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Patricia M. Schwirian

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Introduction

The recent concern about educating America's young people for scientific literacy and competence has turned a critical, unflattering spotlight on science education in general and science teachers in particular. It is understandable that science teachers at all levels would be the object of such close scrutiny since they do indeed have the greatest effect on the development of scientists and, therefore, on future science.

This concern, however, has too often taken the form of generalized panic rather than cool, objective evaluation. Many have described the wrongs, a few have made constructive suggestings toward correction, and a few more have worked to put their suggestions into operation.

Unfortunately, in their haste to right the glaring wrongs which exist in science education, many have made their corrections and changes before they found out all they might about the present situation. Consequently much that is good has been discarded with the bad simply because of "guilt by association."

One aspect of science education most heavily under fire is teacher preparation. In discussing such criticism Conant has given what he has heard as a typical layman's view: "The trouble is that our teachers come out of the teachers colleges, where they spend all their time telling students *how* to teach. We ought to be getting our teachers from the liberal arts colleges where . . . they come out knowing something."[1] Warren Weaver, Vice President of the Rockefeller Foundation has expressed a criticism commonly found among academicians: "Some of us feel rather strongly that the less enlightened leaders among professional educators have placed an unfortunate emphasis on methods as apart from, and sometimes even contrasted with content. We feel that this relative emphasis should be reversed."[2] This same feeling has been expressed by Admiral Rickover in even stronger terms.

While this storm of criticism rages we find that little accurate information is available regarding the personal and professional

[1] James B. Conant, *The Education of American Teachers* (New York: McGraw-Hill Book Company, Inc. 1963), p. 73.
[2] Warren Weaver, "Science Teaching" *Education in the Age of Science*, ed. Brand Blanshard (New York: Basic Books, Inc. 1960), p. 254.

characteristics of science teachers in America. Only a few such studies may be enumerated such as those by Conant (1963) and the National Science Foundation (1961). It is the purpose of this paper to shed a little light on the murky topic of the preparation of science teachers by examining in detail one population of these teachers. Our focus is upon one segment of the junior high school science staff – the seventh grade teachers of Iowa.

Research Design:

The information presented here is part of that collected in a larger study of characteristics of seventh grade science teachers in Iowa, the characteristics of the courses they teach, the interrelationships between the teachers' characteristics and those of their courses, the degree of satisfaction expressed by the teachers for their courses, and improvements the teachers feel are needed in the courses they teach.

Since the study is teacher-oriented, it was felt that the sample should also be teacher-oriented. The names of all the seventh grade science teachers in Iowa were taken from the 1961-1962 Iowa Educational Directory, (a total of 760) and a sample of fifty per cent of these was randomly chosen.

The size of the sample and the widespread distribution of the sample over the state ruled out the possibility of personal contact and interviewing. Therefore, a mailed questionnaire was used to obtain the needed information. Since this is a very select population, one may expect a significantly higher rate of response than that achieved if a more general population were used.[3]

Following a pretest and revision the questionnaire accompanied by a cover letter and a self-addressed, stamped envelope were sent to the 360 teachers in the sample. Of these 67.9 percent responded. The resulting sample was checked as to whether or not it was typical of the population by comparing the respondents with the non-respondents on the basis of the size of the school district in which they teach and on the basis of sex. There was no systematic bias with regard to size of school districts, but the males are slightly over-represented in the return.

The information thus obtained was coded and placed on a series of code sheets; it was then punched, verified and duplicated on IBM cards. The data were tabulated and analyzed by standard procedure on an IBM 101 counter-sorter. Some of the

[3] *William J. Goode and Paul K. Hatt, Methods in Social Research* (New York: McGraw-Hill Book Company, Inc., 1952), p. 174.

distributions thus obtained are presented in individual tables in the following text.

