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A Study of Physics, Chemistry and Advanced Science Enrollments in Iowa's Area Ten with Reference to Enrollment Patterns in the State of Iowa

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This study was initiated under the assumption that advanced science courses could be shown to detract from physics enrollments, thus establishing one possible cause of the continuously declining enrollments in physics in Iowa's Area Ten and nationwide. Initial work failing to support this relationship, a study of chemistry enrollments was added, chemistry enrollments being felt to be indicative of emphasis on science, with or without an advanced course.

Information on enrollments in Area Ten was taken directly from teachers' responses to a questionnaire on such enrollments for 1969-70, received from all 43 public and seven parochial, private or special schools of Area Ten. Information on total nine-12 enrollments in Iowa schools was taken from the data collected for 1969-70 by the State Department of Public Instruction in Des Moines.

Courses described as physics include PSSC, and those described as chemistry include CBA and CHEM STUDY. Those listed here as Area Ten advanced science were defined as science courses felt by the physics teacher to be in competition with physics for student enrollments. These courses had titles including Senior Science, Advanced Biology, Advanced Science, Biology II, Physiology, Science IV and Chemistry II. Physiology courses were not often considered by the physics teacher to be in this category. (Two small schools representing less than one percent of the total Area Ten public school enrollment reported physiology courses as advanced science, the enrollments in these two courses representing 3.4 percent of the advanced science offered in Area Ten public schools. Five other Area Ten public schools representing 23 percent of the total school population and offering physiology courses did not report their courses as advanced science.)

Course enrollments are reported as percentages of nine-12 student enrollments, and the entire population of each group of schools is used to determine the group percentages, rather than to average individual school percentage enrollments. The total enrollment information is summarized in Table 1.

Table 1
AREA TEN ENROLLMENTS

	Total 9-12 Enrollments	Physics (% of 9-12)	Chemistry (% of 9-12)	Advanced Science (% of 9-12)
Area Ten	22,087	3.6	7.7[1]	2.1
Area Ten Public	20,076	3.4	7.6	2.0
Area Ten Parochial, Private, Special	2,011	4.7	8.6[2]	3.3

[1] Based on 21,707 total nine-12 students in 48 reporting schools
[2] Based on 1,631 total nine-12 students in five reporting schools

These enrollment figures were broken down further into two groups of public schools: those offering advanced science courses in addition to chemistry and physics, and those offering only chemistry and physics. See Table 2.

Table 2
SCHOOLS OFFERING ADVANCED SCIENCE

	Total 9-12 Enrollments	Number of Schools	Physics %	Chemistry %	% Advanced Science
Offering Advanced Science	12,829	19	3.4	6.7	3.1
Not Offering Advanced Science	7,267	24	3.5	9.3	

Another breakdown of the information was developed around school size for the 43 public schools. See Table 3.

Table 3
ENROLLMENTS ACCORDING TO SCHOOL SIZE

School Sizes in 9-12 Enrollments	Number of Schools	Total 9-12 Enrollment	% Physics	% Chemistry	% Advanced Science
0- 200	14	1,883	4.8	9.6	2.0
150- 300	14	3,116	3.9	9.2	1.2
250- 500	8	2,685	3.5	8.0	1.9
400- 700	9	4,917	2.4	8.1	2.5
500-1,000	9	5,689	2.4	8.6	2.0
900-3,000	5	8,870	3.6	6.5	1.9

A preliminary examination of these summaries yields the following observations:

1. Schools offering advanced science in Area Ten have nearly the same physics enrollments as those not offering advanced science.
2. Chemistry enrollments in Area Ten seem to be depressed by the offering of advanced science.
3. Small schools have somewhat higher enrollments in both chemistry and physics.
4. Intermediate-sized schools have depressed physics but higher than average chemistry enrollments.
5. Large schools have normal physics but depressed chemistry enrollments.
6. Total advanced science enrollments are fairly uniform among schools of different sizes, in spite of the fact that large schools are more likely to offer advanced science. In other words, if a smaller school offers advanced science, the percentage of enrollment will usually be higher than that of the large school.

Since the information from the Area Ten sample is known to be accurate, but represents just over 10 percent of the Iowa student population, further information relative to the entire state of Iowa was taken from the statistics available from the State Department of Public Instruction. See Table 4.

Table 4
TOTAL STATE ENROLLMENT IN PHYSICS AND CHEMISTRY

Total 9-12 Enrollment	% Physics	% Chemistry
191,700	3.5	8.2

These figures, being slightly higher than the Area Ten enrollments, probably reflect early-in-the-year information, as contrasting with Area Ten's mid-year information. Also, two cases were found of inaccurately high physics reports from among Area Ten schools as reported on the state data.

A summary of the state data from the six major metropolitan school districts representing 20 percent of the state's nine-12 enrollment is summarized in Table 5.

