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A 5-YEAR COMPARISON STUDY OF IOWA HIGH SCHOOL SCIENCE

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Introduction

There have been some major changes among the nation's schools in the past 20 years. These include (a) appearance of paraprofessionals; (b) new instructional technologies; (c) varying levels of desegregation; (d) federal funding accompanied by federal control; (e) larger school districts; (f) more informal instructional arrangements; and (g) unionization of teachers. (1)

Within the context of these changes, it has been professed that science has been experiencing a progressive de-emphasis in the general curriculum. (2) It has been alleged that such general de-emphasis of science can be seen in many ways. Among the major allegations are:

- Decreased graduation requirements for science. (3)
- Declining science enrollments since 1973, especially in the areas of physics and physical science. (4)
- Decreasing numbers of school districts with the largest and smallest districts curricula most severely affected by declining enrollments. (5,6)
- Due to increasing shortages of science teachers, increasing numbers of science courses are taught by teachers without applicable content preparation. (7)
- Changes in science curriculum emphases, generally away from traditional programs (Biology, Chemistry, Physics, etc.) toward general and/or interdisciplinary courses. (8)

The purpose of this study was to address these allegations through a 5-year (1973-74 to 1978-79) comparison of Iowa public high school science curricula and staff characteristics. The study focused upon curricula and staff by school district size. Only teaching staff with bachelor degrees or beyond were included in the study.

Procedure

The sample included all science teachers in Iowa public high schools. The data came from the Basic Education Data Survey of the Department of Public Instruction (DPI). Each year the DPI collects curriculum and staff information concerning every high school (grade 9-12 only) and staff member teaching in Iowa's public and non-public schools. This study was confined to public high schools only. The DPI has gathered

evidence that substantiates the accuracy of the information derived from the BEDS forms filed each year by school districts. It can be concluded that errors of deviations on the forms are the exception and do not generally affect total data validity. The accuracy of this study was consistent with the accuracy provided by the BEDS and subject to the same inherent limitations.

Results

Science Graduation Requirements (grades 9-12)

Since reliable data concerning graduation requirements were available only for the years 1976-77 through 1978-79, this portion of the study encompassed only three years.

Table 1 indicates the science graduation requirements for Iowa public high schools listed by school district size. It is readily apparent that general declining enrollments have affected school district sizes. From 1976-77 to 1978-79 the total number of school districts declined from 449 to 447. In addition, as enrollments declined in large and intermediate size districts additional small districts were created. From 1976-77 to 1978-79 the number of school districts with enrollments of less than 500 increased from 148 to 156; simultaneously the number of intermediate and large school districts declined.

Table 1 Graduation Requirements in Science 1976-7 to 1978-9 for grades 9-12 (9)

K-12 School Enrollment	No. of Districts	Units									
		0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	
<i>Less than 500</i>	(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
<i>500-749</i>	(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
<i>750-999</i>	(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
<i>1,000-1,499</i>	(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
<i>1,500-1,999</i>	(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
<i>2,000-2,999</i>	(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
<i>3,000 or more</i>	(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

In the area of science, small school districts (enrollment less than 500) appear to be increasing the science requirements for graduation. The number of school districts, in this category, requiring 1 unit (1 year) of science declined from 36 in 1976-77 to 34 in 1978-79; 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) graduation requirements have generally been decreasing in the area of science.

Table 2 indicates both the total and average enrollments in each science subject by school district size for the 1973-74 and 1978-79 academic years. Average enrollments were calculated to compensate for fluctuations in the numbers of school districts in each size category. Averages were calculated by taking total enrollments by subject for each of the DPI size categories and dividing these totals by the number of districts of that size. Such figures provide only a general estimation of enrollment trends.

Due to declining enrollments in the larger districts, those districts with enrollments of less than 500 showed a considerable increase in numbers (130 in 1973-74 to 156 in 1978-79). School districts with enrollments of 500-749, 1,000-1,499, and 2,000-2,999 show significant declines in numbers.

It is apparent from Table 2 that 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, and earth science. It may be interesting to note that in large school districts (2,000 or more) 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 this 5-year period 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.