Age and Sex

Data:

The median age of seventh grade science teachers was found to be 30; 90 percent falling in the age range between 21 and 51. Fifty percent are in the 21-30 year group and 40 percent in the 31-50 year group. (See Table 1)

Table 1. Distribution of sample by age & sex.

	21 to 30	31 to 50	over 50	Total	Median Age	% of Sample
Males	58%	35%	7.%	100% (175)	29.7	73.5%
Females	30.1%	52.4%	17.5%	100% (63)	34.9	26.5%
Total	50%	40%	10%	100% (238)	30.0	100% (238)

In determining the sex of the seventh grade science teachers, it was found that 73 percent were males. (See Table 1) As a true representation of seventh grade science teachers all over the state, this may be a little high, since the sample is slightly biased in favor of male respondents.

Nevertheless, there are roughly three times as many men as women engaged in the teaching of seventh grade science in Iowa. This may seem rather surprising in light of the fact that traditionally, elementary school teaching has been viewed as a woman's occupation.

A comparison of the age and sex of Iowa's seventh grade science teachers shows the median age of males as 30, and that of females as 35. Over half the male teachers are in the 21-30 age range; 35 percent are between the ages of 31 and 50, and only seven percent are over 50. Of the females, the largest group is in the middle age-range. Slightly over one-half of the women are between 31 and 50, about one-third are between 21 and 30, and eighteen percent are over 50 years old. It should be noted that the age distribution of the males and females are quite different. The strikingly lower percentages of men in the over-30 groups is likely indicative of the tendency of male junior high school science teachers to be occupationally mobile.

It is suggested that a significant number of such men move within education either into administration or to science teaching at the secondary level. One also suspects that the decrease could be due to their leaving the teaching profession entirely to enter other areas of endeavor, which may be more financially rewarding.

College Degrees Held

The education of the teacher himself is an important factor in how well he carries out his teaching and professional duties. Of those who responded to the questionnaire, 75 percent hold, as their highest degree, a Bachelor of Science or a Bachelor of Arts degree. On a number of questionnaires, respondents had additionally noted the number of hours completed past the bachelor's degree. In many cases, the number was equal to or well above the thirty to forty hours usually required by a college or university for a master's degree, but the possession of such a degree was not noted in these cases. Only fourteen percent of the teachers hold Master of Arts or Master of Science degrees, and none hold Ph.D. degrees. In light of the recent pressures brought to bear in the state regarding the possession of a Bachelor's degree in order to meet certification requirements, it may be surprising that almost as many seventh grade science teachers have less than a bachelor's degree as have master's degrees.

In comparing degree by sex, (See Table 2) it was found that only four percent of the responding males hold less than a bachelor's degree, while 27 percent of the females are in the same category. As would be expected, the greatest number of both males and females hold the B.S. or B.A. degree — three-fourths of the males and two-thirds of the females. At the master's level, there is, again, a notable difference in the males and females; seventeen percent of the males hold masters degrees, and only six percent of the females do.

Table 2. Distribution of sample by degree & sex.

	Less than B.A.	B.A. or B.S.	M.A. or M.S.	Total
Males	4.5%	78.3%	17.2%	100% (175)
Females	27%	66.7%	6.3%	100% (63)
Total	10.9%	75%	14.1%	100% (238)

A comparison of age and degree (See Table 3) held show, as expected, that the major portion of each group possess bachelor's degrees; 92 percent of the youngest group, 70 percent of the oldest, and 56 percent of the middle group. The age distribution in the "less than bachelor's" category is rather interestingly uneven. Only five percent of the youngest group have no degree, but each of the two older groups have a concentration of non-degree teachers almost three times that in the youngest group. At the opposite end of the educational scale it is interesting to note that the same group — the 31 to 50 year olds — that possesses

Table 3. Distribution of sample by degree & age.

