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## Qualifications of Public Secondary School Biology Teachers, 1999–2000

Studies of the qualifications of elementary and secondary school teachers have focused on whether or not teachers have educational backgrounds (a postsecondary major/minor or equivalent) and state certification that match the subjects they teach (Ingersoll 1999; Seastrom et al. 2002). Teachers are described as “in field” or “out of field” based on the presence or absence of a postsecondary major and state certification in the subject taught. However, among teachers who are out of field, further analysis can show the extent to which their training is related to or distant from the field in which they teach.<sup>1</sup> To the extent that out-of-field teachers differ in the subjects in which they have been trained, teachers may differ in the useful knowledge they bring to instruction.

This Issue Brief introduces a measure of teacher qualifications that includes additional detail on the educational backgrounds and certifications of out-of-field teachers. The focal subject for the Issue Brief is biology/life science (called biology in this Issue Brief) at the secondary level. Biology was selected because of its high enrollment rates—in 1998, 93 percent of high school graduates had taken at least 1 year of biology at the secondary level (Roey et al. 2001). For each qualification—postsecondary major/minor and state certification—teachers are grouped first by whether or not they have the qualification in biology. Then, teachers lacking the qualification in biology are grouped by their fields of study or fields of certification. These subjects are grouped by similarity to each other in terms of subject matter and skills. The list of subjects is taken from Seastrom et al. (2002), the most recent National Center for Education Statistics (NCES) Statistical Analysis Report on out-of-field teaching.<sup>2</sup> Teachers are grouped first in terms of educational background and certification separately (table 1) and then grouped based on the combinations of their postsecondary majors/minors and certification (table 2). The Issue Brief makes no judgment about which subjects are further out of field than others, but provides the information that allows the reader to make such

an assessment. Teachers who reported more than one non-biology qualification are included in each group. Thus, the groups of teachers lacking biology qualifications are not mutually exclusive.

Data are drawn from the NCES 1999–2000 Schools and Staffing Survey (SASS) teacher and school surveys. The sample used in the analysis includes teachers who reported teaching predominately in the middle or high school grades (called “secondary level” in the balance of the Issue Brief) and teaching “biology or life science” to at least one student.<sup>3</sup> Information on teachers’ qualifications and grade level and number of students are drawn from teachers’ reports. Findings are reported in terms of the percentage of biology students taught by teachers of various qualifications (see also Seastrom et al. 2002).

Estimates are reported separately for students in each of four poverty categories based on the percentage of students eligible for free or reduced-price lunch. SASS schools were asked to report the number of students eligible for free and reduced-price lunch. Each category includes approximately 25 percent of the sample: less than 10 percent of students in school qualifying for free or reduced-price lunch, 10–25 percent, 25–50 percent, and more than 50 percent. This allows the Issue Brief to address the extent to which students in high- and low-poverty schools experience more or less out-of-field teaching in biology and to explore the variation of out-of-field teachers’ qualifications across the settings.

### Majors, Minors, and Certifications Reported Separately

*What proportion of biology students has a teacher with a major or minor in biology?* About 60 percent of biology students at the secondary level in 1999–2000 were taught by teachers with a postsecondary major or minor in biology, leaving about 40 percent of students taught by teachers who were considered out of field in terms of their postsecondary education (table 1). Among this 40 percent of students, there were differences across school settings in the educational backgrounds their teachers brought to the classroom. Students in the schools with the highest poverty rates were the least likely to have teachers with a major or minor in another natural science (26 percent of the more than 50 percent group, compared with 46 percent of the 25–50 percent group, 62 percent of the 10–25 percent group, and 58 percent of the less than 10 percent group). Secondary-level biology students in

<sup>1</sup> Research on biology and physics teachers has examined courses taken within science, but has not differentiated among teachers who have taken other science coursework in place of subject-specific coursework and those who have taken other science coursework in addition to subject-specific coursework; nor has other research examined coursetaking beyond science (see Wood 2002).

<sup>2</sup> Differences from the Seastrom et al. (2002) list are the addition of categories for “other subjects” and “no subjects” and the inclusion of arts, music, foreign languages, and bilingual education/English as a Second Language in the “other subjects” category. There were too few cases in which out-of-field biology teachers had qualifications in these subjects to provide an accurate estimate of their prevalence separate from the “other subjects” category.