Table 5
METROPOLITAN SCHOOL DISTRICTS

Total 9-12 Enrollment	Number of Districts	% Physics	% Chemistry
39,834	6	3.9	6.5

Another survey of the state data selected every fifth school with 9-12 enrollment of 400 to 1,000. See Table 6.

Table 6

Total 9-12 Enrollment	Number of Schools	% Physics	% Chemistry
10,856	17	2.5	8.3

Yet another statewide survey of all schools with nine-12 enrollments of approximately 400 to 900 (classifications 5 and 6) and offering a course titled Advanced Science, Biology II or Chemistry II is shown in Table 7. From the 19 schools, three were removed because of questionable information.

Table 7

Total 9-12 Enrollments	Number of Schools	% Physics	% Chemistry	% Advanced Science (Including Biology II and Chemistry II)
10,055	16	3.4	8.3	3.1

For Area Ten public schools of size 400 to 1,000 the following summary compares schools with and without advanced science. See Table 8.

Table 8

Number of Schools	Total 9-12 Enrollments	% Physics	% Chemistry	% Advanced Science (As Defined for Area Ten)
7	4,139	2.4	8.4	3.5
4	2,387	2.4	8.1	

Pearson correlation coefficients relating enrollments in the three courses are tabulated in Tables 9 and 10.

Table 9
AREA TEN

Number of Schools	Chemistry Physics	Chemistry Advanced Science	Physics Advanced Science
43	0.44		
19		0.47	0.43

Table 10
STATE OF IOWA
(Schools of approximately 400-900, nine-12 enrollments offering Advanced Science, Biology II or Chemistry II)

Number of Schools	Chemistry Physics	Chemistry Advanced Science	Physics Advanced Science
16	0.38	0.15	0.19

When the 16 Iowa schools above were broken into two groups, one third with high advanced science enrollments and two thirds with moderate to low advanced science enrollments, the following enrollments are noted for the two groups.

Table 11

Total 9-12 Enrollments	Number of Schools	% Physics	% Chemistry	% Advanced Science
3,021	5	3.3	8.4	6.3
7,034	11	3.0	8.3	2.0

Observations

1. The trends among Area Ten schools of intermediate size are almost precisely verified by the sample from the state records. The intermediate-sized high school has a physics enrollment about one percent below that of the state average (3.5 percent to 2.5 percent).

2. The trend of intermediate-sized schools in Area Ten to have relatively higher than average chemistry enrollments is not substantiated by the statewide sample. Area Ten intermediate-sized schools have about 8.3 percent chemistry enrollments, somewhat high for Area Ten but comparable to both the state averages and the average for 400- to 1,000-sized schools across the state. This seems explainable in that Area Ten is made up to the extent of 34 percent by the metropolitan school sample previously reported, higher than the 20 percent across the state and thus having a somewhat deflated overall chemistry enrollment, making the intermediate-sized school enrollment appear large by local comparisons.

3. Physics enrollments in the large metropolitan districts are larger than the state average.

4. Chemistry enrollments in the large metropolitan districts are decidedly smaller than the state average.

5. The deflated chemistry enrollments in Area Ten schools offering advanced science were not substantiated by state data. The state sample for intermediate-sized schools offering advanced science shows average chemistry enrollments, and the small sample of Area Ten intermediate-sized schools offering advanced science approximates the statewide sample.

6. Neither in Area Ten nor statewide can advanced science courses be shown to relate to lower physics enrollments. If the peculiar nature of the school which offers advanced science might be expected to influence generally higher science enrollments, this is not substantiated by chemistry data and lends no credence to a notion that, in some manner, what might have been higher physics enrollments in such a school are in fact deflated to normal values by the presence of advanced science.

7. In the tabulation of schools with high vs. average to low advanced science enrollments, it could be said that the most numerically successful advanced science courses are taking nearly 0.5 percent from physics. But since these are intermediate-sized schools, again showing no high chemistry enrollments to correlate with those of advanced science, the higher than average (for intermediate-sized schools) physics enrollments argue more for a generally supportive rather than detrimental relationship between physics and advanced science.

8. Some correlations exist between the enrollments in these courses, and it is clear that physics is not particularly negatively affected by advanced science enrollments, or, as previously noted, by extremely high advanced science enrollments. These correlations, though remaining positive, are considerably more modest when school size is roughly controlled, as in the state sample.

General Remarks

An unpublished study by Elizabeth Ronat of Des Moines Area Community College, Ankeny, studied a number of factors related to Iowa high school physics enrollments for 1966-67. Her enrollment pattern study shows a similar trend to that of Area Ten in 1969-70, for the rather large enrollments for very small schools, tapering off as schools get larger. Her largest school size group was about 450 and above nine-12 students, and she did not report on the intermediate-size school patterns.

Of considerable interest in her work was the lack of evident relationship, in a cursory examination, between grading standards of the physics teacher and physics enrollments and the clear positive relationship between the academic physics background of the high school counselor and the physics enrollments. In fact, a correlation of average grade and percentage of enrollment for Ronat's 34 samples yields r=0.088.