	Less than B.A.	B.A. or B.S.	M.A. or M.S.	Total
21 to 30	5.0%	91.7%	3.3%	100% (175)
31 to 50	16.8%	55.8%	27.4%	100% (95)
over 50	13.1%	69.5%	17.4%	100% (23)
Total	10.9%	75.0%	14.1%	100% (238)

the highest percentage of non-degree teachers also possess the highest percentage of teachers with master's degrees—almost 30 percent. Additionally, the 21 to 30 year-old group has the lowest percentage of non-degree teachers *and* the lowest percentage of teachers with master's degrees—3.3 percent. The older age group is intermediate in both cases.

Professional Preparation

The teachers in the sample were asked what type of institution they attended for their undergraduate work. (See Table 4) The type of school from which the largest number of respondents came is the private liberal arts college. These are the relatively small, privately endowed or church-related colleges which are dispersed so generously throughout the state of Iowa and the surrounding states.

Table 4. Distribution of sample by type of college attended.

No Response	Private L.A. College	General State College	University	Teacher's College	Other	Total
2.0%	36.5%	4.2%	23.0%	31.8%	2.5%	100% (239)

The percentage of respondents graduated from these schools is 36.5 percent; the only other group which was close to this was the teacher's college graduates and near-graduates which comprise 32 percent of the effective sample. The only other type of institution which provides a sizeable number of seventh grade science teachers is the state university. On a number of questionnaires respondents specified the State University of Iowa or Iowa State University in particular. The general state colleges and others accounted for a total of only seven percent of all the respondents.

These data may be compared to Conant's findings that of the nearly 400 teachers he interviewed across the United States, 20 percent came from schools which were *exclusively teachers'* colleges. Conant also calls attention to the 1961 National Science Foundation survey which reported that 29 percent of the sampled

science teachers received a Bachelor's degree from teachers' colleges, 39 percent from liberal arts colleges, 20 percent from universities, and twelve percent from others.[4]

The teachers described in this study, then appear to be representative of the nation's teachers in regard to their place of preprofessional education. The relatively high proportion of liberal arts college graduates in science teaching should bring to the attention of teacher educators the importance of the education departments and teacher preparation facilities of these institutions.

Several questions on the questionnaire were designed to determine the number of semester hours in education, mathematics, and various science courses the respondents had completed. (See Table 5) The median number of hours in education is 25.5, while the median total number of hours in science (excluding mathematics) is 28.7. A comparison of these shows that the respondents have a few more hours of science than education; however, further investigation shows that these hours in science are not concentrated in a single area, or even in a few areas, but tend to be spread over all the science areas. The median number of hours in the areas of chemistry, physics, earth science, botany, and zoology ranges from a high of 4.0 to a low of 1.1. These are medians!

Table 5. Distribution of sample by total number of hours in science (Excluding Mathematics)

	Hours in Science						
	None	1 to 20	21 to 40	41 to 60	Over 60	Total	Median
Percent	4.2%	32.6%	36.0%	18.4%	8.8%	100% (239)	28.7 hrs.

These shockingly low figures reflect the finding that in each of the areas previously mentioned, from one-third to one-half of the respondents reported no college work.

Since mathematics is felt to be a foundation for good science investigation and understanding, the teachers were asked to report their total number of semester hours in this area also. Thirty percent have had none, and the median number of hours in mathematics was found to be four. (See Table 6) This is particularly disturbing when one considers the fact that in many elementary and junior high schools, the seventh grade science teacher is also the teacher of mathematics. This distribution of science and mathematics courses would lead us to conclude that the general educational pattern among the respondents is the completion of only one or two introductory courses in an assortment of science areas.

[4] Conant, *op. cit.* p. 74.

Table 6. Distribution of sample by college semester hours of education and science completed.