<sup>3</sup> The sample includes 1,680 public school teachers. The analysis weighted cases using the TFNLWGT weighting variable.

**Table 1. Percentage of public school students in biology classes taught by secondary-level teachers, by percentage of students in the school qualifying for free or reduced-price lunch, and by subject field of teachers' postsecondary majors, minors, and certification: Academic year 1999–2000**

Teacher's subject field of major, minor, or certification	Total	Percent free/reduced-price lunch			
		<10%	10–25%	25–50%	>50%
<b>Major or minor in biology</b>	<b>60.8</b>	<b>63.8</b>	<b>64.0</b>	<b>52.6</b>	<b>63.4</b>
Major in biology	55.3	59.8	58.3	46.3	57.0
Minor in biology	5.6	4.0	5.7	6.4	6.4
<b>No major or minor in biology</b>	<b>39.2</b>	<b>36.2</b>	<b>36.0</b>	<b>47.4</b>	<b>36.6</b>
Major or minor in:					
Other natural science	49.3	57.7	61.9	46.5	26.0
Elementary education	22.3	8.2 !	19.0	22.0	46.2
English	3.9 !	8.3	0.4 !	3.3 !	3.4 !
Mathematics	7.8	1.8 !	21.2	3.6 !	5.3 !
Physical education	15.4	12.0 !	23.5	14.7 !	10.6
Secondary education	14.9	23.0	8.8 !	15.4	11.1 !
Social science	11.7	12.4	9.3 !	9.8	17.2
Special education	7.1	7.0	6.2	9.2	4.7 !
Other subject	10.4	11.8	8.1	9.4	13.5 !
No major or minor	4.7 !	3.6 !	#	11.8 !	0.3 !
<b>Certification in biology</b>	<b>74.7</b>	<b>83.4</b>	<b>78.2</b>	<b>71.3</b>	<b>62.9</b>
<b>No certification in biology</b>	<b>25.3</b>	<b>16.6</b>	<b>21.8</b>	<b>28.7</b>	<b>37.1</b>
Certification in:					
Other natural science	36.6	18.0 !	34.7	51.4	34.1 !
Elementary education	5.7 !	23.5 !	0.5 !	3.2 !	1.7 !
English	3.4 !	5.7 !	1.1 !	5.7 !	1.5 !
Mathematics	7.9 !	2.7 !	21.9 !	3.9 !	3.9 !
Physical education	8.3 !	2.8 !	3.6 !	20.2 !	3.2 !
Social science	4.5	8.1 !	3.3 !	3.1 !	4.6 !
Special education	12.0	9.6	9.2 !	9.9	18.0 !
Other subject	3.2	3.7 !	3.3 !	1.1 !	5.0 !
No certification	35.5	32.9 !	29.3	33.8	43.7

# Rounds to zero.

! Interpret data with caution. Standard error is more than one-third as large as the estimate.

NOTE: Secondary-level teachers include teachers who taught students in grades 5–12; teachers who taught in grades 5–9 who identified themselves as elementary or special education teachers were not included. Detail may not sum to totals because of rounding. Detail below “No major or minor in biology” and “No certification in biology” do not sum to totals because they are not percentages of the table total, but percentages of the category (“No major or minor in biology” or “No certification in biology”); they do not add to 100 percent, because teachers could report majors/minors or certifications in multiple subjects. Not all apparent differences in this table are statistically significant. Standard errors are available at <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2005081>.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey (SASS), 1999–2000 “Public School Questionnaire,” “Charter School Questionnaire,” “Public Teacher Questionnaire,” and “Charter Teacher Questionnaire.”

the highest poverty schools were more likely to have out-of-field teachers with elementary education majors or minors than those in all other types of school settings.

*What proportion of biology students has a teacher with a certification in biology?* Overall, 25 percent of secondary-level biology students were taught by teachers without a state certification in biology. Students in the highest poverty schools were more likely to be taught by teachers with out-of-field certifications than were those in the two lowest school poverty categories (37 percent of the more than 50 percent group, compared

with 22 percent of the 10–25 percent group and 17 percent of the less than 10 percent group).

