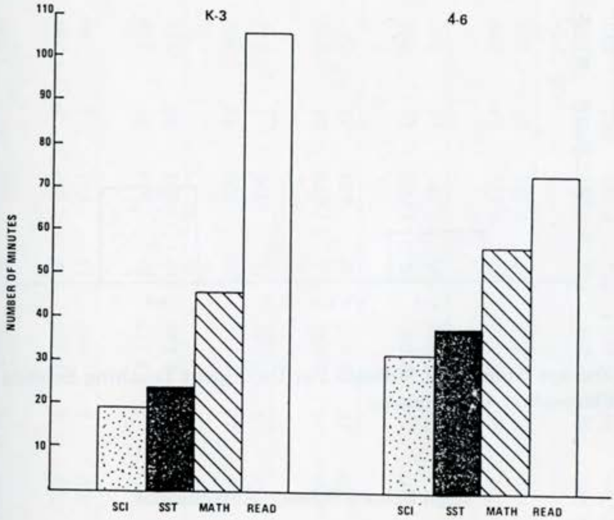


Fig. 1. Average Number of Minutes Per Day Spent on Each Subject in Self-Contained Classes.

In a recent Iowa study, (2) data revealed that students in grades 1-3 spend an average of approximately 11 minutes per day on science. In grades 4-6, the average number of minutes spent on science increases to slightly over 21 minutes per day. (see Fig. 2)

When comparisons are made between Iowa and national averages, it can be readily seen that students in grades 1-6 in Iowa receive far less science instruction than is received on the national level. In all studies reviewed, the amount of time spent teaching science increased with each grade level.

Further comparisons to a 1961-62 national survey conducted by Blackwood (3) reveal that Iowa students in grades 1-6 received less instruction in science than did students in schools included in this national survey. The conclusion could be drawn that students in Iowa receive even less instruction in science today than they did in the immediate post-Sputnik era.

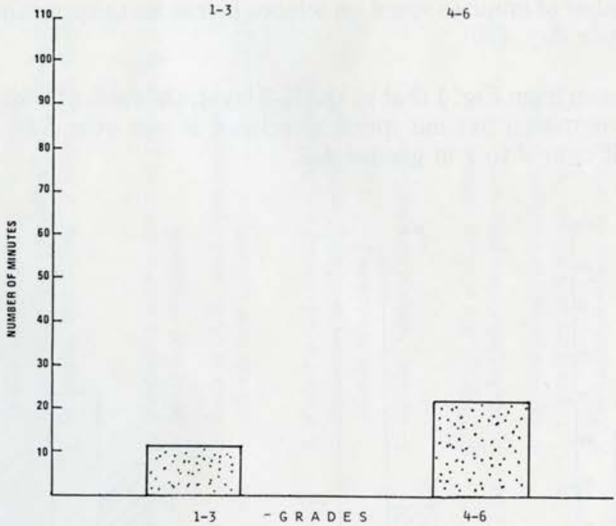


Fig. 2. Average Number of Minutes Per Day Spent Teaching Science in Iowa Elementary Classrooms.

High School Science Enrollments

In Iowa, there has been a general increase in enrollment in the subject areas of biology, chemistry and general science, with a concomitant decrease in physics, physical science and earth science. (Table 2.)

It may be interesting to note that in large schools (2,000 or more students), physics and earth science have shown significant average enrollment increases, while the smaller districts have held stable or declined. This average enrollment increase in physics and earth science for large school districts is even more significant when it is observed that during the five years 1973-78, there has been a substantial decrease in the number of school districts with enrollments of 2,000 or more students. General science appears to be the science subject area showing the fastest and most uniform growth in enrollment. (5)

Science and Math Teacher Supply and Demand

A study by Howe and Gerlovich (8), indicates that there are shortages of science teachers, especially in the physical sciences, throughout the U.S. Currently, there are 32,000 elementary and secondary teachers employed in 445 school districts in Iowa. In 1971, there were 113 school districts in Iowa with less than 500 students in grades K-12, now

Table 2. Average Enrollment in Iowa Public High Schools (9-12) Science Courses by School District Size