	NUMBER OF HOURS							
COURSES	None	1 to 4	5 to 10	11 to 20	Over 20	Median No. of Hours	Inter Quartile Range	TOTAL N
Education	8.8%	.0%	2.4%	20.8%	68.0%	25.5	18.2-32.8	239(100%)
Mathematics	30.1%	26.4%	28.1%	9.1%	6.3%	4.0	.24- 7.9	239(100%)
Chemistry	43.6%	10.1%	24.6%	19.3%	2.4%	3.7	0-13	239(100%)
Physics	49.5%	18.4%	24.4%	6.7%	1.0%	1.2	0-5.6	239(100%)
Earth Science	39.9%	29.0%	23.0%	7.9%	0.2%	1.1	0-6.0	239(100%)
Botany	26.9%	26.9%	24.4%	9.6%	2.4%	3.0	0-6.7	239(100%)
Zoology	34.0%	21.0%	26.0%	12.2%	7.2%	4.0	0-7.2	239(100%)
Other Science Courses	38.1%	13.8%	25.1%	16.2%	6.9%	4.0	0-11.8	239(100%)

John S. Richardson has suggested that the undergraduate work for those persons preparing for work in the teaching of science be distributed in the following manner: general education, 30 percent; professional education, 20 percent; and academic work in science and mathematics, 50 percent.[5] Obviously there is a wide discrepancy between this suggested preparation and that reported by the respondents. The sampled teachers come very close to the 20 percent educational courses suggested, but only 25 percent of their work is in science and mathematics – the rest must be assumed to be classified as general education.

A comparison of the numbers of hours in science by age and by sex was also made. (Table not included) It was found that the median number of hours in science completed by men is eleven hours higher than that completed by women – 31 and 20 hours, respectively. The age distribution shows no significant difference among the groups.

In comparing the science preparation of teachers who teach seventh grade science in a school system which has an eight-year elementary-four-year high school organization to those who teach in a system which includes seventh grade in a junior high school, distinct inequalities are noted. (See table 7) Of those who teach in 8-4 systems nearly one-half reported having taken 20 semester hours or *less* of science, while only about one-fourth of those who teach in junior high schools fall in the same category. This difference is further clarified by the fact that the junior high school seventh grade science teachers have a median of 39 science hours while their counterparts in 8-4 systems have only 21.6 hours in college science. This difference reflects the variance in the structure of the two types of systems. In the 8-4 arrangement an elementary teacher's preparation must be broad, thereby necessitating a few hours in many areas. Since many who teach in the junior high school hold certificates which enable them to teach in grades 7-14, they tend to specialize in a subject matter area.

Table 7. Distribution of sample by total number of hours in science (Excluding Mathematics) and type of school organization.

	Hours in Science					
Organization	None	1 to 20	21 to 40	Over 40	Total	Median
8-4	5.9%	43.2%	35.3%	15.6%	100% (102)	21.6 hrs.
Jr. High	2.9%	25.4%	36.3%	35.4%	100% (138)	39.0 hrs.

[5] John S. Richardson, "The Education of the Science Teacher", The 59th N.S.S.E. Yearbook, *Rethinking Science Education* (Chicago: University of Chicago Press, 1960), p. 265.

Discussion:

In this paper it has been shown that:

1. The seventh grade science teachers in Iowa are relatively young, the median age being 30.
2. The majority of these teachers are male.
3. Seventy-five percent hold bachelor's degree, with more higher degrees being held by males than females.
4. Slightly over one-third of the teachers received their undergraduate education at liberal arts colleges.
5. The teachers are relatively well prepared in the areas of professional education, but rather poorly prepared in science areas. The median number of semester hours was no higher than four in any science area.
6. Teachers who teach seventh grade science in a junior high school report a significantly better preparation in science than those who teach the same course in an eight-grade elementary school.

It is clear then from this report that teachers of junior high school-level science must have further training in science if they are to perform at the level of competence which our science-and-technology-oriented society demands. Many agencies, most notably the National Science Foundation, have contributed vast amounts of time and money toward the improvement of the quality of secondary school science teaching. It is now apparent that contributions of equal or greater magnitude must be made toward the junior high school level, because it is undeniably a crucial educational point demanding teachers of extensive background and high quality.