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# Broadening theßase: <br> High School Physics Education at the Turn of a New Century 

Findings from the
2001 Nationwide Survey of High School Physics Teachers
by Michael Neuschatz and Mark McFarling

The findings in this report are the fruit of a collaborative effort of many individuals and organizations. Special thanks are due to the American Association of Physics Teachers and to the education administrators and school principals whose schools took part in the survey. As always, our deepest gratitude is to the physics teacher participants, whose generosity with their time and willingness to express their experiences and feelings made this study possible.

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## HIGHLIGHTS

- Enrollments in high school physics have continued their impressive rise since the middle of the 1980s (Figure 1). The number of students taking physics is now approaching one million. Yet, despite these gains, two out of every three high school seniors across the country head for graduation without ever having taken a separate course in physics.
- The overall participation of girls in high school physics classes remains close to parity, consolidating the gains of the late 1980s and early 1990s (Figure 3). However, gaps persist, with girls more concentrated in basic introductory classes and less evident among those sitting for advanced placement physics exams.
- The long-standing disparity in physics enrollments between white and Asian-American students on the one hand, and African-American and Hispanic students on the other, has shown a marked reduction in the past four years (Figure 4). However, it is too soon to say whether this will develop into the type of consistent trend that helped to reduce the gender disparity over the last two decades.
- Rising enrollments have also brought benefits to the corps of physics teachers now numbering 21,000. In the past four years, more teachers have been able to concentrate on physics teaching (Figure 5), and more now consider themselves to be physics specialists (Figure 6), rather than primarily as specialists in other fields who have just been called upon to teach a class or two in physics. On the whole, teachers regard themselves as better prepared in physics than was previously the case (Table 8), although there remain important areas where teacher confidence is still not very high.
- Despite all these significant gains, there are also areas where little change has occurred over the past fifteen years. For example, less than a fourth of high school physics teachers majored in physics in college, and even when degrees in physics education are included, the proportion increases to only a third. (Figure 7).


## HIGHLIGHTS (cont.)

- Professional activity and continuing education are other areas where progress has been slow (Table 12). Only a quarter of all respondents are members of the US physics teacher professional society, the American Association of Physics Teachers (AAPT) (Figure 11), and more than half belong to neither the AAPT nor to the National Science Teachers Association.
- Other aspects of professional life also remain problematic. While both starting and continuing teacher salaries have risen steadily-outpacing inflation during the period (Figures 13, 14) -they continue to lag behind many of the alternative career options available to those with academic credentials in science (Figure 15). And the amount of funding schools provide for laboratory supplies and equipment also remains woefully inadequate, both in absolute (Figure 9) and subjective (Table 10) terms.
- One of the likely spurs to increased enrollments in physics has been the differentiation of the curriculum. In the mid-1980s, over $80 \%$ of the students took the traditional algebra- and trigonometry-based introductory course. That figure is now down to $65 \%$, with almost all the difference accounted for by growth at the two ends of the academic spectrum. The last 15 years have seen a more than quadrupling of enrollments in Advanced Placement Physics, and in conceptual physics and similar courses for students with a more limited math background (Figure 2).
- Many teachers have embraced the arrival of conceptual physics, and few regard its growth as coming at the expense of enrollments in higher level courses. However, we found much less enthusiasm for the notion of inverting the traditional sequence of high school science courses to teach physics first, prior to biology or chemistry (Table 16). Still, in the few places where such an approach had already been tried, primarily private schools and a handful of public schools (Figure 16), there was much more enthusiasm for the idea (Figure 17). Whether or not this positive experience can be successfully generalized to encompass the mainstream of public schools remains an open question.


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## I. INTRODUCTION

Physics has traditionally occupied a singular place in the high school curriculum of school districts across the United States. Even as recently as fifteen years ago, when only about one-fifth of all U.S. high school seniors took physics (see Figure 1), the course served as an implicit marker identifying primarily the group of students who were heading for college and had an interest in science or a science-related field. According to longitudinal studies conducted by the US Department of Education, even in the early 1990s, most high school students fit this description,
with far fewer of either non-science-oriented or non-college-bound students taking high school physics (NCES, 2000). So the dramatic change in physics enrollments that has occurred in recent years is noteworthy not only in its own right, but also suggests important shifts going on in the broader structure of science education across the nation as well.

The main reason that physics enrollments had historically been so low, relative to other science fields like biology and chemistry, was that physics was

traditionally taught as an elective, the third science (or even fourth, if $9^{\text {th }}$ grade physical science and similar courses are counted) in a curricular sequence that required most students to take only two science courses to graduate. In addition, the perception that physics was difficult and required "advanced" mathematics further deterred those students who were not actively considering a science-related career. This also contributed to the creation of daunting roadblocks for girls and minority students, two groups traditionally underrepresented in higher math classes. As a result, although introductory physics was almost universally available in our nation's high schools, in most places enrollment supported only one or two classes (see, for example, Figure 4 in Neuschatz and Alpert: 1994).

Part of the recent increase in the absolute numbers of high school students taking physics, especially since the mid-1990s, is attributable simply to an approximately $15 \%$ rise in the population of 17 -year olds, leading to a roughly equivalent rise in the number of high school juniors and seniors who constitute the pool from which physics students come. However, this is only a fragment of the big picture - as Figure 1 showed, even in percentage terms, enrollments have risen substantially in this period. Some of this percentage increase is undoubtedly a by-product of the slow but steady rise in the proportion of graduating seniors going on to four-year college (NCES, 2001), reaching $47 \%$ by 1999. But as much or more of the increase is probably related to student and guidance counselor
perceptions that college entrance requirements have been toughened. Among other things, this may have lead many students, especially those not on the science track, to believe that having physics on the transcript would boost their college admission chances. As a result, high school physics appears to be slowly spreading beyond its traditional constituency, taking in a significant slice of those college-bound students who are leaning towards social sciences majors, and even a portion of those with aspirations in the humanities.

This broadening has meant that the growth in physics enrollments has shown up especially at the two extremes of the physics academic spectrum, with conceptual physics on one end and Advanced Placement and honors courses on the other. Not only has there been a broadening of the curriculum, but there has also been a diversification in the students who take it. Girls now make up nearly half of all physics students, consolidating the gains made in the late 1990s, and underrepresented minority groups have seen sizeable gains in physics enrollment in the past four years.

The information for these and other findings on high school physics comes from a regular nationwide survey of high school physics programs and teachers that the American Institute of Physics' Statistical Research Center has been conducting for the past fifteen years, supported by the American Association of Physics Teachers and other professional physics societies. The study is designed to yield $a$
representative picture of physics instruction in both public and private high schools across the country, based on a sample of over 3,000 schools and physics teachers newly-drawn this year from the database of all U.S. schools, maintained by the federal Department of Education. To preserve the longitudinal character of the study, a portion of the schools that had been in previous studies over the years was retained in the current sample.

Over $99 \%$ of the schools contacted by mail, phone and e-mail in the Fall of 2000 agreed to participate in the study, providing a brief description of their school, their physics program, (or the reason they did not have one) and the names and physics teaching load for all their teachers with physics classes that term. (See the survey instruments reproduced at the end of this report.) In the Spring of 2001, these teachers were sent a detailed eight page questionnaire covering their personal and academic background, their school's physics program, their current assignment, teaching practices and experiences, their
views on recent reforms in science education and physics instruction, and their plans for the future.

Many questions were identical to those used on earlier rounds of the study, enabling us to track long-term trends. At the same time, a series of questions was added on such topics as: the use of materials other than textbooks (lab and activity manuals, software and other multimedia); the impact of standardized testing and Physics Education Research; teacher views on Physics First and other reform initiatives; participation in science education discussion groups and listservs; and primary sources for seeking answers to physics content questions. The response rate for teachers was $63 \%$, with $56 \%$ completing the full questionnaire and $7 \%$ answering a shorter follow-up version. This represents a drop from what was obtained in previous studies despite intensive follow-up efforts. A detailed discussion of study methodology, including a discussion of potential response bias and approaches to analyzing change over time, can be found in Appendix B.

## II. CURRICULUM \& STUDENT CHARACTERISTICS

As was just noted, the recent growth in physics enrollments has been fueled in large part by a broadening of the physics curriculum with increases at the extremes (see Figure 2). Where once the traditional
algebra- and trigonometry-based syllabus predominated, by 2001 the classes using that approach were being taught to only just over half of the students taking physics. At the upper end, the fastest growth has been in

Figure 2. High School Physics: Enrollment Distribution


* Percent of students in regular first-year physics courses that use conceptual physics textbooks.

AIP Statistical Research Center: 1986-87, 1989-90, 1992-93, 1996-97 \& 2000-01 High School Physics Surveys
the advanced placement course designated AP-B, which is designed to mirror the introductory algebra/trigonometry-based physics course typically offered in colleges and universities to students aiming to major in the life and health sciences and similar fields. Growth in AP-C physics, the calculus-based class typically required of prospective physical science and engineering majors in college, was only a bit slower.