K-12 District Enrollment	No. Districts	Biology		Chemistry		Physics		Physical Science		Earth Science		Conservation		General Science	
Size and Year		Total	Ave	Total	Ave	Total	Ave	Total	Ave	Total	Ave	Total	Ave	Total	Ave
0-500															
1973-4	*130*	*1,401*	*11*	*1,261*	*10*	*623*	*5*	*1,593*	*12*	*608*	*5*	*69*	*61*	*2,022*	*16*
1978-9	*156*	*5,294*	*34*	*1,525*	*10*	*805*	*5*	*1,966*	*13*	*614*	*4*	*260*	*2*	*2,302*	*15*
500-749															
1973-4	*102*	*4,776*	*47*	*1,572*	*15*	*788*	*8*	*2,177*	*21*	*988*	*10*	*215*	*2*	*2,008*	*20*
1978-9	*92*	*4,982*	*54*	*1,580*	*17*	*632*	*7*	*1,698*	*19*	*893*	*10*	*134*	*2*	*1,972*	*21*
750-999															
1973-4	*76*	*5,409*	*71*	*1,728*	*23*	*747*	*10*	*2,719*	*36*	*977*	*13*	*301*	*4*	*1,728*	*23*
1978-9	*76*	*5,702*	*75*	*1,951*	*26*	*653*	*9*	*2,573*	*34*	*537*	*7*	*314*	*4*	*2,167*	*29*
1,000-1,499															
1973-4	*52*	*4,919*	*95*	*1,390*	*46*	*598*	*12*	*3,003*	*58*	*1,372*	*26*	*124*	*2*	*1,130*	*22*
1978-9	*39*	*4,376*	*112*	*1,300*	*33*	*466*	*12*	*2,050*	*53*	*663*	*17*	*167*	*4*	*1,257*	*32*
1,500-1,999															
1973-4	*25*	*2,919*	*117*	*974*	*39*	*540*	*22*	*2,135*	*85*	*1,052*	*42*	*329*	*13*	*685*	*27*
1978-9	*27*	*4,387*	*163*	*1,477*	*58*	*548*	*20*	*1,232*	*46*	*1,230*	*46*	*600*	*22*	*1,785*	*66*
2,000-2,999															
1973-4	*36*	*6,421*	*178*	*2,182*	*61*	*707*	*20*	*2,958*	*82*	*1,374*	*38*	*229*	*6*	*2,158*	*60*
1978-9	*29*	*6,013*	*207*	*1,957*	*68*	*740*	*26*	*2,370*	*82*	*1,131*	*39*	*128*	*4*	*2,036*	*70*
3,000 or more															
1973-4	*29*	*17,760*	*612*	*5,880*	*203*	*2,365*	*82*	*6,184*	*213*	*6,387*	*220*	*1,256*	*43*	*5,928*	*204*
1978-9	*28*	*16,608*	*593*	*5,260*	*188*	*2,586*	*92*	*5,418*	*194*	*6,222*	*222*	*982*	*35*	*9,354*	*334*
TOTAL															
1973-4	*450*	*46,303*	*103*	*14,989*	*33*	*6,638*	*15*	*20,769*	*46*	*12,758*	*28*	*2,523*	*6*	*15,660*	*35*
1978-9	*447*	*47,362*	*106*	*15,050*	*34*	*6,430*	*14*	*17,307*	*39*	*11,290*	*25*	*2,585*	*6*	*20,873*	*47*

there are 173 such districts. In Iowa, school enrollments and the demand for teachers are declining; however, not as rapidly as the supply of physical science teachers. Fig. 3 provides a summary of actual school enrollments (K-12) for 1972-73 through 1978-79, indicating a decline of 77, 847 students in six years. Projected enrollments indicate an enrollment drop of an additional 66,121 students between 1978-79 and 1982-83.