Staff characteristics

The National Center for Educational Statistics reports that since 1961 the percentage of bachelor degrees earned in science has held steady at almost 8%, while the percentage of master and doctorates declined from 8% to 4% and 30% to 20% respectively. (11) This may indicate that fewer teachers are pursuing advance degrees or that in a growing economy, more lucrative and rewarding science careers are available in the private sector of business for those with specific science education. (12)

Tables 3 and 4 provide a comparison of Iowa public high school science staff characteristics by subject area and school district size. The total number of bachelor degrees in science increased from 2,273 in 1973-74 to

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	
		Total	Ave	Total	Ave	Total	Ave	Total	Ave	Total	Ave	Total	Ave	Total	Ave
<i>Less than 500</i>															
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
<i>500-749</i>															
1973-4	102	4,776	47	1,572	15	788	8	2,177	21	988	10	215	2	2,008	20
1978-9	92	4,932	54	1,530	17	632	7	1,698	19	893	10	134	2	1,972	21
<i>750-999</i>															
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
<i>1,000-1,499</i>															
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
<i>1,500-1,999</i>															
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
<i>2,000-2,999</i>															
1973-4	36	6,421	178	2,132	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
<i>3,000 or more</i>															
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	932	35	9,354	334
<i>Total</i>															
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	2,535	6	20,373	47

2,274 in 1978-79, while the number of master degrees declined from 1,300 to 1,225 during the same time period.

Biology and chemistry both showed increases in the total number of teachers between 1973-74 and 1978-79. Both subject areas exhibited increases in the number of teachers with bachelor degrees, with a simultaneous decrease in the number with master degrees. With the exception of those with enrollments of less than 500 or between 1,500 and 1,999, all school district size categories showed decreases in the number of biology and chemistry teachers. Declining enrollments in intermediate (500-1,500 students) and very large districts (3,000+ students) resulted in increasing numbers of very small (less than 500 students) and large (1,500-2,000 students) districts.

A comparison of Tables 3 and 4 indicates a common pattern concerning changes in the numbers of physics, physical science, earth science, and general science teachers between 1973-74 and 1978-79. In general there has been a decrease in the number of teachers in all four subject areas. Again the effect of declining enrollments on the numbers of teachers was felt least in school district categories with K-12 enrollments of less than 500 or between 1,500 and 1,999 students.

It is apparent from Tables 3 and 4 that conservation and related environmental courses have increased in emphasis in the past five years. Increases in the number of teachers has been almost universal in all school district sizes. In 1973-74 the ratio of conservation teachers with bachelor and master degrees in Iowa's public high school was approximately 1 to 1; by 1978-79 the former had surpassed the latter by almost 2 to 1.

Table 5 indicates that, in addition to changes in teacher preparation, there have been significant changes in some teaching assignments. The total number of teachers who presently have math/science combination teaching assignments in Iowa's public high schools has increased from 245 in 1973-74 to 282 in 1978-79. The most significant increase in such teaching assignments has been in the very small (less than 500 students) and very large school districts (3,000+ students).

Table 6 provides a five year comparison of Iowa public high school science teachers with undergraduate and/or graduate majors in their present teaching subject area. The table only considers biology, chemistry, physics and physical science due to the availability of data within the DPI BED system. It is apparent that in the area of chemistry, physics and physical science most teachers do not have a major in that specific subject area. The biological sciences appear to have many more teachers instructing in the subject area in which they majored in college. It also appears that the large and very large school districts have a greater percentage of teachers with majors in their current teaching area.

Curricular offerings

Table 7 provides a comparison of the number of teachers instructing in specific subjects by grade level and school district size in Iowa's public

Table 3 Iowa Public High School Science Teachers by Subject and School District Size (1973-4) (13)

K-12 District Enrollment	Biology			Chemistry			Physics			Physical Science			Earth Science			Conser- vation			General Science		
	BA	MA	Total	BA	MA	Total	BA	MA	Total	BA	MA	Total	BA	MA	Total	BA	MA	Total	BA	MA	Total
<i>Less than 500</i>	116	22	138	72	24	96	60	25	86 ^e	49	9	58	49	10	59	2	1	3	100	18	118
<i>500-749</i>	112	30	143 ^a	60	32	94 ^d	59	31	91 ^f	49	13	63 ^g	43	11	55 ⁱ	4	2	6	112	22	135 ^j
<i>750-999</i>	79	37	116	43	27	70	41	27	68	38	26	64	37	9	46	8	1	9	90	28	118
<i>1,000-1,499</i>	66	24	90	22	27	49	20	29	49	33	16	49	30	11	41	2	2	4	77	18	95
<i>1,500-1,999</i>	38	15	54 ^b	8	15	23	7	16	23	14	13	27	15	9	24	2	3	5	40	16	56
<i>2,000-2,999</i>	47	50	97	12	24	36	15	23	38	27	25	52	24	22	46	4	4	8	86	41	127 ^k
<i>3,000 or more</i>	109	140	252 ^c	20	49	69	5	43	48	72	71	146 ^h	43	52	95	7	11	18	205	126	334 ^k
Total	567	318	890	237	198	437	207	194	403	232	173	459	241	124	366	29	24	53	710	269	983

Key: a - 2 specialists c - 1 doctorate e - 1 specialist g - 1 doctorate i - 1 doctorate k - 1 specialist,
 b - 1 doctorate d - 2 doctorates f - 1 doctorate h - 1 specialist, j - 1 doctorate 2 doctorates