It is important to note that a large part of these increases is not specific to physics, but
rather reflects the phenomenal growth in popularity of AP courses across the board, with a tripling of students taking at least one AP course from 1987 to 2001 (The College Board, 1989, 2001). Nevertheless, AP physics, especially the AP-B course, has enjoyed some additional gains on top of this generalized increase. While the overall rise in AP taking may be seen as stemming from the ever-greater competitiveness of college entrance and the desire of students to present the "strongest" transcript possible, the rise in AP physics may also be indirectly due, as was suggested earlier, to the broader
increase in "regular" physics enrollments to include a larger swath of college-bound students, spurring the more academically-ambitious and scienceoriented to take AP as a way of distinguishing themselves further. Table 1 provides greater detail on the advanced end of the physics curriculum.

The growth at the other end, encompassing what is commonly-called "conceptual physics," represents an equally sharp increase over the past 15 years. In addition to explicitly labeled classes, we have also indicated in Figure 2 the subset of courses designated as traditional introductory physics that use one of the conceptual physics books as their primary text. Since 1987, percentage enrollments have almost tripled—and absolute numbers have grown more than fourfold-in "official" conceptual physics courses, while a steadily growing fraction of regular introductory
courses have employed conceptually oriented texts. Still other regular-and occasionally even honors physics classessupplement their traditional texts with conceptually-oriented material. These are drawn not only from textbooks but from other sources as well, including materials assembled by the teachers themselves.

It is growth at this end of the physics spectrum that is likely to have had the greatest impact on enrollments. As we noted earlier, prior to the spread of conceptual physics, few students beyond the traditional "science-oriented college-bound" sector ventured to try physics, and few were encouraged to do so. But in recent years, as more schools have offered a version of the conceptual course in addition to the more conventional approach, increasing numbers of non-traditional students have been willing to give physics a try.


Figure 3. Girls as a Percentage of Total Enrollment in High School Physics


AIP Statistical Research Center: 1986-87, 1989-90, 1992-93, 1996-97 \& 2000-01 High School Physics Surveys

As the physics curriculum has broadened, so has the reach of physics expanded to include students that were once underrepresented. In 1987, boys outnumbered girls by better than 3 to 2 in physics classes. During the next ten years, enrollment rates among girls increased relatively quickly, accounting for about half of the total enrollment increase (see Figure 3). By 1997, the process was largely complete, with girls approaching $50 \%$ of all physics students. However, some important disparities persist in the gender make-up of individual courses.

During the same period, enrollment rates for African-American and Hispanic students gained only slightly relative to the rates for white and Asian-American students. In 1997, while girls had mostly made up their overall gap with boys in physics taking, the underrepresented minority groups remained less than half as likely as white and Asian students to take high school physics.

However, in the most recent four-year period, physics enrollments among black and Hispanic students began to experience the type of growth that enrollments for girls had exhibited in the previous decade (see Figure 4), presenting a large enough jump to account for close to half of all the absolute gain in physics enrollments during this period. Of course, this positive movement still leaves a large racial and ethnic gap in physics enrollments, and it is far too early to know whether the improvement will turn out to be a long-term trend or a one-time aberration.

Table 2 shows physics teachers' assessments of how prepared their students were to take physics when they first entered the classroom. We see little improvement in most aspects of student preparation, with the one notable exception being that students seem significantly better prepared to use computers than was the case four years ago. On the other hand, there was a bit

Figure 4. Percent of Students in Each Racial Group Taking Physics


AIP Statistical Research Center: 1989-90, 1992-93, 1996-97 \& 2000-01 High School Physics Surveys

Table 2. Student Preparation Levels in 2001 (comparison to 1997 in parenthesis)
Percent of teachers describing their students as:

|  | Percent of teachers describing their students as: |  |  |
| :--- | :---: | :---: | :---: |
|  | Very well <br> prepared <br> \% | Adequately <br> prepared <br> $\%$ | Poorly <br> prepared <br> \% |
| Math background | $20(21)$ | $59(62)$ | $21(17)$ |
| Physical science background | $16(15)$ | $65(68)$ | $19(17)$ |
| Ability to think and pose questions <br> scientifically | $10(8)$ | $57(58)$ | $33(34)$ |
| Familiarity with general laboratory <br> methods | $20(18)$ | $62(63)$ | $18(19)$ |
| Use of computers in science | $15(8)$ | $48(42)$ | $37(50)$ |

of slippage in student math background. Confirmation for this comes later, in Table 10 , where $22 \%$ of teachers, up from $18 \%$ four years ago, cite inadequate student math preparation as a serious problem. Similarly, $20 \%$ of the teachers, compared to $17 \%$ four years ago, say that their students' negative attitudes towards physics are a major difficulty. One explanation may be that as groups of students that historically avoided physics start taking it, classes will likely include greater numbers of students with less advanced math backgrounds and less prior interest in the discipline. Finding ways to teach these students effectively is one of the great challenges facing the burgeoning field of Physics Education Research (PER).

In addition to changes in the mix of physics courses, there have been some changes in the distribution of textbooks used over the past 15 years. As Table 3 illustrates, what was once the dominant text in the traditional
algebra/trigonometry course, Modern Physics published by Holt, Rinehart and Winston, has now been almost totally phased out, while the Merrill-Glencoe text has held on to its roughly $50 \%$ share. Within the growing conceptual physics market, Paul Hewitt's high school text remains dominant. Likewise, the classic Fundamentals of Physics (often referred to just as "Halliday \& Resnick") holds sway in the calculus-based AP course, while in fast growing algebra/trig-based AP classes, several texts have a significant share but none dominates the field.

For the first time we asked teachers whether they used companion materials with their texts (see Table 4). No more than one half of teachers use any one companion materials, with lab manuals being more popular than other types of materials. In general the ratings for these materials were lower than for the textbooks themselves.

## III. TEACHERS

Over the years that this study has been conducted, we have found that many of the characteristics that describe the corps of physics teachers in this nation's public and private schools have generally been quite stable. In numerical terms, growth has been modest. The 2001 total of 21,000 represents a cumulative increase of only about $15 \%$
since 1987, despite the rise in physics enrollments of around $50 \%$. The difference, discussed in detail below, is accounted for by a significant jump in the amount of physics taught by each teacher.

The greatest stability can be found in such background characteristics as age, race and

## Table 3. Most Widely Used Textbooks

## Regular first year physics

1. Physics: Principles \& Problems (Zitzewitz / Merrill-Glencoe)
2. Conceptual Physics (Hewitt / Addison Wesley)
3. Holt Physics (Serway \& Faughn / Holt)

| $\%$ |
| :--- | :---: |
| rating |

4. Modern Physics (Trinklein / Holt)

## Physics for non-science students

1. Conceptual Physics (Hewitt / Addison Wesley)
2. Physics: Principles \& Problems (Zitzewitz / Merrill-Glencoe)

## Honors physics

1. Physics: Principles \& Problems (Zitzewitz / Merrill-Glencoe)
2. Physics (Giancoli / Prentice Hall)
3. Holt Physics (Serway \& Faughn / Holt)

| 83 | 84 | 79 | 75 | 27 | 78 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 6 | 7 | 8 | 7 | 28 | 40 |

4. College Physics (Serway \& Faughn / Harcourt Brace)
5. Physics (Cutnell \& Johnson / Wiley)
6. Modern Physics (Trinklein / Holt)

## Advanced Placement B

1. Physics (Giancoli)
2. College Physics (Serway \& Faughn / Harcourt Brace)
3. Physics (Cutnell \& Johnson / Wiley)

## Advanced Placement C

1. Fundamentals of Physics (Halliday et al. / Wiley) $\quad 47 \begin{array}{llllllll} & 41 & 39 & - & - & 85\end{array}$
2. University Physics (Sears et al. / Addison-Wesley) $\quad 10 \begin{array}{lllllll}10 & 19 & 23 & - & - & 8\end{array}$
3. College Physics (Serway \& Faughn / Harcourt Brace)

- not separately rated ${ }^{*}$ less than $5 \% *^{*}$ On a scale of 1 to 5 , with 5 the highest quality rating, the percent rating a text as a 4 or 5 . AIP Statistical Research Center: 1986-87, 1989-90, 1992-93, 1996-97 \& 2000-01 High School Physics Surveys

| Table 4. Teacher Use of Companion Materials for Four Popular Texts |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Conceptual Physics | Holt Physics | Physics: <br> Princ. \& Prob. | Physics (Giancoli) |
| \% of All Teachers Using This Textbook | 23 | 13 | 45 | 10 |
| \% Rating Text High in Quality | 70 | 64 | 52 | 75 |
| \% Of Those Using Textbook Who Also Use: |  |  |  |  |
| Lab Manual | 46 | 40 | 46 | 4 |
| \% Rating High in Quality | 47 | 34 | 35 | 43 |
| Activity Manual | 31 | 23 | 25 | 4 |
| \% Rating High in Quality | 65 | 39 | 40 | 72 |
| Associated Computer Software | 12 | 17 | 10 | 13 |
| \% Rating High in Quality | 51 | 53 | 38 | 52 |
| Other Multimedia | 14 | 6 | 8 | 7 |
| \% Rating High in Quality | 57 | 42 | 47 | 100 |

academic credentials (see Tables 5 and $\mathbf{6}$ ). Slight fluctuations in age composition mostly reflect the normal ebb-and-flow of retirements and new hiring. One area of inching progress, mirroring slow but steady changes in the physics classroom and in the make-up of physics students at higher academic levels, has been the increase in the proportion of women within the teaching ranks, although differences still persist by region and school type (see Table 7).