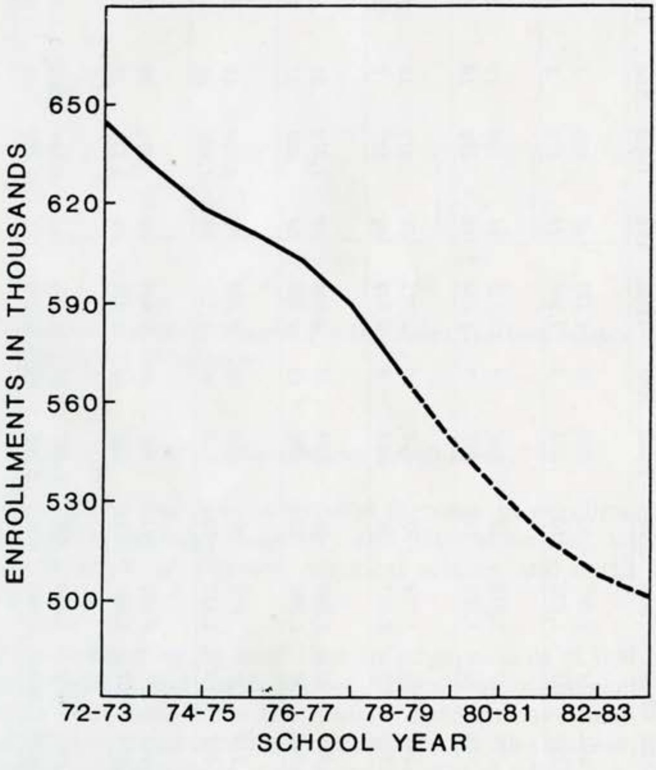


Fig. 3. Iowa Public School (K-12) Enrollments and Projections.

Table 3 provides an historical perspective of the demand for teachers, as indicated by the number hired to fill various positions between 1972-73 and 1979-80. It is apparent that the demand for science and mathematics teachers has declined due primarily to decreasing enrollments. Table 4 provides an overview of the supply of teachers completing preparation for a teaching certificate with a bachelor's degree from all 27 Iowa colleges and universities between 1970 and 1981.

Table 3
Summary of New Personnel Hired to Fill Public School Teaching Vacancies in Iowa
Comparing Fall 1972 Through Fall 1979 by Subject Area and Level

	Number of Vacancies							
Subect Area or Level	Fall 1972	Fall 1973	Fall 1974	Fall 1975	Fall 1976	Fall 1977	Fall 1978	Fall 1979
A. ELEMENTARY								
1. Classroom Teachers	1,371	1,562	1,237	1,135	1,093	890	834	754
B. SECONDARY								
1. Agriculture	59	73	65	61	79	61	66	65
2. Art	90	137	138	148	159	144	94	93
3. Business Education	111	143	110	96	125	89	135	127
4. Distributive Education	6	16	10	5	3	3	3	4
5. Driver Education	19	18	31	16	13	12	4	3
6. English Language Arts	395	412	404	351	436	341	443	397
7. Foreign Languages	112	121	101	92	63	73	30	30
8. Home Economics	130	147	140	141	172	120	109	101
9. Industrial Arts	117	148	132	129	145	115	122	94
10. Mathematics	196	214	217	189	221	185	189	165
11. Music	289	276	272	291	302	294	205	230
12. Health and Physical Ed.	188	157	195	178	222	196	169	169
13. Science	172	261	248	176	217	176	156	159
14. Social Studies	238	290	241	211	218	213	166	182
15. Other	44	35	109	47	23	25	15	11
Secondary Subtotal	2,166	2,448	2,413	2,131	2,398	2,047	1,906	1,830
TOTAL	3,537	4,010	3,650	3,266	3,491	2,937	2,740	2,584

Table 4

Summary of the Number of Graduates From the Twenty-Seven Teacher Education Institutions in Iowa Completing Preparation for a Teaching Certificate with a Bachelor's Degree By Subject Area for the Years 1970-81