## Majors, Minors, and Certifications Reported in Combinations

*Among students of teachers with a certification in biology:* Fifty-two percent of secondary-level biology students had teachers with both a certification and a major or minor in biology (table 2). Students in the two lowest school poverty categories were more likely than those in the 25 to 50 percent school poverty category to have teachers with both qualifications (58 percent of the less than 10 percent group and 57 percent of the 10–25 percent group, compared with 44 percent of the 25–50 percent group).<sup>4</sup>

Among students taught by teachers who reported having in-field certification but out-of-field educational backgrounds, the most common type of postsecondary major or minor was natural science (56 percent of these students). Among the students with teachers who were certified but had out-of-field educational backgrounds, those in the highest poverty schools were more likely than those in the lowest poverty schools to have teachers with an elementary education major or minor (38 percent of the more than 50 percent group, compared with 4 percent of the less than 10 percent group).

*Among students of teachers with no certification in biology:* Overall, 9 percent of secondary-level biology students had a teacher who had no certification in biology but did have a major or minor in biology. This combination was more prevalent among the teachers of students in the highest poverty schools than in the two lowest school poverty categories (17 percent of the more than 50 percent group, compared with 7 percent of the 10–25 percent group and 6 percent of the less than 10 percent group).

Among all secondary-level biology students, 16 percent had teachers with neither a certification nor a major or minor in biology. For these students, those in schools in the two lowest school poverty categories were more likely than those in the highest poverty schools to have teachers with a major or a minor in a natural science (56 percent of the less than 10 percent group and 69 percent of the 10–25 percent group, compared with 10 percent of the more than 50 percent group). Also in this group, students in the highest poverty schools were more likely than those in the 10–25 percent school poverty category to have teachers with a major or minor in elementary education (53 percent of the more than 50 percent group, compared with 13 percent of the 10–25 percent group).

## Conclusion

Measures of out-of-field teaching that report only the absence or presence of educational and certification qualifications provide important but incomplete information about student exposure to teachers with differing qualifications in the subjects

<sup>4</sup> In the highest poverty group, 46 percent of students had a teacher with both qualifications, but the estimate for this group had a large standard error and, as a result, apparent differences compared with the lower poverty groups are not statistically significant.

**Table 2. Percentage of public school students in biology classes taught by secondary-level teachers, by percentage of students in the school qualifying for free or reduced-price lunch, and by combinations of teachers' postsecondary majors/minors and certification subject fields: Academic year 1999–2000**

Teacher's combination of major/minor and certification	Total	Percent free/reduced-price lunch			
		<10%	10–25%	25–50%	>50%
<b>Certification in biology</b>	<b>74.7</b>	<b>83.4</b>	<b>78.2</b>	<b>71.3</b>	<b>62.9</b>
<b>And major or minor in biology</b>	<b>51.8</b>	<b>57.8</b>	<b>57.1</b>	<b>44.5</b>	<b>46.3</b>
Major in biology	47.4	54.7	51.7	40.2	41.4
Minor in biology	4.4	3.2	5.4	4.3	4.9
<b>And no major or minor in biology</b>	<b>22.9</b>	<b>25.6</b>	<b>21.1</b>	<b>26.8</b>	<b>16.6</b>
Major or minor in:					
Other natural science	55.5	58.5	57.2	56.3	44.9
Elementary education	17.6	4.4 !	23.4 !	16.2 !	37.8
English	2.9 !	6.0 !	0.3 !	2.1 !	2.6 !
Mathematics	4.1	0.4 !	10.4 !	2.5	4.1 !
Physical education	19.1	14.4 !	26.4	20.7 !	13.0 !
Secondary education	20.8	29.3	8.9 !	23.8 !	17.0 !
Social science	12.2	11.7 !	13.8 !	10.4 !	14.4 !
Special education	5.0	4.4 !	4.6 !	8.3 !	0.3 !
Other subject	6.9	8.7 !	5.4 !	7.9 !	3.7 !
No major or minor	1.7 !	5.1 !	#	0.4 !	#
<b>No certification in biology</b>	<b>25.3</b>	<b>16.6</b>	<b>21.8</b>	<b>28.7</b>	<b>37.1</b>
<b>And major or minor in biology</b>	<b>9.0</b>	<b>6.0</b>	<b>6.9</b>	<b>8.2</b>	<b>17.1</b>
Major in biology	7.9	5.2 !	6.6	6.1	15.6
Minor in biology	1.2 !	0.8 !	0.3 !	2.1 !	1.5
<b>And no major or minor in biology</b>	<b>16.3</b>	<b>10.6</b>	<b>14.9</b>	<b>20.6</b>	<b>20.0</b>
Major or minor in:					
Other natural science	40.4	55.7	68.6	33.7 !	10.3 !
Elementary education	29.1	17.4 !	12.7 !	29.7 !	53.2
English	5.2 !	13.7 !	0.6 !	5.0 !	4.0 !
Mathematics	13.1 !	5.0 !	36.6 !	5.0 !	6.3 !
Physical education	10.2	6.3 !	19.3 !	6.8 !	8.6 !
Secondary education	6.5	7.8 !	8.7 !	4.5 !	6.1 !
Social science	10.9	14.0 !	3.0 !	9.0 !	19.4 !
Special education	10.0	13.5 !	8.6 !	10.4 !	8.4 !
Other subject	15.4	19.3 !	11.9 !	11.3 !	21.6 !
No major or minor	9.0 !	#	#	26.7 !	0.6 !