When it comes to factors that describe teaching assignments and conditions, however, we find a much more dramatic evolution taking place. Once again, many of these changes are a by-product of steadily rising physics enrollments, and continue trends that first became evident in earlier
rounds of the study. For example, a steadily growing fraction of teachers has been able to focus more on physics in their daily class assignment, rather than just teaching one physics class while having their main assignment in, say, chemistry or mathematics (see Figure 5). As a result, a significantly higher proportion of physics teachers now see themselves as physics specialists (see Figure 6).

And, probably as a result of the increased ability of teachers to concentrate on physics teaching in the classroom, higher proportions see themselves as better prepared in physics content than was the case in earlier rounds, and many express greater confidence in their ability to teach it effectively (see Table 8). These are

|  | 2001 | 1997 | 1993 | 1990 | 1987 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Number of physics teachers in sample | 3444 | 3548 | 3374 | 3341 | 3301 |
| Response rate (\%) | 63 | 76 | 73 | 70 | 75 |
| Median age (years) | 46 | 44 | 43 | 43 | 41 |
| \% Women | 29 | 25 | 23 | 22 | 23 |
| AAPT membership (\%) | 24 | 25 | 29 | 26 | 24 |
| Degree level (\%) |  |  |  |  |  |
| Bachelor's | 35 | 42 | 38 | 38 | 37 |
| Master's | 60 | 54 | 58 | 58 | 59 |
| Doctorate | 5 | 4 | 4 | 4 | 4 |
| Any physics degree (\%) | 33 | 33 | 29 | 27 | 26 |
| in physics (\%) | 22 | 22 | 18 | 19 | - |
| in physics education (but not physics) (\%) | 11 | 11 | 11 | 8 | - |


| Table 6. Teaching Background in Selected Survey Years |  |  |  |
| :--- | :---: | :---: | :---: |
|  | $\mathbf{2 0 0 1}$ | $\mathbf{1 9 9 3}$ | $\mathbf{1 9 8 7}$ |
| Median years teaching physics | 7 | 11 | 8 |
| Years teaching secondary school (\%) |  |  |  |
| $1-5$ |  | 19 | 18 |
| 6-10 | 25 | 17 | 15 |
| $11-20$ | 20 | 27 | 40 |
| $21+$ | 25 | 37 | 27 |
| Type of school (\%) | 30 |  |  |
| Public |  | 81 | 82 |
| Private- Secular | 81 | 6 | 6 |
| Private- "Mainstream" Religious | 5 | 10 | 9 |
| Private- Fundamentalist | 9 | 4 | 3 |
|  | 5 |  |  |


| Table 7. Women as a Percentage of Physics Teachers |  |  |
| :---: | :---: | :---: |
| Region | 2001 | 1990 |
| South | 37\% | 38\% |
| Rest of US | 25 | 19 |
| School type |  |  |
| Public | 29 | 20 |
| Private-Secular | 24 | 22 |
| Private-"Mainstream" Religious | 35 | 41 |
| Private-Fundamentalist | 28 | 13 |
| Total Years Teaching |  |  |
| 1-10 years | 33 | 32 |
| 11-20 years | 32 | 23 |
| $21+$ years | 21 | 10 |
| AIP Statistical Res. Cntr: $1989-90 \& 2000-01$ High School Physics Surveys |  |  |

important changes that impact areas that were among the core concerns of the movement for reform in physics education 15 years ago-the scarcity of physics specialists, the lack of confidence many teachers displayed in their ability to teach physics effectively, and so on. Still, the newest findings show that there are still some areas, including the teaching of developments in modern physics and the integration of computers into laboratory instruction, where teachers are clearly less secure.

While rising enrollments have a relatively immediate effect on such characteristics as current assignment and subjective sense of
specialization, it is only after many years of sustained change that we would expect to see an impact on such background variables as the type of academic training that teachers bring to their career when they first enter. While such training has never been as inadequate as rumors often depicted, it is still true that fully half of all current physics teachers have neither majored nor minored in either physics or physics education in college (see Figure 7). This means that measures of specialization that depend on academic background as well as current teaching assignment (see Figure 8) indicate a much smaller fraction of physics specialists than do measures that focus on their subjective assessment alone. Still, Figure 8 shows that virtually all physics teachers did major in one of the science or mathematics disciplines, and prior surveys have found that essentially all reported taking at least one full year of introductory physics in college. But it is likely that future improvement in the production of graduates specifically trained in physics or physics education will not appear until an even more sustained rise in enrollments can offer a better chance that teachers will be able to concentrate on physics when they actually begin their teaching career.

Another area of concern has been the introduction of new technologies into the physics classroom and laboratory. We noted earlier that, although there is still a long way to go, there was considerable improvement in teacher self-confidence about the use of computers as instructional tools. This accords well with other findings (see Table

Figure 5. Place of Physics in Current Teaching Assignment


Figure 6. Percent of Teachers Describing Themselves* as Specializing in Physics Teaching


[^0] AIP Statistical Research Center: 1989-90, 1992-93, 1996-97 \& 2000-01 High School Physics Surveys

Table 8. Teacher Self-Assessed Level of Preparation in 2001 (1990 results in parenthesis)
Percent describing themselves as:

| Very well | Adequately | Not adequately |
| :---: | :---: | :---: |
| prepared | prepared | prepared |
| $\%$ | $\%$ | $\%$ |

Basic physics knowledge

72 (67)
27 (30)
2 (2)
Other science knowledge
Application of physics to everyday experiences
Instructional laboratory design and
50 (50)
48 (41)
45 (45)
46 (48)
5 (5)
6 (11) demonstration
Use of computers in physics
24 (19*)
46 (48)
15 (21)
instruction and labs
Recent developments in physics
15 (17)
$50 \quad$ (49)
35 (35)

Figure 7. Percent of Physics Teachers with a Physics Degree


Figure 8. Teacher Specialization: Academic Training and Experience

*Teachers with physics degrees but insufficient physics teaching experience are excluded from this figure (3\%).
${ }^{* *}$ Career physics teachers include those who have taught physics as much as, or more than, any other subject, or have taught it for ten or more years. The distribution of highest degree earned by career teachers was spread evenly across the sciences, with $29 \%$ in math/engineering, $25 \%$ chemistry, $22 \%$ biology, and $14 \%$ in other science fields. AIP Statistical Research Center: 2000-01 High School Physics Survey
9) that suggest that, over the course of 15 years, computers have become solidly entrenched as a learning tool in high school physics instruction. The biggest problem continues to be the ability of students to take advantage of the new equipment, and especially to master the software that drives it, with more than half of teachers feeling that most students enter their classes unprepared to use these resources to their full advantage.

Despite the spread of computers and related sensors and software, teachers reported that
the overall funding available to them for laboratory supplies and equipment was essentially unchanged (see Figure 9), and actually remains below the level prevailing in the late 1980 s , even when ignoring inflation. While we found a slight decline in the proportion of physics teachers who regarded the lack of such funding as a serious problem (see Table 10), the continued low level of available resources makes clear why this still remains a problem area for almost three-fourths of all physics teachers, and a serious problem for a third of them.

Table 9. Availability of Equipment in the Physics Classroom

| Percent of teachers reporting <br> that equipment is: | Graphing <br> Calculators | Computers for <br> Student Use | Specialized <br> Physics Software |
| :--- | :---: | :---: | :---: |
| Available at school | $71 \%$ | $89 \%$ | $45 \%$ |
| Where available, supply adequate | 75 | 60 | 57 |
| Where available, students are <br> generally prepared to use | 69 | 78 | 48 |


| Figure 9. Median Funding Available Per <br> Class for Equipment and Supplies |
| :--- |
| $\$ 350$ |
|  |
| $\$ 300$ |

$\left.\begin{array}{|ll|}\hline \text { Table 10. Percent of Physics Teachers } \\ \text { Citing Selected Problems as } \\ \text { Serious }\end{array}\right]$ 34\%

## IV.TEACHERS' PROFESSIONAL ENVIRONMENT \& ACTIVITIES

Despite the increasing weight of physics in respondents' teaching assignments, and their growing sense of identification as physics specialists, many other aspects of physics teachers' professional lives have remained relatively unchanged over the course of the five surveys we have conducted since the mid-1980s. One key aspect is membership in professional societies. These societies are a good source of physics information, teaching insight and professional insight, allowing teachers to interact with colleagues, fostering both an exchange of ideas and a sense of community. This is especially critical for the many physics teachers who work as the single physics instructor in their school (see Figure 10).