	Number of Graduates by Year											
Subject Area or Level	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
A. *ELEMENTARY*												
1. *Nursery-Kindergarten*										236	230	123
2. *Classroom Teachers*	2,100	1,997	2,296	2,281	1,722	1,562	1,426	1,357	1,433	908	842	984
ELEMENTARY SUBTOTAL	2,100	1,997	2,296	2,281	1,722	1,562	1,462	1,357	1,433	1,144	1,072	1,107
B. *SECONDARY*												
1. *Agriculture*	51	52	49	44	44	39	40	36	44	62	37	40
2. *Art*	217	206	214	216	220	196	190	144	153	113	112	106
3. *Business Ed.*	143	142	133	116	105	82	70	96	96	83	63	81
4. *Distributive Ed.*	15	15	15	4	7	8	6	6	10	8	8	7
5. *English Language Arts*												
English	523	498	515	341	327	273	222	193	186	139	131	150
Journalism	15	15	5	7	7	7	14	18	9	6	12	12
Speech/Dramatic Art	112	111	114	102	90	76	76	64	68	52	40	50
6. *Foreign Language*												
Combined	15	15	15	37	32	29	42	29	21	14	9	10
French	77	70	79	49	30	20	22	18	17	18	20	17
German	51	51	26	36	30	20	16	15	10	11	9	7
Latin	5	5	0	0	0	2	1	1	1	0	3.5	0
Spanish	107	95	59	62	45	44	38	50	33	25	18	20

Table 4. Continued.

7. Home Economics	197	187	203	187	157	128	109	151	149	110	92	96
8. Industrial Arts	90	90	86	96	88	73	79	53	68	65	74	67
9. Mathematics	234	218	228	207	166	95	104	75	60	46	49	39
10. Music	227	218	243	249	296	275	257	243	264	223	214	211
11. Phys. Ed./Health Ed.	553	504	550	566	590	503	525	468	461	380	354	391
12. Science												
Combined	57	56	29	24	60	61	77	71	56	42	49	39
Biology	137	129	107	119	84	77	66	66	61	52	36	58
Chemistry	17	15	19	17	16	13	11	16	13	7	5	4
Earth Science	0	0	0	0	7	4	12	6	7	2	3	0
General Science	43	40	16	34	7	7	7	14	5	12	5	10
Physical Science	0	0	0	0	9	14	7	11	8	0	0	0
Physics	15	15	19	18	9	9	7	6	5	2	2	3
13. Social Studies												
Combined	310	279	199	165	171	127	146	97	98	68	53	60
History, Geography	328	294	306	252	188	109	118	111	120	84	82.5	83
Econ., Soc., Psych.	94	81	94	98	91	73	71	58	45	26	24	36
14. Other Secondary Subjects	0	0	0	54	71	70	43	57	59	52	60	46
SECONDARY SUBTOTAL	3,633	3,401	3,323	3,100	2,947	2,434	2,376	2,173	2,127	1,702	1,565	1,643
FINAL TOTAL	5,733	5,398	5,619	5,381	4,669	3,996	3,802	3,530	3,560	2,846	2,637	2,750

SOURCE: Special acknowledgement to the members of the Iowa Association of Colleges for Teacher Education representing the twenty-seven institutions in Iowa.

It is readily apparent that the future supply of both mathematics and science teachers is declining rapidly. The number of mathematics teachers produced declined from 234 in 1970 to 39 in 1981. In all areas of science, teachers have declined dramatically between 1970 and 1981, with the physical sciences especially hard hit.

The study by Howe (8) indicated that many prospective math and science teachers are taking jobs in the private sector due to economic differences, working conditions and expectations and perceptions of job availability. It is apparent that if such patterns are not changed, serious future shortages of science and math teachers are to be expected.

Science Achievement-NAEP

Science achievement of U.S. students has been assessed by the National Assessment of Educational Progress (NAEP) on three occasions: 1969-70, 1972-73, 1976-77. The assessments were designed to measure achievement among groups of American students, ages 9, 13, and 17, versus performance of individual students. Questions were designed to assess three broad objectives of science education: (1) students should know the fundamental aspects of science; (2) they should understand and apply the fundamental aspects of science in a diversity of problem situations; and (3) they should appreciate the knowledge and process of science, the consequences and limitations of science and the personal and social relevance of science and technology in our society. (11)

