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## Science Learning Matters: Iowa within the Context of the NAEP Assessments

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# SCIENCE LEARNING MATTERS: IOWA WITHIN THE CONTEXT OF THE NAEP ASSESSMENTS

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The National Assessment of Educational Progress (NAEP) report (Mullis and Jenkins, 1988) states that "science exerts a pervasive influence on the quality of the lives of all citizens, and that it is essential that all productive citizens be able to understand and resolve the increasing number of societal problems related to science and technology." Our national position as a world leader is dependent upon such knowledge and skills. In Iowa, a state striving to improve its national and world economic status, these NAEP analyses are critical.

## The Status of Science Learning

The trends for nine-, thirteen- and seventeen-year-old students across five national science assessments conducted by NAEP between 1969 and 1986 indicated peaks in science performance at approximately 1965 followed by declines and then some recovery. To date, however, the recoveries have not matched the declines.

International science assessments reveal that U.S. students, especially those completing high school, are among the lowest achievers of all participating countries.

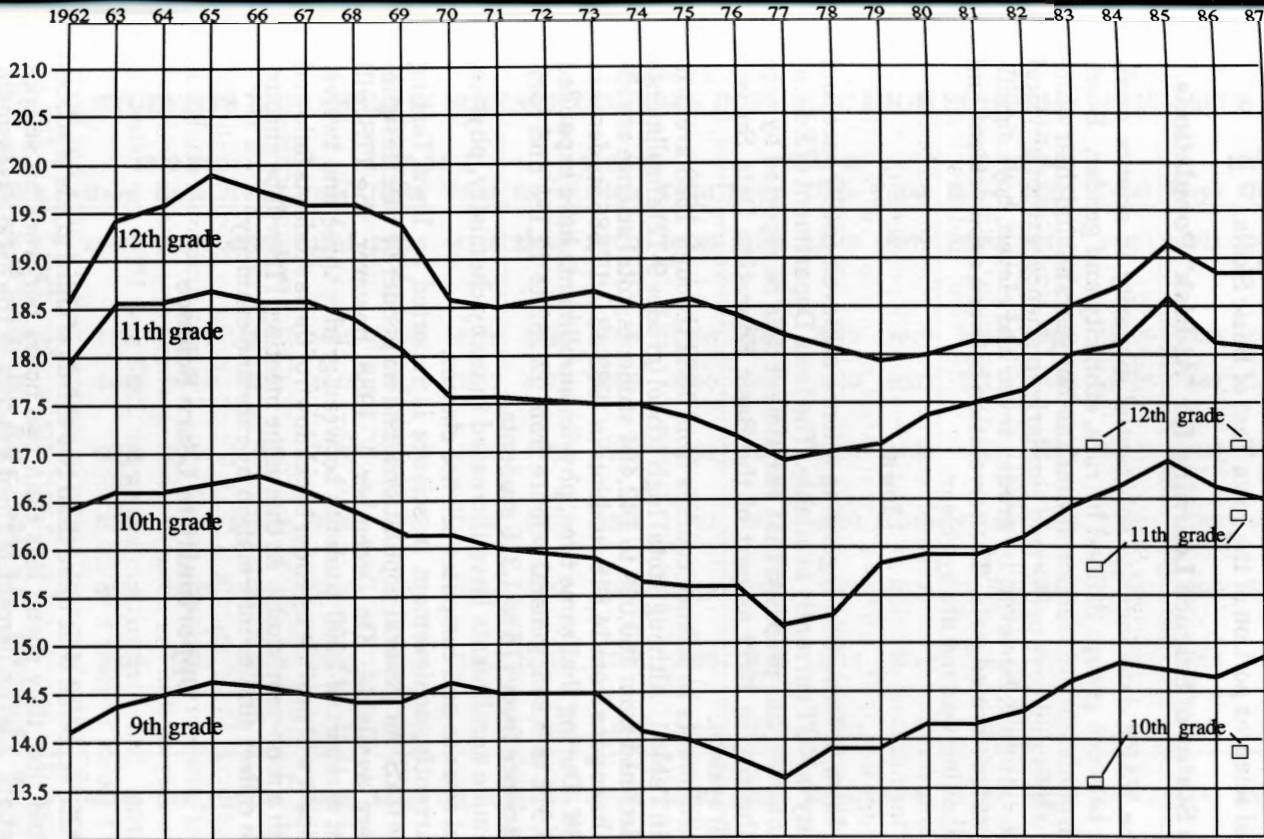
### Iowa

Caution must be exercised in lumping Iowa students into some of these discouraging trends. Iowa Department of Education personnel discovered that NO Iowa students were included in such studies (International Assoc. for Educational Achievement, 1988).