Yet, as we saw in Table 5, the fraction of high school physics teachers who are members of the American Association of


Physics Teachers, the premier physics education organization, has been essentially stagnant over the past 15 years. And the reason is not that they have been siphoned off into the National Science Teachers Association, the broader professional society devoted to science education. The numbers for both groups, shown in Figure 11, have remained essentially unchanged since we began this survey.

In light of the persistently low level of professional society membership, this year's survey sought to explore whether teachers have developed alternative ways of linking up with their counterparts. To this end, we asked teachers if they took part in face-to-face or electronic discussion groups with other teachers, or whether they were part of any other forum for discussing physics education (see Table 11). As with professional society participation, the

Figure 11. Physics Teacher Membership in Professional Organizations


AIP Statistical Research Center: 2000-01 High School Physics Survey
results showed that few teachers maintained regular professional contact with their colleagues. Only one in five reported involvement in a face-to-face group, one-sixth in an Internet group, and $5 \%$ in any other type of forum.

A similar outcome was revealed when we asked teachers where they turned when they had a substantive question about physics (see Figure 12). The most common answer by far was textbooks-first college texts and then high school level books. Another popular option was the World Wide Web which, while rarely the top choice, was a popular secondary source. Human resources-other science educators or scientists-were far down the list. Only $15 \%$ of teachers turned first to any of their high school colleagues, college faculty members, science researchers or listserv discussion mates, and even among secondary sources, only high school teachers figured prominently.

Similarly, when we asked teachers how often they had participated in professional development activities over the previous year, the responses indicated a lack of widespread regular attendance (see Table 12). This was especially pronounced among those who were not members of professional societies. This is certainly not a total surprise, since attendance at a local or national professional society meeting is one of the main forms of participation for society members. But the pattern persisted when we asked about exposure to workshops on classroom and laboratory issues. Overall, only a third of teachers had attended a full-day meeting on classroom instruction, and even fewer had sat in on one covering laboratory issues. Only one in eight mentioned any other type of organized professional participation.

The other side of the professional coin is salaries. In recent years, the starting and continuing salaries reported by responding teachers have risen steadily, outpacing inflation during the period (See Figures 13

Table 11. Teacher Networking and Communication

| Percent indicating they were a member of: | All Teachers <br> $\mathbf{\%}$ | AAPT \& NSTA <br> Members <br> $\%$ | Non- <br> Members <br> $\%$ |
| :--- | :---: | :---: | :---: |
| a formal group of science teachers that meets <br> regularly to discuss classroom issues | 20 | 26 | 15 |
| an Internet list-serve or discussion group for <br> physics or science teachers | 15 | 23 | 9 |
| other forum for discussing physics education | 5 | 7 | 4 |

and 14). Nevertheless, comparisons based on other data collected by AIP's Statistical Research Center indicate that starting salaries for high school teachers (at least those with physics degrees) have languished well behind those enjoyed by physics majors who have followed other career paths (see Figure 15).

Low salaries compared to the alternatives may contribute to turnover among teachers. Another factor, especially in recent years, was simply the aging of the secondary school workforce over the previous decade, which combined with an additional modest increase in hiring due to rising enrollments to produce the slightly less experienced


## Table 12. Teacher Professional Activities

| Percent who reported attending at least once in 2000 a: | All Teachers | Members of AAPT or NSTA | NonMembers |
| :---: | :---: | :---: | :---: |
| professional association local or national meeting | 34\% | 54\% | 16\% |
| workshop on physics classroom instruction techniques | 33 | 44 | 23 |
| workshop on physics lab design or delivery | 28 | 36 | 21 |
| other professional activities | 13 | 16 | 11 |

Figure 13. Starting Salaries for New Physics Teachers

## Median Salary

(in current dollars)


Figure 14. Salaries for Experienced Physics Teachers Continuing in the Study

Median Salary
(in current dollars)


[^1]Figure 15. Starting Salaries for Physics Bachelors by Employment Sector

profile for physics teachers this time than had been found in earlier studies, as was shown in Table 6. Added to substantial movement of teachers in the early stages of their careers between schools, this has meant that around $30 \%$ of all physics teachers had three or fewer years of seniority at their current school. Such levels of turnover can exacerbate the incidence of problems felt most acutely by those with less experience, such as heightening the difficulties new teachers encounter in making connections with more senior
colleagues or in assembling adequate lab equipment and supplies. Still, turnover is in some respects a self-correcting problem over time, and while a considerable proportion of our respondents remained at or close to the final stage of their career, it is likely that in coming years, even with a continued steady increase in enrollments, turnover rates will be somewhat lower than they have been recently.

## V. REFORM EFFORTS AND NEW INSTRUCTIONAL TOOLS

As we mentioned earlier, computers and graphing calculators have become standard equipment in most physics classes (see Table 9), although there seems to be mixed results in students' readiness to use them. The latter problem does not seem especially bad when it comes to adeptness with the hardware-in that regard, as noted in Section III, less than a third of all physics teachers still find their students poorly prepared. But when we turn to the specialized software that is necessary to take full advantage of these tools, both availability and student readiness drop off sharply.

Perhaps related to this, when we look at the results for recently-developed alternative classroom approaches in Table 13, we also
find a more complex and less encouraging picture. Moreover, some of these figures may actually be overestimates, since we intended to focus on particular "branded" modules or materials for teaching physics, while some respondents may have answered in terms of their efforts to introduce general instructional approaches embodying the new educational philosophies into their classroom practice.

But even allowing for a broader definition, it is clear that change has been uneven. While a few of these new approaches to teaching physics have gained a foothold in the past five years, not even the most popular has yet managed the kind of growth that Advanced Placement and conceptual physics have seen in the past 15 years, nor

| Table 13. Percent of Physics Teachers Reporting Using the Following Instructional Tools |  |
| :---: | :---: |
|  | \% |
| Calculator Based Labs (CBL) | 35 |
| Interactive Physics | 25 |
| Physics by Inquiry | 22 |
| Modeling Instruction | 18 |
| Microcomputer-Based Laboratories (MBL) | 17 |
| Active Physics | 15 |
| Interdisciplinary Instruction | 12 |
| Real Time Physics | 5 |
| Workshop Physics | 5 |
| $\mathrm{C}^{3} \mathrm{P}$ (Comprehensive Conceptual Curriculum for Physics) | 4 |
| CPU (Constructing Physics Understanding) <br> AIP Statistical Research Center: 2000-01 High S | $2$ <br> ss Survey |

even that PSSC enjoyed for a period of time a generation ago.

We also asked teachers about the impact of broader educational initiatives on their schools and within their physics classrooms (see Table 14). The spread of block (or "double-mod") scheduling to physics classes, originally noted in our previous survey four years ago, seems to have continued, albeit slowly. About a third of the respondents now teach physics in double periods, either every other day
across the school year, or else every day, completing in one term what formerly took two. In the 1997 survey, when we asked teachers for their assessment of this change the reaction was largely positive.

In contrast, despite many high hopes, the incorporation of findings from Physics Education Research and the development of collaborations with local colleges and universities to improve high school physics education are much less common, cited by only about one physics teacher in ten. While many of the teachers who take advantage of this pedagogical research have high praise for its practical benefits in their teaching, the penetration of this growing body of knowledge has been quite limited. And even that can be seen as relatively successful when juxtaposed with the impact of the international comparative study known as TIMSS. While this ambitious project spawned a series of papers and workshops on lessons that could be learned from physics teaching practices abroad, it seems to have hardly registered at all on our respondents' radar screens.

Another important source of change in physics teaching is the impact of changes in administrative practices, policies and regulations that flow from state or school district educational authorities. Table 15 shows the effect that respondents felt such mandates had on their physics teaching. One-third of the teachers reported an increase in science graduation requirements and the same percentage indicated an increase in national education standards in science. In both cases
less than half of the affected teachers viewed these changes as positive. Some teachers seemed to lament the lost autonomy and constricting nature of standards that might not be appropriate for a particular class. As one teacher in an online discussion group said, "The adoption of the [State] Academic Standards 2000 for Physics I by [this state] is forcing our course to move away from an in-depth conceptual approach to physics toward a more-traditional equa-

## Table 14. Impact of Broader Educational Initiatives

## Percent of teachers impacted by:

Block Scheduling 32\%
Collaboration with a college 11 or university

Physics Education Research 10
TIMSS (International Math 2 \& Science Test)

AIP Statistical Research Center: 2000-01 High School Physics Survey
tion-based survey course. We will be supplementing the text with many numerical exercises and problems this year in order to align our course with the state standards."