Table 4 Iowa Public High School Science Teachers by Subject Area, Education and School District Size (1978-9)

K-12 District Enrollment	Biology			Chemistry			Physics			Physical Science			Earth Science			Conser- vation			General Science		
	BA	MA	Total	BA	MA	Total	BA	MA	Total	BA	MA	Total	BA	MA	Total	BA	MA	Total	BA	MA	Total
<i>Less than 500</i>	179	37	216	103	33	136	88	27	116 ^d	61	14	75	60	9	69	13	3	16	130	32	162
<i>500-749</i>	100	27	127	59	29	89 ^b	52	26	79 ^e	36	19	56 ^f	45	7	52	10	2	12	96	15	111
<i>750-999</i>	88	27	115	42	22	64	29	27	56	30	24	54	36	7	43	10	1	11	85	25	111 ^g
<i>1,000-1,499</i>	53	26	84	14	23	37	15	21	36	25	12	37	27	7	34	5	3	8	57	16	73
<i>1,500-1,999</i>	42	22	64	11	17	28	13	15	28	21	15	36	12	15	27	6	4	10	42	16	58
<i>2,000-2,999</i>	45	37	82	10	19	30 ^c	10	20	30	18	14	32	19	9	28	4	2	6	52	18	70
<i>3,000 or more</i>	108	140	250 ^a	21	47	68	11	36	47	54	65	119	45	41	86	14	17	31	163	135	298
Total	620	316	938	260	190	452	218	172	392	245	163	409	244	95	339	62	32	94	625	257	883

Key: a - 1 specialist, b - 1 specialist d - 1 specialist f - 1 specialist
 1 doctorate c - 1 doctorate e - 1 specialist g - 1 specialist

Table 5 Iowa Public High School Teachers with Math/Science Combination Teaching Assignments by School District Size (15)

K-12 District Enrollment	1973-4	1978-9
	No. of Teachers	
<i>Less than 500</i>	68	82
<i>500-749</i>	53	44
<i>750-999</i>	39	38
<i>1,000-1,499</i>	27	29
<i>1,500-1,999</i>	10	16
<i>2,000-2,999</i>	17	20
<i>3,000 or more</i>	31	53
<i>Total</i>	245	282

Table 6 Iowa Science Teachers with Undergraduate or Graduate Majors in their Teaching Area by Subject and School District Size (16)

1973-4

K-12 District Enrollment	Biology		Chemistry		Physics		Physical Science	
	Major	Non Major	Major	Non Major	Major	Non Major	Major	Non Major
	<i>Less than 500</i>	81	57	23	73	11	75	7
<i>500-749</i>	80	63	24	70	17	74	3	60
<i>750-999</i>	59	57	30	40	15	53	9	55
<i>1,000-1,499</i>	55	35	18	31	14	35	1	48
<i>1,500-1,999</i>	35	19	12	11	8	15	4	23
<i>2,000-2,999</i>	78	19	16	20	14	24	9	43
<i>3,000 or more</i>	170	82	32	37	19	29	11	135
<i>Total</i>	558	332	155	282	98	305	44	415

1978-9

K-12 District Enrollment	Biology		Chemistry		Physics		Physical Science	
	Major	Non Major	Major	Non Major	Major	Non Major	Major	Non Major
	<i>1</i>	133	83	36	100	13	103	8
<i>2</i>	70	57	31	58	19	60	10	46
<i>3</i>	65	50	30	34	13	43	3	51
<i>4</i>	47	37	14	23	7	29	3	34
<i>5</i>	45	19	14	14	10	18	7	29
<i>6</i>	54	28	9	21	8	22	5	27
<i>7</i>	173	77	37	31	20	27	15	104
<i>Total</i>	587	351	171	281	90	302	51	358

Table 7 Dominant Iowa Public High School Science Course offerings by Grade Level and School District Size (17)

1973-4

Subject, Grade Level, and number of teachers

K-12 District Enrollment	Biology				Chemistry				Physics				Physical Science				Earth Science				Conser- vation				General Science			
	9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12
<i>Less than 500</i>	10	113	39	44	2	6	91	57	8	11	25	54	43	5	14	6	19	3	3	3	0	0	1	3	54	6	8	11
<i>500-749</i>	20	109	61	56	2	9	88	58	11	10	27	55	45	9	13	4	20	5	5	4	0	4	5	6	45	10	10	16
<i>750-999</i>	21	75	49	49	1	11	68	53	1	5	18	56	48	13	9	6	18	4	2	2	1	5	7	8	30	8	15	21
<i>1,000-1,499</i>	9	54	40	38	0	12	47	45	1	3	25	44	39	10	9	7	15	2	2	1	1	3	4	4	11	16	22	26
<i>1,500-1,999</i>	3	31	23	23	0	5	23	18	1	3	8	18	16	3	7	6	12	2	2	2	1	5	5	5	8	7	10	15
<i>2,000-2,999</i>	11	63	48	44	1	11	36	35	0	2	16	33	33	8	12	9	19	3	3	2	2	0	4	6	18	8	10	14
<i>3,000 or more</i>	29	137	113	104	0	34	66	64	2	12	33	44	69	27	29	25	40	18	17	16	5	12	12	14	37	32	33	38
<i>Total</i>	103	582	373	358	6	88	419	330	24	46	152	304	293	75	93	63	143	37	34	30	10	29	38	46	203	87	108	141