Figure 1 provides a longitudinal measure of Iowa student achievement in science over a 25-year period. The data is based on Iowa Tests of Educational Development (ITED) which provide a good measure of "general" students' performance. Figure 1 shows that Iowa students perform very well in the natural sciences when compared to national standards. National median scores for 1983 and 1987 are noted in Figure 1 (Iowa Testing Service, 1988).

Since 1979, the "general" trend in student performance has been improving. The recent decline in performance for grades 10, 11 and 12 is a concern. However, the data is not indicative of a trend. This situation needs to be carefully monitored.

Standard Scores



**Figure 1**  
**STATE OF IOWA: IOWA TEST OF EDUCATIONAL DEVELOPMENT (ITED)**  
**MEAN SCORES 1962-1987**  
**NATURAL SCIENCE TEST: READING BACKGROUND**

National Median □

At the elementary level, similar information concerning student science achievement needs to be collected on a larger, more representative scale than can currently be achieved through the "optional" natural sciences portion of the Iowa Test of Basic Skills.

## **The Status of Science Learning for "At-Risk" Populations**

The NAEP data indicate substantial disparity in science proficiency between groups defined by race, ethnicity and gender. Black and Hispanic students remain as much as four years behind their white peers. Girls and boys performed similarly in science, except physical science, at age 9; however, by grades seven and eleven, boys significantly outperformed girls. The correlation between achievement and course taking was not always clear.

### **Iowa**

In Iowa, information regarding science achievement by race and ethnicity is NOT currently available. The Iowa Department of Education, however, has proposed that enrollment data be reported by race and ethnicity in 1989 as part of the Basic Education Data Survey (BEDS) system.

Enrollments in science courses from 1982 through 1988 are provided in Table 1. Although total high school (grades 9-12) enrollments have declined from 160,028 to 142,464 students, total science enrollments have gone from 14,818 students in 1982-83 to 17,686 students in 1987-88. During that same time, physics enrollments have expanded from 6,912 to 9,243; general science from 12,282 to 17,183 and computer science from 778 to 1,216 students.

Female enrollments have increased in many chemistry, physics, general science and computer science classes.

Currently, achievement in science is reported by Iowa Testing Service (ITS) for general populations, and no gender or race designations are available. On December 1, 1988, however, the ITS will present a report of 3000 students between grades three and twelve. This report will provide a gender breakdown of these students followed through a nine-year study. At this same meeting, ITS will be encouraged to collect similar information by race and ethnicity.

## **Opportunity to Learn Science**

### **NAEP**

NAEP reported that more than two thirds of third grade teachers indicated that they spend less than two hours per week on science instruction. Eleven percent of third graders in the 1986 assessment

**Table 1**  
**STUDENTS ENROLLED IN SCIENCE COURSES IN PUBLIC HIGH SCHOOLS, 1982/3-1987/8**

COURSE	1982-83			1983-84			1984-85			1985-86			1986-87			1987-88		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Biology (Including Life Science)	21407	22351	43758	21921	22295	44216	22069	22620	46689	23130	23749	46879	22263	22618	44881	20393	20669	41062
Chemistry	7434	7384	14818	8010	8268	16278	8628	8680	17308	9066	8879	17945	9283	8826	18109	8930	8756	17686
Physics	4396	2516	6912	4645	2712	7357	5071	3329	8300	5511	3540	9051	5541	3464	9005	5649	3594	9243
Physical Science	8098	7354	15452	7433	6963	14396	7703	7279	14982	7659	7080	14739	7059	6768	13827	6508	6164	12672
Earth Science	6332	5416	11748	6169	5470	11639	6306	5395	11701	5648	4700	10548	6063	5276	11339	5186	4797	9983
General Science	6555	5727	12282	7127	6327	13454	7714	6915	14629	8240	7588	15828	7448	6943	14391	8895	8288	17183
Environ. Science	1502	1173	2675	2249	1793	4042	2112	1786	3898	2156	1814	3970	2151	1796	3947	1586	1141	2727
Computer Science				468	310	778	570	480	1050	652	480	1132	677	543	1220	694	522	1216
Science Totals	55742	51921	107645	58022	54138	112160	60173	56384	116557	62062	58030	120092	60485	56234	116719	57841	53931	111772
9-12 Students Enrollments			160028			155675			153830			152134			148292			142464

Data from State of Iowa Basic Education Data Survey (BEDS)

reported having no science instruction provided to them. Approximately half of the seventh and eleventh grade teachers reported spending less than three hours per week devoted to science instruction.