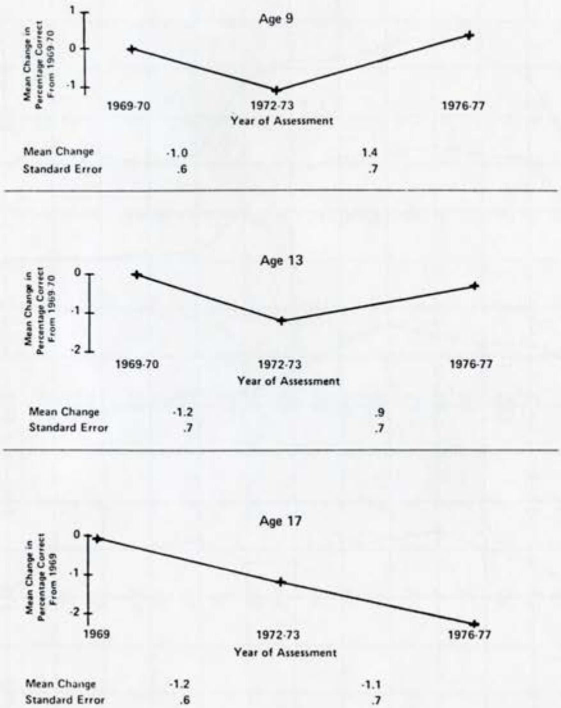
As indicated in Fig. 4, biological achievement declined for 9, 13 and 17 year olds from 1969-70 to 1972-73, however, biology achievement increased for 9 and 13 year olds from 1972-73 to 1976-77. Physical science achievement declined for all testing periods for all age groups.

Someof the reasons suggested for such declinesin science achievement include: decreased societal emphasis placed on science following the high level of public consciousness during the post-Sputnik days of space exploration; over-emphasis on "basics" in the elementary classroom resulting in a decrease in the amount of time available for the study of science; decrease in the number of students enrolling in elective science beyond grade 10; (11) and emphasis on environmental and biological sciences at the expense of the generally more difficult physical sciences.

Science Achievement-ITED

The *Iowa Test of Educational Development (ITED)* are achievement tests in the broadest sense. The tests are designed to measure such broad skills as: the ability to write clearly and correctly; to resolve quantitative problems; to weigh discussions of social issues critically; to recognize sound methods of scientific inquiry; to perceive subtle mean-

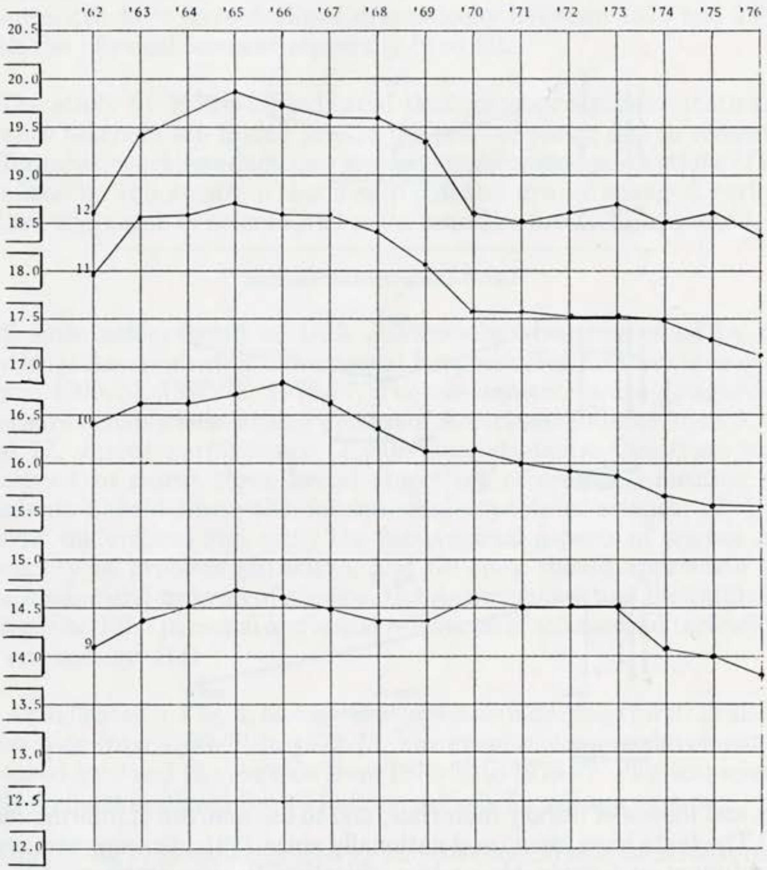
Fig. 4. Changes in Biology Achievement From 1969-70 to 1972-73 and From 1972-73 to 1976-77 for 9, 13 and 17 Year-olds.



ings and moods of library materials; and to use sources of information. (15) The tests have been used nationally since 1941 to assess how well the student can apply his or her education to new settings. Fig. 5 indicates a longitudinal study of achievement in the natural sciences for Iowa students in grades 9 through 12 from 1962 to 1977.