As Table 15 also shows, even more teachers reported new state or district standardized testing, and even fewer felt that these new tests had a positive impact. As one teacher commented, "Graduation exams and other standardized tests tend to use up many hours of classroom time to test for standards that are trivial or antiquated. Memorization, not thinking ability, is tested."

Each time we conduct the survey, we ask teachers to give their views on a number of controversial policy issues and on statements concerning their professional self-image (see Table 16). Items relating to career satisfaction evoked strongly positive responses: over three-fourths of respondents were pleased with their choice of teaching as a career and physics as a discipline. On the other hand, many respondents reflected the isolation referred

Table 15. The Impact of State- or District- Implemented Administrative Changes

| $\begin{array}{l}\text { Schools that in the last four years } \\ \text { introduced: }\end{array}$ | $\begin{array}{c}\text { Percent of } \\ \text { teachers reporting } \\ \text { this change }\end{array}$ | $\begin{array}{c}\text { Of those reporting a } \\ \text { change, percent who } \\ \text { answered that the } \\ \text { impact was positive }\end{array}$ |
| :--- | :---: | :---: |
| increased graduation requirements in science | $36 \%$ | $47 \%$ |
| $\begin{array}{l}\text { national education standards in science }\end{array}$ | 38 | 36 |
| $\begin{array}{l}\text { state or district mandated standardized } \\ \text { testing }\end{array}$ | 52 | 25 |
| AIP Statistical Research Center: 2000-01 High School Physics Survey |  |  |$]$

Table 16. Teacher Views on Career and Policy Issues

|  | Agree <br> $\%$ | Neutral <br> $\%$ | Disagree <br> $\%$ |
| :--- | :---: | :---: | :---: |
| I prefer teaching physics to teaching other subjects | 77 | 14 | 10 |
| If I had it to do over again, I would still choose high <br> school teaching as my career | 76 | 11 | 13 |
| Only people who majored in physics in college should <br> be allowed to teach it in high school | 46 | 17 | 38 |
| I have ample opportunity to share ideas with other <br> physics teachers | 30 | 16 | 54 |
| The sequence of high school sciences should be <br> reversed, so that students take physics first, before <br> chemistry or biology | 22 | 17 | 61 |
| Conceptual physics enrollments in my school have <br> grown at the expense of algebra / trig physics | 18 | 38 | 44 |

to earlier, with few feeling they had ample opportunity to share ideas with colleagues. Respondents seemed broadly divided on the issue of whether only teachers with a college major or minor in physics should be allowed to teach it in high school. Not surprisingly, $68 \%$ of individuals who themselves had a major or minor in physics agreed with the statement, while only $26 \%$ of the rest were in agreement.

Finally, in light of the nationwide effort to revamp the order in which the sciences are taught in high school, we also included a question that asked teachers whether they agreed or disagreed with the statement, "The sequence of high school sciences should be reversed, so that students take physics first, before chemistry or biology."

The "Physics First" movement is a strong and growing campaign that sees physics as the most basic of sciences, and argues that it should be taught as the foundation for introductory chemistry, which in turn should provide the underpinnings for high school level biology.

Overall, as can be seen in Table 16, we found a good deal more skepticism than support for the idea among our physics teacher respondents in 2001, although subsequent discussions and implementation may since have won more converts. But at the time of the survey, not only did many more oppose the notion than favor it, but most of these opponents registered strong disagreement, while most of the proponents indicated only equivocal support. Overall,

Figure 16. Percent of Teachers with 9th and 10th Graders in their Physics Classes


Private


No 9th or 10th graders taking physics
A few, but not enough for a separate class
Enough to support at least one "Physics First" class

AIP Statistical Research Center: 2000-01 High School Physics Survey
the small number in the neutral category and the large number indicating strong feelings reinforce the sense that this is indeed a "hot topic."

Further analysis shows that the opposition was relatively evenly spread across the community of physics teachers. While the reasons for this similarity of views may vary from group to group, we found few differences between physics specialists (including those with a physics degree) and "crossover" teachers whose primary specialty is in another field, between young and old teachers, between men and women, and so on.

However, while many respondents had strong views about putting physics first, few had direct experience with it. As Figure 16
shows, even using a very broad definition that includes sophomores as well as freshmen, only $5 \%$ of all teachers had enough underclassmen in their physics classes to populate even one course dedicated to this age group.

On the other hand, combining the findings on implementation with those on teacher attitudes towards "Physics First" yields a result which may give some encouragement to proponents of this approach. While only a tiny handful of teachers may currently teach physics primarily to 9th or 10th graders, many of those who do so are enthusiastically supportive of the idea. As Figure 17 shows, almost half strongly agree with the statement on the survey, with another one-eighth offering moderate agreement. It is hard to know in which direction the cau-

# Figure 17. Opinion on Physics First, by Teacher's Current Exposure to It in the Classroom 



AIP Statistical Research Center: 2000-01 High School Physics Survey
sation predominates-whether the experience made believers of the teachers who tried it, or whether those who subscribed to the idea in theory were the first to try it. But even if it was the latter, proponents could at least argue that real experience with the approach doesn't dampen teachers' pre-existing enthusiasm for it.

However, this finding does not at all ensure that the reversal of the science sequence will handily win converts once it is tried. We found that the schools, probably numbering around six hundred, that reported enough upperclassmen taking physics to suggest that they at least had the potential to have fully or partially implemented "Physics

First," are concentrated among the more elite private schools, especially secular college preparatory academies, with generally wealthier and more academically-prepared students. Such private schools are generally smaller and have greater curricular flexibility than public schools, allowing more experimentation with course sequencing if a teacher is so inclined.

The handful of public schools whose teachers reported some experimentation with Physics First also seem to be atypical, including a disproportionate number of magnet schools. Such schools also tend to have a population of more academically oriented and prepared students, more of
whom may have both the interest and the background to take physics earlier. Indeed, these same factors help explain why this group of schools has a far higher enrollment of students in physics generally. Moreover, there is anecdotal evidence that, in cases where public schools have begun with a partial implementation by offering ninth grade physics to some students while preserving the traditional sequence for others, it is often the academically most well-prepared students who opt to, and are encouraged to, try the new program.

The real test for Physics First will be when entire public school districts, and especially the urban and suburban school systems that make up the largest districts in the country, move to implement the change across the full range of schools and students in their
systems. Indeed, a "natural experiment" of sorts is currently taking place, as several districts, led by San Diego, CA, and Cambridge, MA, have introduced "Physics First" systemwide in the last year or two. But the challenge facing these pioneers is considerable. Moving beyond the enthusiastic ranks of teacher pioneers and highly-motivated science-oriented students could, if implementation is perceived to be poorly-coordinated or heavy-handed, turn off teachers, students and parents to physics. The greatest need will be, in a period of long-standing shortages of qualified physics teachers, to find or prepare sufficient numbers of reasonably prepared and confident teachers to fill the demand caused by the rapid expansion in the number of students taking physics.

## VI. CONTINUING CHALLENGES

Figure 3 depicted the significant gains that have been registered in erasing the historical gender imbalance in high school physics, although the disparity remains substantial at the more advanced end of the curricular spectrum. Figure 4 showed the first hints of progress in addressing the physics enrollment gap between white and Asian-American on the one hand, and African-American and Hispanic students on the other. But, as we have noted repeatedly
in earlier reports, a good part of the racial and ethnic discrepancy can be understood as overlapping with a much broader nationwide divergence-that between academic high achievers and everybody else, as illustrated in Figure 18.

For all the recent attention to expanding its purview to encompass all students, high school physics largely remains the province of students heading to four-year colleges

Figure 18. Estimated Exposure to Introductory Physics in High School and College (by Post-High School Outcome)


NCES, National Education Longitudinal Study, Fourth Follow-Up, 2000:Unpublished Data;
after graduation, and to the careers to which bachelors and graduate degrees give them access. The high correlation of socioeconomic status and academic attainment is well documented-for example, $61 \%$ of 18 -year olds coming from families in the top economic quartile complete a bachelor's degree by age 24 , compared to only $9 \%$ of those from the bottom quartile (Mortenson, 2001). While there has been a small degree of progress since 1997 in lessening the physics enrollment gap across the socioeconomic divide, it remains quite wide, as shown in Figure 19. Moreover, this figure far understates the full extent of the socioeconomic gap, since it is based on averages for entire schools. That is, each school contains students from a range of socioeconomic backgrounds, and it is
probable that the same pattern holds intramurally as extramurally-students who come from better-to-do families are more likely to aspire to go to college, and are more likely to take physics, than students from poorer families. Of course, some students from less-advantaged backgrounds still take physics, but the proportions will be lower.

What is true for overall physics enrollments is even more the case when we focus on the upper end of the physics spectrum (see Figure 20). Even just considering between-school differences, the disparity between rich and poor schools is great, and actually seems to have grown discernibly in the last four years, as AP enrollments have continued their surge.