## Iowa

In the recently implemented *New Standards for Iowa Schools*, science is defined and identified as a required subject for grades one through eight. In grades nine through twelve, five units of science must be offered. Table II, *Iowa High School Graduation Requirements in Science for 1982/3-1987/8*, shows that most schools are requiring increasing units (120 hours of instruction) in science for all students.

The great majority of Iowa schools are currently requiring two units of science for high school graduation, with one unit being a biological science course and one a physical science course. At the elementary grade levels (1-6), science is typically taught in self-contained classrooms. Information concerning science instruction in self-contained classrooms has been difficult to collect. As of 1989, the Iowa Department of Education (1988) has been requested to collect time devoted to science instruction at these levels through its Basic Education Data Survey (BEDS). The BEDS information is a required annual report of all Iowa schools relative to personnel and curriculum.

## Science Curriculum and Instruction

### NAEP

The "Spirit of Science" model as described in the NAEP report suggests that learners who are actively engaged in the learning process are the ones who are most affected. Science educators maintain that hands-on laboratory experiences should be an integral part of science instruction. Many of them believe that science teaching and learning should parallel the methods of investigation used by scientists (Welch, 1984). The 1986 NAEP report, however, indicated that very low percentages of students, in all grades, had experienced any lab or experiential-based science. NAEP also observed that Japan, China, East Germany, West Germany and the Soviet Union have linked science content closely to the requirements for living in their contemporary society.

## Iowa

Iowa's *New Standards for Approved Schools* requires that the science curriculum in grades one through twelve include life science, earth science, physical science and environmental awareness. In addition, the standards require that courses include science knowledge, science process skills (reflecting a higher order thinking process

**Table 1**  
**IOWA HIGH SCHOOL SCIENCE GRADUATION REQUIREMENTS**  
**1976-1987**

Year	Number Districts	Units Required by Local Districts									K-12 School Dist. Enrollment
		0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	
1976-77	148	0	0	36	1	108	1	1	0	1	<500
1978-79	156	1	0	34	2	117	0	1	0	1	
1980-81	175	0	0	32	2	137	1	2	0	1	
1981-82	173	0	0	30	2	137	1	2	0	1	
1982-83	182	0	0	29	3	145	1	2	0	2	
1983-84	180	0	0	23	4	145	3	4	0	1	
1984-85	187	0	0	16	4	158	4	5	0	0	
1985-86	193	0	0	14	3	168	3	5	0	0	
1986-87	194	0	0	10	4	168	4	8	0	0	
1987-88	194	0	0	9	4	166	4	11	0	0	
1976-77	94	0	0	36	1	55	0	2	0	0	500-749
1978-79	92	0	0	35	2	53	0	2	0	0	
1980-81	99	0	0	34	4	60	0	3	0	0	
1981-82	99	0	0	30	5	63	0	1	0	1	
1982-83	106	0	0	31	6	66	1	2	0	0	
1983-84	106	0	0	29	6	68	1	2	0	0	
1984-85	104	0	0	16	4	158	4	5	0	0	
1985-86	97	0	0	20	1	72	2	2	0	0	
1986-87	98	0	0	19	1	73	2	3	0	0	
1987-88	98	0	0	17	1	74	2	4	0	0	
1976-77	75	0	0	34	1	39	0	1	0	0	750-999
1978-79	76	0	0	32	2	40	0	2	0	0	
1980-81	59	0	0	20	2	36	0	1	0	0	
1981-82	59	0	0	19	2	35	0	3	0	0	
1982-83	48	0	0	15	1	32	0	2	0	0	
1983-84	48	0	0	12	1	33	0	2	0	0	
1984-85	44	0	0	9	1	32	1	1	0	0	
1985-86	43	0	0	7	1	31	1	2	0	0	
1986-87	41	0	0	8	0	30	1	2	0	0	
1987-88	41	0	0	7	0	30	1	3	0	0	
1976-77	47	1	0	17	1	27	0	0	0	0	1000-1499
1978-79	39	1	0	13	1	24	0	0	0	0	
1980-81	33	1	1	10	1	20	0	0	0	0	
1981-82	33	0	1	9	9	23	0	0	0	0	
1982-83	37	0	1	11	1	24	0	0	0	0	
1983-84	37	0	0	10	1	25	0	0	0	0	
1984-85	37	0	0	12	0	24	1	0	0	0	
1985-86	37	0	0	10	1	25	1	0	0	0	
1986-87	39	0	0	8	0	30	1	0	0	0	
1987-88	39	0	0	8	0	30	1	0	0	0	