1978-9

Subject, Grade Level, and number of teachers

K-12 District Enrollment	Biology				Chemistry				Physics				Physical Science				Earth Science				Conser- vation				General Science			
	9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12
<i>Less than 500</i>	28	170	110	114	5	11	129	91	7	12	64	62	60	11	34	7	16	4	5	4	5	10	14	15	91	23	21	25
<i>500-749</i>	17	91	56	59	2	11	86	65	8	11	37	51	44	12	23	4	20	1	1	1	1	5	10	9	51	15	12	14
<i>750-999</i>	24	73	57	54	1	15	63	59	4	5	23	40	45	18	15	7	10	1	1	1	1	3	10	11	33	17	19	22
<i>1,000-1,499</i>	9	44	41	37	0	12	36	35	1	4	17	22	28	5	5	3	9	4	5	5	1	5	7	6	16	15	17	16
<i>1,500-1,999</i>	4	42	27	27	5	6	27	23	1	2	8	17	22	3	6	3	14	2	1	1	3	7	7	8	13	10	8	11
<i>2,000-2,999</i>	7	54	43	43	1	11	29	29	0	6	11	17	20	7	7	6	13	1	1	1	2	3	2	2	19	2	3	6
<i>3,000 or more</i>	33	148	132	122	1	36	62	64	1	12	29	39	42	17	21	20	54	19	18	17	10	20	20	21	74	38	44	47
<i>Total</i>	122	622	466	456	15	102	432	366	22	52	189	248	261	73	111	50	136	32	32	30	23	53	70	72	297	120	124	141

high schools. Although there were slight differences among school districts by size, there was a great deal of agreement as to the grade level at which each subject is taught. The subject and dominant grade each subject offered were: Biology — grade 10; chemistry — grade 11; physics — grade 12; physical science — grade 9; earth science — grade 9; conservation — grade 12; and general science — grade 9. Between 1973-74 and 1978-79 there were no major shifts in the grade levels at which each subject was taught.

Discussion and Conclusions

As a result of this 5-year (1973-74 to 1978-79) comparative study of Iowa public high school (grades 9-12) staff and curricula, certain allegations may be more confidently addressed.

- Due to general declining enrollments, reorganization and consolidation have resulted in reductions in the number of intermediate (1,000-2,000 students) and very large (3,000+ students) school districts. The number of very small (500 students) school districts, however, have increased significantly.
- Science graduation requirements are generally increasing in small public high schools, while they are generally stable or declining slightly in larger school districts. It must be cautioned, however, that such changes may be partially explained by increases in the number of small to general declining enrollments and resultant reorganization and/or consolidation.
- Average and total enrollments are increasing in most areas of science in very small school districts, while they are experiencing sporadic changes in the larger districts. Average and total enrollments have generally increased in biology, chemistry and general science, regardless of school district size.
- The numbers of course offerings in conservation, general science, biology, and chemistry have generally increased, while those in physics, physical science and earth science have generally declined.
- The most significant and uniform growth in science courses, regardless of school district size, appears to be in biology and general science.
- There have been no significant changes in the grade levels at which science subjects are taught.
- The number of science teachers with master degrees are generally decreasing, while the number with bachelor degrees are increasing. Biology, chemistry, and conservation have shown total increases in the number of teachers.
- There has been a general increase in the number of biology and chemistry teachers who have undergraduate or graduate majors in their teaching area. Very large school districts have shown uniform increases in the number of teachers with majors in their teaching area and decreases in the number of teachers without majors in their teaching area.

- There appears to be significant increases in the number of teachers with combination math/science teaching assignments.
- Consistent with national trends, it appears that the very small and very large school districts are experiencing the greatest staff and curricular changes.

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Bad Breath

Why do garlic, onions and other pungent foods impart a lingering odor to breath?

The odor doesn't come from the stomach, because the gullet opens only occasionally, generally remaining collapsed like an empty tooth-paste tube, according to Claire Reyner in *Everything Your Doctor Would Tell You If He Had Time*. And it's not because remnant of foods linger in the mouth.

It's because the molecules that give foods a pungent aroma pass through the stomach walls and into the bloodstream, then into the lungs, from which they are expelled by breathing.