Figure 19. Percent Taking Physics by Socioeconomic Profile* of School

*Teacher and principal estimated ranking of school relative to others in local area
*Public schools only

Figure 20. Percent of Schools Offering AP Physics by Socioeconomic Profile* of School**

*Out of all public schools with physics programs
**Teacher and principal estimated ranking of school relative to others in local area AIP Statistical Research Center: 1996-97 \& 2000-01 High School Physics Surveys

One of the barriers to ameliorating this situation is that prior student preparation at the poorest schools continues to be problematic. Four years ago, teachers at the poorest schools not only reported the least prepared students, but more of them noted a decline in preparation from four years earlier, while their counterparts from wealthier schools reported stable preparation. For the current survey, while there was an increase in the percentage of teachers at the poorest schools indicating that their students' overall preparation was improved (see Figure 21), students at these schools continued to show the lowest level of preparation, by far.

On the other hand, increasing enrollments even at the poorest schools are probably at least partly responsible for two encouraging
findings. First, there was a sharp rise in the number of physics specialists teaching at the poorest schools from $19 \%$ in 1997 to $29 \%$ in 2001. Second, there was an even steeper jump, from $7 \%$ to $16 \%$, in the fraction of teachers who are able to devote their teaching completely to physics. Still, despite these gains, a large gap remains between the better-off schools and the worse-off schools, and, within each school, between those on the academic fast track and the rest of the student body. Further gains in overall enrollments and in lessening racial disparities will require far greater efforts to bring physics, along with other sciences and advanced mathematics, to groups of students who have generally not been part of the equation.

Figure 21. Recent Change in Overall Preparation of Entering Physics Students by Socioeconomic Profile* of School**

*Teacher estimated ranking of school relative to others in local area
**Public schools only
**Public schools only

AIP Statistical Research Center: 2000-01 High School Physics Survey

## VII. THE OUTLOOK FOR THE FUTURE

As we noted in the opening pages of this report, the sustained increase in physics enrollments across this nation's high schools over the past 15 years is a rare and significant advance, even though those enrollments have yet to encompass even a third of all graduates. The increase has been driven by the historical confluence of many factors, including a heightened concern over the scientific and technical preparation of our nation's workforce, a nationwide movement to raise high school graduation requirements, including those for science and mathematics, and a slow but steady long-term increase in college attendance by ever-widening swaths of the U.S. population.

In the broadest view, the recent gains in physics enrollments represent the spread of high school physics beyond the subset of four-year college and university-bound seniors who were intent on pursuing science, engineering and math studies, to a substantial fraction of all students heading to four-year colleges and universities after graduation, regardless of their field of intended study. It also represents a partly-overlapping change from a course dominated by boys to one approaching gender balance, at least in the conceptual and regular introductory classes.

However, difficult as achieving these gains may have been, maintaining the momentum of growth may prove far more challenging.

As we mentioned in the preceding section, moving beyond the ranks of the academically most successful to encompass students going on to two-year colleges or directly out to the workforce after graduation may require a whole new approach, including a greater emphasis on career-relevant applications. Physics First may represent an important lever in achieving this goal, if it can overcome the barriers to effective implementation.

In terms of student demographics, the increased enrollment of girls was aided by the noteworthy, though by no means completed, opening of technical and professional career opportunities to women throughout society. While we reported some significant enrollment gains for high school physics among underrepresented minorities, future increases will have additional hurdles to clear. While the issues with girls involve mainly long-term patterns of gender discrimination and cultural bias, low minority enrollments in physics involve not just ethnic and racial bias, but also deep-seated disparities in economic and academic resources, and in educational attainment, among families and communities. The challenges facing a meaningful effort to further raise minority enrollments in physics coincide in many respects with those facing the campaign to expand physics for all students beyond its current core constituency to encompass students heading towards additional
technical or vocational training or directly out into the workforce.

Achieving these goals may require nothing less than a culture change in high school physics. It has sometimes been suggested that, perhaps more than other disciplines, physics instruction is influenced by its highest reaches. Some have described undergraduate physics courses as abridged versions of graduate courses. As the former Education Director of the American Physical Society, put it in 1998: "Many students in engineering, chemistry and other related sciences literally fear physics. In part this is because introductory physics courses have often been designed with only the physics majors who will go on to graduate school in mind..." (Lopez, 1998).

Moving down the chain, others have in turn contended that the traditional high school physics course was in many ways modeled
as a "junior" version of the standard algebra- and trigonometry-based introductory undergraduate course. In this system, each level is seen to some degree as a pool from which the most promising candidates may be identified and helped up to the next level. While that type of culture may do an excellent job of replenishing the top rungs of the discipline, it does a poorer job of introducing the subject matter and excitement of the field to the potentially more substantial number of students for whom physics will not be the central focus of their academic or professional career. The recent progress in enrollment, curriculum and instructional practices recounted in this report may be viewed as early steps in the movement from a high school physics that touches only a select few, towards one that at some point in the future may truly be described as "Physics for All".

## APPENDIX A. ADDITIONAL TABLES OF FINDINGS

Table A-1. General Characteristics: Physics Programs

| Physics offered: | Percentage of all <br> schools | Percentage of all <br> enrolled students |
| :--- | :---: | :---: |
| $\quad$ Every year | 76 | 93 |
| Alternate years | 14 | 4 |
| Rarely or never | 10 | 3 |
| Schools not offering physics this year | 18 | 5 |
| Schools offering AP / 2nd year physics | 21 | 37 |
| Schools where half or more of physics teachers are <br> specialists (defined by academic background and <br> teaching experience) | 33 | 47 |


|  | Public (77\%) | PrivateSecular (4\%) | Private"Mainstream" Religious (8\%) | Private-Fundamentalist (11\%) |
| :---: | :---: | :---: | :---: | :---: |
| Median size of senior class | 113 | 35 | 85 | 12 |
| \% physics offered: |  |  |  |  |
| Every year | 80 | 80 | 90 | 41 |
| Alternate years | 13 | 10 | 6 | 28 |
| Rarely or never | 8 | 10 | 4 | 31 |
| \% of schools with physics offering single class in physics only | 47 | 39 | 31 | 80 |
| \% of schools with physics offering advanced physics courses | 22 | 30 | 23 | 6 |
| \% of students taking physics | 28 | 84 | 54 | 41 |
| \% of students at school who are members of underrepresented minority groups | 25 | 8 | 16 | 13 |
| \% of students taking physics who are members of underrepresented minority groups | 19 | 10 | 14 | 9 |
| Median funds available per physics class | \$250 | \$708 | \$333 | \$400 |
| \% where half or more teachers are physics specialists | 34 | 38 | 42 | 15 |
| Median salary of physics teachers | \$40,000 | \$38,800 | \$33,300 | \$29,000 |


| Table A-3. Characteristics of Physics Program by Size of Senior Class |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{gathered} \mathbf{1 - 4 9} \\ (35 \%) \end{gathered}$ | $\begin{gathered} \mathbf{5 0 - 1 9 9} \\ (39 \%) \end{gathered}$ | $\begin{gathered} \mathbf{2 0 0 - 2 9 9} \\ (11 \%) \end{gathered}$ | $\begin{gathered} \text { 300-499 } \\ (12 \%) \end{gathered}$ | $\begin{aligned} & \mathbf{5 0 0 +} \\ & (3 \%) \end{aligned}$ |
| \% of schools offering physics: |  |  |  |  |  |
| Every year | 47 | 89 | 95 | 99 | 99 |
| Alternating years | 30 | 7 | 3 | 1 | 0 |
| Never | 23 | 5 | 2 | 0 | 1 |
| Number of physics classes (at schools with physics in 2001) |  |  |  |  |  |
| 1 | 84\% | 51\% | 20\% | 8\% | 6\% |
| 2 | 11 | 26 | 19 | 18 | 11 |
| 3 | 3 | 9 | 12 | 14 | 9 |
| 4 or more | 3 | 14 | 50 | 60 | 74 |
| $\%$ of schools with physics offering advanced physics courses | 4 | 16 | 40 | 44 | 78 |
| \% of students taking physics | 37 | 30 | 31 | 30 | 32 |
| $\%$ of students at school who are members of underrepresented minority groups | 15 | 20 | 23 | 28 | 32 |
| \% of physics students who are members of underrepresented minority groups | 9 | 16 | 21 | 18 | 20 |
| Number of physics teachers |  |  |  |  |  |
| 0 | 39\% | 8\% | 3\% | 1\% | 1\% |
| 1 | 59 | 81 | 68 | 57 | 30 |
| 2 or more | 2 | 11 | 29 | 42 | 69 |
| $\%$ of schools where half or more teachers are physics specialists | 12 | 31 | 50 | 54 | 68 |
| Median salary of physics teachers at school | \$30,000 | \$40,000 | \$40,000 | \$42,500 | \$46,750 |
| AIP Statistical Research Center: 2000-01 High School Physics Survey |  |  |  |  |  |