The high physics enrollments in smaller schools is probably a result of a number of factors, not necessarily desirable or conducive to good physics instruction. Since advanced science courses cannot in this study be shown to be detrimental to physics enrollments, the smaller choice of competing subjects in the smaller high school is not likely an important factor. In the Ronat study, the group of physics teachers with a mean academic preparation of 7.7 semester hours in physics had decidedly higher enrollments. Those physics teachers with 20 or more hours of preparation had the lowest enrollments; and, among teachers with 20 or more semester hours of physics preparation, greater preparation did not correlate with higher physics enrollments.

If there is a feature of the small school physics instructor which would be generally true, it might be that he teaches at least several subjects other than physics; and, secondarily, he has weak academic preparation in physics. This could account for a course in which the instructor would simply not be able to provide consistent attention to the broad areas of physics, but would rather spend large amounts of time on areas of his specific interest, perhaps in project fashion, providing greater amusement for his students, but perhaps not necessarily sound physics instruction.

To explain the low physics and average chemistry enrollments in the intermediate-sized school, one might turn again to the secondary nature of the physics duties of the instructor. He likely has a sound science background (or perhaps math), but his teaching strength is likely to be in chemistry. He knows how to teach chemistry in an appropriate fashion, but he is in fact learning physics himself; and, when a strong desire to offer a sound physics program couples with his lack of academic background, a course develops which represents unbalanced attention to topics he begins to consider important but that the well-prepared teacher might treat more judiciously.

Notes on PSSC and CHEM STUDY

Among the seven Area Ten public schools known to use PSSC as the basis

for their course of study, the following enrollments are summarized in Table 12.

Table 12

Total 9-12 Enrollments	% PSSC Physics	% Chemistry	% Advanced Science
2,411	3.3	9.5	2.7

And from the sample of every fith Iowa school of size 400 to 1,000 nine-12 students, six of the 17 schools reported the use of PSSC, with 2.9 percent of the 3,572 students enrolled.

It may be important to note that all Area Ten public schools known to use PSSC as the basis for their physics instruction are in the size categories below 1,000 nine-12 students, with 67 percent of this total nine-12 population in schools with 400-1,000 nine-12 students and enrolling 3.2 percent in PSSC Physics. This category (400-1,000 nine-12 students) has been shown both in Area Ten and throughout Iowa to have depressed physics enrollments. In both cases the PSSC schools, though having less than average physics enrollments, have higher enrollments than the schools of comparable size using other than PSSC and have enrollments nearly the same as that group from the state sample offering advanced science.

Also, among five Area Ten schools of size 400 to 1,000 nine-12 students known to use CHEM STUDY, 8.4 percent of the 2,786 nine-12 students take chemistry.

And, among the six CHEM STUDY reporting schools of the sample of every fifth Iowa school of size 400 to 1,000, 9.0 percent of the 3,409 students were enrolled in chemistry. Both groups show CHEM STUDY enrollments slightly above the average chemistry enrollments.

Conclusion

It seems clear to this former intermediate-sized school physics teacher whose main interest was chemistry and whose declining physics enrollments were often personally attributed to an advanced biology course's competition, that advanced science courses are not an overall threat to physics. If something can be pointed to as influencing negatively the enrollments in physics, it might be whatever phenomena influence physics instruction in the intermediate-sized school. Of equal interest might be the nature of the negative influence on chemistry (unparalleled by physics) in the large school.

If the rigor of the course, a feature commonly related to the decline of physics in the high schools, is to be even loosely associated with grading standards and with the PSSC curriculum, it is not possible to show with these

summaries that students are skipping physics because of the difficulty of the course or the standards of the instructor. The implications here may be significant. If students are *not* avoiding physics because of its rigor, would it not be a mistake to modify physics instruction in such a way as to attempt to make it more appealing to this non-existent student?

Rebuilding a Tornado To See What Makes It Tick

Hurricanes can be studied from airplanes flown through them and from instruments located in their paths. But even if a meteorologist or engineer could predict the narrow path of a tornado, any instruments he might place in its path would be swept away by the force of the storm. As a consequence, relatively little research has been done and little is known about the forces that swirl inside those funnel-shaped land storms.

So the National Science Foundation is supporting a combined effort by teams of Texas engineers and meteorologists to work backwards: to reconstruct from the damage it caused the tornado that ripped through Lubbock, Texas, on May 11, 1970, killing 26 persons and destroying property worth some $130 million.

The engineers, led by Kishor C. Mehta and Albert J. Sanger of the Department of Civil Engineering of Texas Tech University, have been examining and documenting in detail the structural damage done by the storm.

The meteorologists, behind Joseph L. Goldman of the Institute for Storm Research at the University of St. Thomas in Houston, Texas, are attempting to use the engineers' and other available data to construct a model of the storm.

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