Year	Number Districts	Units Required by Local Districts								K-12 School Dist. Enrollment	
		0	0.5	1.0	1.5	2.0	2.5	3.0	3.5		4.0
1976-77	25	0	0	8	0	17	0	0	0	0	1500-1999
1978-79	27	0	0	9	2	16	0	0	0	0	
1980-81	31	0	1	12	2	16	0	0	0	0	
1981-82	31	0	0	13	2	16	0	0	0	0	
1982-83	28	0	0	11	1	16	0	0	0	0	
1983-84	28	0	0	8	2	17	1	0	0	0	
1984-85	26	0	0	6	2	17	1	0	0	0	
1985-86	27	0	0	6	1	19	0	1	0	0	
1986-87	25	0	0	4	2	17	1	0	0	0	
1987-88	25	0	0	3	2	18	1	1	0	0	
1976-77	31	0	1	12	0	17	0	1	0	0	2000-2999
1978-79	29	0	1	12	0	14	0	2	0	0	
1980-81	19	0	0	10	0	8	0	0	0	4	
1981-82	19	0	0	10	0	9	0	0	0	0	
1982-83	16	0	0	10	0	6	0	0	0	0	
1983-84	16	0	0	7	0	9	0	0	0	0	
1984-85	16	0	0	7	0	8	1	0	0	0	
1985-86	16	0	0	7	0	8	1	0	0	0	
1986-87	16	0	0	5	1	9	1	0	0	0	
1987-88	16	0	0	4	1	10	1	0	0	0	
1976-77	29	0	0	19	0	10	0	0	0	0	3000 +
1978-79	28	0	1	19	0	8	0	0	0	0	
1980-81	27	0	1	18	0	8	0	0	0	0	
1981-82	27	0	0	19	1	6	0	0	0	0	
1982-83	24	0	1	17	1	5	0	0	0	0	
1983-84	24	0	1	15	1	8	0	0	0	0	
1984-85	24	0	0	13	2	9	0	0	0	0	
1985-86	23	0	0	9	3	11	0	0	0	0	
1986-87	23	0	0	7	3	13	0	0	0	0	
1987-88	23	0	0	7	2	14	0	0	0	0	

Data from State of Iowa Basic Education Data Survey (BEDS)

and experiential activities), and the application of process and content to societal issues. Such curriculum components and their level of emphases are based upon ten years of data collected by the Iowa Department of Education.

In order to assist schools in contouring such curricula to local needs, the *Iowa Guide to Curriculum Development in Science* has been disseminated to educators in paper copy, microfiche and Apple and IBM computer software. In addition, the curriculum guide includes methods for implementing and assessing science/technology/society components in the curriculum. Locally developed curricula based upon



such guides must be on file for Department of Education review, along with plans for implementing necessary changes to meet state standards. In the majority of schools, such "balanced" science curricula are becoming the mode.

## Summary

The NAEP report raised several serious concerns regarding science education. Many of the weaknesses identified are already being addressed in Iowa educational institutions.

Iowa students perform very well in science, and we must caution against overreacting to national studies which sound alarms. This is especially critical when our state is allegedly categorized in such reports, we do not have any students included in the data and we have state data suggesting contradictions.

Several concerns raised by the NAEP assessments suggest areas for investigation within Iowa, including: 1) the need for information regarding science instruction time and achievement at the elementary level (grades 1-6); 2) more inclusive science enrollment and achievement data for minorities and gender and 3) monitoring of student achievement progress, pre- and post-implementation of Iowa's new educational standards for approved schools.

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