| Table A-4. Selected School Characteristics by Geographic Region |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Northeast (5\%) | Middle Atlantic (12\%) | South Atlantic (14\%) | East north central (18\%) | East south central (7\%) | West north central (13\%) | West <br> south central (14\%) | Mountain (7\%) | $\begin{aligned} & \text { Pacific } \\ & (11 \%) \end{aligned}$ |
| $\%$ of schools in rural setting | 29 | 21 | 23 | 30 | 38 | 63 | 44 | 48 | 21 |
| Median seniors | 126 | 109 | 120 | 106 | 84 | 45 | 56 | 40 | 136 |
| $\%$ of students who are minority | 13 | 20 | 31 | 14 | 26 | 9 | 40 | 24 | 34 |
| \% of physics students who are minority | 9 | 12 | 23 | 14 | 20 | 5 | 35 | 14 | 22 |
| \% of students taking physics | 45 | 40 | 30 | 33 | 20 | 29 | 33 | 23 | 24 |
| \% of schools with physics offering single class in physics only | 20 | 28 | 43 | 48 | 73 | 67 | 55 | 57 | 39 |
| \% of schools with physics offering advanced physics | 34 | 32 | 27 | 19 | 13 | 9 | 17 | 17 | 28 |
| Median salary for physics teachers (\$000) | 45.0 | 47.0 | 36.3 | 42.5 | 32.0 | 34.0 | 33.0 | 32.0 | 46.0 |

Table A-5. School Characteristics by Metropolitan Setting (Public Schools Only)

|  | Central <br> city of large <br> metro area | Suburbs of <br> large <br> metro area | Medium- <br> sized <br> metro <br> area | Small <br> city/large <br> town | Rural |
| :--- | :---: | :---: | :---: | :---: | :---: |
| \% of public schools | 7 | 19 | 17 | 15 | 42 |
| Median seniors | 269 | 267 | 218 | 133 | 44 |
| \% of schools offering physics in 2001 | 90 | 96 | 91 | 93 | 74 |
| Number of physics classes offered this <br> year (at physics offering schools) | $11 \%$ | $19 \%$ | $29 \%$ | $53 \%$ | $77 \%$ |
| 1 |  |  |  |  |  |
| 2 or more | 89 | 81 | 71 | 47 | 23 |
| \% of students who take physics | 31 | 33 | 25 | 21 | 29 |
| \% of students who are minority | 56 | 23 | 24 | 20 | 12 |
| \% of physics students who are | 51 | 15 | 16 | 11 | 6 |
| minority |  |  |  |  |  |
| Median salary for physics teacher | $\$ 43,500$ | $\$ 47,000$ | $\$ 40,000$ | $\$ 38,000$ | $\$ 35,000$ |

AIP Statistical Research Center: 2000-01 High School Physics Survey

Table A-6. School Characteristics by Metropolitan Setting (Private Schools Only)

|  | Central <br> city of large <br> metro area | Suburbs of <br> large <br> metro area | Smaller <br> metro <br> area | Small <br> city/large <br> town | Rural |
| :--- | :---: | :---: | :---: | :---: | :---: |
| \% of private schools | 20 | 27 | 28 | 14 | 11 |
| Median seniors | 55 | 36 | 27 | 15 | 14 |
| \% of schools offering physics in 2001 | 79 | 76 | 74 | 61 | 66 |
| Number of physics classes offered this <br> year (at physics offering schools) <br> 1 | $30 \%$ | $43 \%$ | $51 \%$ | $71 \%$ | $82 \%$ |
| 2 or more | 70 | 57 | 49 | 29 | 18 |
| \% of students taking physics | 66 | 74 | 46 | 39 | 42 |
| \% of students who are minority | 24 | 13 | 9 | 5 | 10 |
| \% of physics students who are | 19 | 11 | 6 | 5 | 9 |
| minority |  |  |  |  |  |
| Median salary for physics teacher | $\$ 38,000$ | $\$ 33,000$ | $\$ 30,000$ | $\$ 31,000$ | $\$ 28,500$ |
| AIP Statisical Research Center: $2000-01$ High School Physics Survey |  |  |  |  |  |

Table A-7. Characteristics of Physics Program by Socioeconomic Profile of School*
(Public Schools Only)

|  | Much better off than average | Somewhat better off than average | Average | Somewhat worse off than average | Much worse than average |
| :---: | :---: | :---: | :---: | :---: | :---: |
| \% of schools offering physics: |  |  |  |  |  |
| Every year | 96 | 92 | 82 | 74 | 68 |
| Alternating years | 3 | 6 | 12 | 17 | 22 |
| Never | 1 | 2 | 7 | 9 | 10 |
| Number of physics classes (at schools with physics in 2001) |  |  |  |  |  |
| 1 | 14\% | 30\% | 51\% | 56\% | 62\% |
| 2 or more | 86 | 70 | 49 | 44 | 38 |
| $\%$ of schools with physics offering advanced physics courses (AP + 2nd Year) | 56 | 31 | 21 | 15 | 9 |
| \% of students taking physics | 45 | 31 | 25 | 26 | 22 |
| $\%$ of students at school who are members of underrepresented minority groups | 12 | 15 | 22 | 38 | 57 |
| \% of physics students who are members of underrepresented minority groups | 8 | 11 | 15 | 38 | 55 |
| Number of physics teachers |  |  |  |  |  |
| 0 | 3\% | 5\% | 14\% | 19\% | 21\% |
| 1 | 47 | 67 | 76 | 69 | 71 |
| 2 or more | 50 | 28 | 10 | 12 | 8 |
| \% of schools where half or more teachers are physics specialists | 62 | 41 | 31 | 26 | 29 |
| Median salary of physics teachers at school | \$48,000 | \$42,000 | \$38,000 | \$38,000 | \$37,000 |

## APPENDIX B. SURVEY METHODOLOGY

The 2000-01 Nationwide Survey of High School Physics Teachers is the fifth in a series of studies begun by the American Institute of Physics in the mid-1980s, in response to concern expressed publicly both nationwide and within the physics community over the state of physics education in our nation's schools. The initial round of the survey was undertaken during the 1986-87 school year, with subsequent surveys in 1989-90, 1992-93, 1996-97 and 2000-01. The findings of all four studies were discussed in final reports (Physics in the High Schools I \& II, Overcoming Inertia: High School Physics in the 1990s and Maintaining Momentum: High School Physics for a New Millennium), which along with a number of shorter auxiliary reports and articles, are available from the American Institute of Physics.

The first four rounds of the study were conducted by contacting the same pool of $3000+$ schools that made up a stratified sample of schools drawn in 1986. For more information on this initial sample drawing, please refer to the methodology section in the 1987 report. Because a small but not insignificant number of schools (especially the smallest ones) close every year, the number of schools in our sample had fallen every year. By 1997, nearly $10 \%$ of the schools in the original list had closed, although they only accounted for $3 \%$ of the student enrollment from the original
sample. Nearly half of the closed schools had had fewer than ten seniors and more than half had not offered physics classes at all.

This attrition of sample schools is natural, mirroring the closings of schools in the larger population. But the counterpart of these are new schools that open each year. And in the case of this study, sticking with the original sample meant that schools that had opened after the initial sample was drawn were missed. As with the closing schools, this was most common among the smallest, especially private, schools. Given that small schools, by definition, only teach a tiny percentage of the nation's seniors, and that these schools often do not offer a single physics course, we were able to use national lists of new schools to determine that the effect of missing these new schools from 1987 to 1997 was small, with a loss of physics enrollment coverage of 1-2\%. One thing that helped keep this number small was the fact that, for most of this period, the population of high school seniors nationally was falling, or hovering around its recent trough. But given that the count of seniors began to rise steadily in the mid-1990s, and in an effort to minimize the cumulative effect, it was decided that a new survey would be drawn for the 2000-01 survey.

The new sample was drawn from two parallel sources. Public schools were drawn from the 1997-98 Common Core of Data
(CCD), a database of public schools maintained by the Department of Education's National Center for Education Statistics (NCES). Private schools were drawn from the Private School Survey (PSS), another database managed by the NCES. In both cases, the 1997-98 lists were the most recent available at the time the sample was drawn. We selected only those schools with at least one senior in 1997-98 and, among public schools, only those classified as regular and vocational schools, excluding alternative and ungraded schools, as well as continuation schools for high school drop-outs and schools exclusively for special needs students. The universe consisting of schools meeting these criteria included 16,219 public schools and 6,042 private schools. A sample, stratified by state, was drawn at a rate of one sixth, yielding 2,704 public schools and 1007 private schools. Because of the decision not to use size of school as a stratification variable, the sample ended up with a total number of seniors that was $2.9 \%$ lower than the population as a whole.