# Rounds to zero.

! Interpret data with caution. Standard error is more than one-third as large as the estimate.

NOTE: Secondary-level teachers include teachers who taught students in grades 5–12; teachers who taught in grades 5–9 who identified themselves as elementary or special education teachers were not included. Detail may not sum to totals because of rounding. Detail below "And no major or minor in biology" do not sum to totals because they are not percentages of the table total, but percentages of the category ("And no major or minor in biology"); they do not add to 100 percent, because teachers could report majors/minors or certifications in multiple subjects. Not all apparent differences in this table are statistically significant. Standard errors are available at <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2005081>.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey (SASS), 1999–2000 "Public School Questionnaire," "Charter School Questionnaire," "Public Teacher Questionnaire," and "Charter Teacher Questionnaire."

they teach. For subjects like secondary-level biology in which close to 40 percent of students have teachers without a major or minor in the field, 25 percent have teachers without a certification in the field, and 16 percent have teachers with neither a certification nor a major or minor in the field, it is useful to examine in more detail what certifications and majors and minors these teachers actually have. This Issue Brief reported the combination of certifications and majors and minors to which secondary-level biology students are exposed and how these qualifications vary across schools with differing levels of student poverty. Students of teachers lacking a major or minor in biology in the highest poverty schools were less likely than those in all other schools to have teachers with a major or minor in another natural science and more likely than those in all other schools to have teachers with a major or minor in elementary education. Similarly, among those students with teachers who had neither a certification nor a major or minor in biology, students in the highest poverty schools were less likely than those in the two lowest school poverty categories to have a teacher with a major or minor in natural science.

Of course, certification and postsecondary education are not the only routes through which teachers can gain subject matter expertise in the subjects they teach. Teachers may bring other professional and life experiences that provide them the subject matter grounding needed to teach effectively; future data collections may address these issues. However, with current data, additional research could also examine if similar patterns of teacher qualifications across school settings are apparent among other subjects.

## References

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The Issue Brief series presents information on education topics of current interest. All estimates shown are based on samples and are subject to sampling variability. All differences discussed are statistically significant at the .05 level as measured by Student's two-tailed *t* tests. In the design, conduct, and data processing of National Center for Education Statistics (NCES) surveys, efforts are made to minimize the effects of nonsampling error, such as item nonresponse, measurement error, data processing error, or other systematic error. For more information on the Schools and Staffing Survey, visit <http://nces.ed.gov/surveys/sass>.

This Issue Brief was prepared by Daniel J. McGrath and Emily W. Holt of the Education Statistics Services Institute (ESSI) and Marilyn M. Seastrom of the National Center for Education Statistics (NCES). This Issue Brief was formatted by Carol Rohr of Pinkerton Computer Consultants, Inc. For further information, contact Edith McArthur, NCES, at 202-502-7393 or [edith.mcarthur@ed.gov](mailto:edith.mcarthur@ed.gov). To order additional copies of this Issue Brief or other NCES publications, call 1-877-4ED-PUBS or visit <http://www.edpubs.org>. NCES publications are also available on the Internet at <http://nces.ed.gov>.