It may be noted that natural science achievement during this period in Iowa, peaked about 1965-66. There may be a diversity of reasons for such patterns. The launch of the Soviet satellite, Sputnik I, initiated a strong reactionary response in America. Heavy emphasis was placed on the production of scientists in all U.S. schools. The science curriculum was strengthened and student achievement increased until about 1965-66. At about this time, social changes in U.S. society initiated a de-emphasis on cognitive science. Process science was encouraged, resulting in a down-play of knowledge emphasis. About this same time, science became an elective in the curriculum of many Iowa schools, thus resulting in a smaller pool of students enrolling in science classes. The com-

Fig. 5. Mean ITED Natural Science Test Scores from 1962-77 for Grades 9, 10, 11 and 12.



bination of these pressures resulted in expected decreases in science achievement in grades 11 and 12. The decline in achievement in grades 9 and 10 raise some unique concerns, since this is required science in most Iowa schools.

High School Science Graduation Requirements

Science graduation requirements for Iowa public high school students appear to be increasing among small school districts (enrollments less than 500). The number of school districts in this category requiring 1 unit (1 year) of science declined from 36 in 1976 to 34 in 1978; simultaneously, the number of districts requiring 2 units has increased from 108 to 117 for the same time period. In large school districts (2,000 or more students), graduation requirements have generally been decreasing in the area of science. (5) (See Table 5)

Table 5. Graduation Requirements in Science 1976-7 to 1978-9 for grades 9-12 (9)

K-12 School Enrollment	No. of Districts	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	year
Less than 500	*(148)*	*0*	*0*	*36*	*1*	*108*	*1*	*1*	*0*	*1*	*1976-77*
	(154)	*0*	*0*	*37*	*2*	*112*	*1*	*1*	*0*	*1*	*1977-78*
	(156)	*1*	*0*	*34*	*2*	*117*	*0*	*1*	*0*	*1*	*1978-79*
500-749	*(94)*	*0*	*0*	*36*	*1*	*55*	*0*	*2*	*0*	*0*	*1976-77*
	(91)	*1*	*0*	*36*	*1*	*51*	*0*	*2*	*0*	*0*	*1977-78*
	(92)	*0*	*0*	*35*	*2*	*53*	*0*	*2*	*0*	*0*	*1978-79*
750-999	*(75)*	*0*	*0*	*34*	*1*	*39*	*0*	*1*	*0*	*0*	*1976-77*
	(74)	*0*	*0*	*32*	*2*	*38*	*0*	*2*	*0*	*0*	*1977-78*
	(76)	*0*	*0*	*32*	*2*	*40*	*0*	*2*	*0*	*0*	*1978-79*
1,000-1,499	*(47)*	*1*	*1*	*17*	*1*	*27*	*0*	*0*	*0*	*0*	*1976-77*
	(46)	*0*	*1*	*16*	*1*	*28*	*0*	*0*	*0*	*0*	*1977-78*
	(39)	*0*	*1*	*13*	*1*	*24*	*0*	*0*	*0*	*0*	*1978-79*
1,500-1,999	*(25)*	*0*	*0*	*8*	*0*	*17*	*0*	*0*	*0*	*0*	*1976-77*
	(23)	*0*	*0*	*7*	*1*	*15*	*0*	*0*	*0*	*0*	*1977-78*
	(27)	*0*	*0*	*9*	*2*	*16*	*0*	*0*	*0*	*0*	*1978-79*
2,000-2,999	*(31)*	*0*	*1*	*12*	*0*	*17*	*0*	*1*	*0*	*0*	*1976-77*
	(32)	*0*	*1*	*14*	*16*	*0*	*0*	*1*	*0*	*0*	*1977-78*
	(29)	*0*	*1*	*12*	*0*	*14*	*0*	*2*	*0*	*0*	*1978-79*
3,000 or more	*(29)*	*0*	*0*	*19*	*0*	*10*	*0*	*0*	*0*	*0*	*1976-77*
	(29)	*0*	*1*	*17*	*11*	*0*	*0*	*0*	*0*	*0*	*1977-78*
	(28)	*0*	*1*	*19*	*0*	*8*	*0*	*0*	*0*	*0*	*1978-79*

Generally speaking, in the United States, state education agencies have not established guidelines for science instruction. Only 14 of the states have set guidelines for the minimum amount of instruction time to be spent in science, and only 11 of the states require more than one year of science instruction for graduation.

Local school districts, by and large, have been more supportive of the requirements for science education, with 47% of the nation's districts requiring one year of science for graduation, while 33% require more than one year. Almost half (49%) of the districts require a specific course in science in grades 9-12, with general science (27%), biology (21%) and physical science (12%) the most frequently required courses. (1)

Saving an Endangered Species

Societies in the United States and Iowa are based upon a technology premised on sound scientific concepts. A public which does not have, at the very least, a working knowledge of science, will make many of its science-related decisions based upon emotion and misunderstanding. This is a problem which is aggravated as the public progressively loses its confidence, or ability to comprehend the ultimate value of science.

It is essential that the educational institutions of the state of Iowa and of the country as a whole begin to hold a strong line on science education standards for all its citizens, before the implications are felt in research and development, international trade, defense and the political arena.

It is ironic that U.S. schools are reducing their science graduation requirements at a time when scientific knowledge is doubling every two years. A poignant warning appeared in 1970 when the United Nations did a world-wide assessment of the technological literacy of 10- and 14-year old students. Japanese students came out number one, while the U.S. students placed fifteenth among such developing nations as Chile, Thailand, Iran and India.

In order to reverse the anti-science apathetic attitude of the general public, certain needs must be addressed. At the local school district level, science teachers must establish and maintain high standards for science K-12. Teachers must also inform the public, through news media, of the changes in enrollments, funding administrative decisions, counseling practices and other activities which compromise the science curriculum. Students should be encouraged to pursue scientific careers as challenging and rewarding. The value and essential role of science to all citizens should be presented. Involvement of parent-teacher organizations should be incorporated in efforts to defend the need for a strong science curriculum. Local citizens, teachers, administrators, school boards and civic organizations should be encouraged to lobby regional, state and national science and educational agencies to establish and/or maintain high standards for science education at all educational levels for all citizens.

At the regional level, science teachers must insist that regional or area education agencies establish and maintain a cadre of qualified science consultants, provide science curriculum materials and budget the necessary funds to adequately assist teachers at the local classroom level. Science teachers must also notify congressional representatives of the deleterious changes and shortcomings in science education at their regional level. Further, science teachers need to make use of qualified consultants, materials and services at the regional level, to assist in providing diversity and increased quality to the local science curriculum.

At the state level, officials at the Department of Education must be urged to maintain high standards for teacher certification and curriculum minimums. State legislators must be notified of any shortcomings in science education at the state level. State officials must also maintain adequate records of science teacher supply at the college level. Demand for science teachers at the local level can be correlated with the supply to assist in assuring that critical shortages of personnel can be anticipated, thus averting a crisis situation. Further, state and local teacher organizations should be encouraged in their efforts to establish and maintain equitable salary scales for science educators which are competitive with comparable positions in private industry, and which reflect the essential role these science teachers play in our society.

At the national level, science organizations must establish and maintain pragmatic, clear goals for science education, which are communicated to all science educators. Encouragement should be given to national science education leaders to establish and maintain effective communications with legislators and White House personnel, emphasizing the essential role of science education for all citizens, which is necessary for establishing a productive informed society.

As Aristotle once said of education, "All who have meditated on the art of governing mankind have been convinced that the fate of empires depends on the education of youth." In a society premised on science and technology, it is the science education of that society which is essential.

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A gorilla had two keepers. One read Darwin, and the other read the Bible. The perplexed gorilla wanted to know, "Am I my keeper's brother or my brother's keeper?" *CSTA Newsletter 29(6), 1982*

Science has proofs without certainty; creationists have certainty without proofs. *Ashley Montague*

We cannot escape from the past, but neither can we avoid inventing the future. *Rene Dubos*

I like the dreams of the future better than the history of the past. *Thomas Jefferson*