After the sample draw, principals at each of the sample schools were contacted to determine the existence of a physics program. It was primarily at this stage where most of the whittling down of the sample began, in an effort to ensure that we only retained schools that under normal circumstances had at least the possibility of offering physics. Table B-1 shows the reasons that schools were removed from the sample. After this process, we were left with 3,329 sample schools ( 2554 public and 775
private). Of this total, 2730 ( $82 \%$ ) (2166 public and 564 private) offered physics. At these latter schools, principals identified 3,444 teachers who were teaching physics for the 2000-01 academic year, including 2,749 public and 695 private school teachers.

Newer versions of the data files were released by NCES after the sample was drawn, including one covering 2000-01 for public schools and 1999-2000 for private schools. Table B-2 shows the results of comparisons between the original data files from which the sample was drawn and the newer files that were made available. These schools represent the known amount of undercoverage that resulted from shortcomings in the databases from which the sample was drawn.

In the resulting sample draw, approximately one-sixth of the schools that were part of the earlier sample were now a part of the new sample. This group of schools was considered the "control" group, and was used to confirm that any changes seen in physics programs were real and not just the result of the new sampling procedure. Because the "control group" was essentially a subsample of the previous sample draw, a look at the profile of this group can show areas where attrition and new school openings have had an impact. Tables B-3 and B-4 confirm that there was an underrepresentation in the "control group" of private fundamentalist schools, smaller schools, K-12 schools, and schools that
either never offered physics or offered it every other year.

Each teacher listed by the principals was sent an eight page questionnaire asking about their teaching experience and reponsibilities, their school's physics program, their educational background and their future plans. Many of the questions were identical to those used in earlier rounds of the study, enabling us to track long-term trends. At the same time, questions were added that covered topics such as: the use of materials other than
textbooks (lab and activity manuals, software, and other multimedia); the impact of standardized testing and Physics Education Research; teacher views on Physics First and other reform initiatives; participation in science education discussion groups and listservs; and primary sources for seeking answers to physics content questions. The teacher response rate was $63 \%$, with $56 \%$ completing the full questionnaire and $7 \%$ answering a shorter follow-up version, significantly lower than the $77 \%$ response achieved in 1997. Some of the drop in response rate may be due to

## Table B-1. Reason for Removal from Sample

|  | Number of Schools |
| :--- | :---: |
| No Regular Classes- Independent Study Only | 95 |
| School Closed | 77 |
| Night School | 57 |
| Not a High School | 57 |
| Other Types of Alternative Schools | 31 |
| No Seniors | 30 |
| Technical school, with students also attending a regular <br> high school <br> Merged into another larger school <br> Homeschool <br> Total | 20 |

the use of monetary incentives in 1997, that was not repeated in 2001 because of their prohibitive cost.

## Teacher Response Bias

One major source of error that can lead to a distorted picture in studies such as ours is response bias, resulting from systematic differences in relevant characteristics between those who responded to our survey and those who did not. As noted previously, thirty-seven percent of the teachers in our sample did not complete the questionnaire in 2001. We can use ancillary sources of data to gain insight into teachers
who did not respond in this round, allowing us to roughly gauge the potential magnitude and effect of response bias.

Because of the new sample draw, we have little information about the educational and personal backgrounds, and current attitudes of non-responding teachers. On many school-level variables, describing the academic environment in which teachers work, the information is more complete. The information about schools was gathered from the original population database obtained from CCD/PSS, as well as from school principals. In the case of schools with more than one physics teacher, if only one of the teachers responded, this still

## Table B-2. Schools Missed from Sample Draw to Survey Time (1998-2001) (Population numbers in parenthesis)

## PUBLIC SCHOOLS

|  | Number of <br> schools | Number of Seniors |  |  |
| :--- | :---: | :---: | :---: | :---: |
| New School | 20 | $(120)$ | 4,511 | $(27,066)$ |
| Incorrectly classified in '98 | 3 | $(18)$ | 336 | $(2,016)$ |
| Misclassified as having no seniors | 10 | $(60)$ | 2,593 | $(15,558)$ |
| No Seniors in '98, seniors in '01 | 17 | $(102)$ | 4,752 | $(28,512)$ |
| Missed by CCD in '98 | 2 | $(12)$ | 106 | $(636)$ |
|  | PRIVATE SCHOOLS |  |  |  |
| New School | 39 | $(234)$ | 2,415 | $(14,490)$ |
| No Seniors in '97, seniors in '01 |  | 25 | $(150)$ | 684 |
| $(4,104)$ |  |  |  |  |

## Table B-3. Comparison of Control Group to Entire Sample

|  | Control Group | Entire Sample |
| :---: | :---: | :---: |
| School Type $\dagger$ | \% | \% |
| Public | 79 | 77 |
| Private Secular | 5 | 4 |
| Private "Mainstream" Religious | 9 | 8 |
| Private Fundamentalist | 6 | 11 |
| Setting |  |  |
| Central city of large metropolitan area | 10 | 10 |
| Suburbs of large metropolitan area | 23 | 21 |
| Small metropolitan area | 18 | 20 |
| Small city/large town | 15 | 15 |
| Small town/rural | 34 | 35 |
| Region |  |  |
| South | 36 | 35 |
| North + West | 64 | 65 |
| Grade Range $\dagger$ |  |  |
| Senior high | 66 | 62 |
| Jr/Sr high | 20 | 20 |
| K-12 | 14 | 18 |
| Physics Offered $\dagger$ |  |  |
| Every year | 81 | 76 |
| Alternate years | 12 | 14 |
| Rarely or Never | 7 | 10 |
| Socioeconomic Profile of School |  |  |
| Much better off than average | 11 | 10 |
| Better off than average | 20 | 20 |
| Average | 41 | 40 |
| Worse off than average | 21 | 22 |
| Much worse off than average | 7 | 7 |
| Physics Teachers at school |  |  |
| 0 | 16 | 18 |
| 1 | 67 | 68 |
| 2 or more | 18 | 15 |
| Number of Courses Taught at School |  |  |
| 1 | 42 | 48 |
| 2 | 22 | 19 |
| 3 | 9 | 8 |
| 4 or more | 28 | 24 |

[^2]| Table B-4. School Characteristics and Physics Program for Entire Sample and Control Group |  |  |
| :--- | :---: | :---: |
|  |  | Entire <br> Cample |
| Control Group | 104 | 87 |
| Median size of senior class | 42 | 48 |
| \% of schools with physics offering single class in physics only | 23 | 21 |
| \% of schools with physics offering advanced physics courses | 23 | 24 |
| \% of students at school who are members of underrepresented <br> minority groups | 19 | 18 |
| \% of students taking physics who are members of | 32 | 31 |
| underrepresented minority groups | 300 | 294 |
| \% of students taking physics | 36 | 33 |
| Median funds available per physics class | $\$ 40,000$ | $\$ 38,000$ |
| \% where half or more teachers are physics specialists |  |  |
| Median salary of physics teacher |  |  |

provides us detailed information about the physics instruction at that school. Tables B-5 and B-6 show the percentage of schools with information from principals and teachers. While our participation rate for principals is $100 \%$, as mentioned earlier, this provides only limited information on physics programs or physics teachers.

As Table B-7 shows, a wide-ranging probe of this year's data revealed a few school-level differences between responders and non-responders. Among those that were found was a substantially lower response rate among teachers at fundamentalist schools and a slightly lower response from teachers at Southern schools, at schools that teach kindergarten through twelfth grade, at schools offering only one
physics course, and between the different socioeconomic categories. No statistically significant differences were found between respondents and non-respondents in terms of geographic setting, the number of teachers at the school, whether or not the school offered physics every year, and the number of courses taught at the school.

In trying to account for the significant differences, we should note that schools offering only one physics course are by definition likely to be taught by a teacher whose primary teaching load is outside of physics. Thus, the teacher currently assigned to teach physics may feel less inclined to respond to a survey specifically devoted to that subject. A similar circumstance may account for the lower
response rate at fundamentalist religious schools. Moreover, that under-response, consistent in all five rounds, has a small impact on our overall findings, simply because of the small percentage (around $1 \%$ ) of the nation's high school students attending such schools. Similarly, schools that offer kindergarten through twelfth grade and schools in the South may have a lower response because of the
overrepresentation of fundamentalist and secular private schools in their ranks.

Many, but not all, of the findings displayed in Table B-7 are consistent with response rate differences found in earlier years. In 1997, while considering school characteristics, we found lower response rates among teachers at fundamentalist religious schools (and at private schools in

Table B-5. Types of Information Available for 2001 School Sample

> \% of schools with known characteristics
General characteristics of schools from CCD/PSS or reported by principal

Detailed description of current physics program and faculty characteristics at schools offering physics, from 2001 teacher respondents

Table B-6. Types of Information Available for 2001 Physics Teacher Sample

> \% with known characteristics

## School background information for teachers in the study:

Characteristics of teacher's school derived from CCD/PSS file or principal response
Current characteristics of physics program derived from 200172 responses, including from colleagues at school

## Information on personal characteristics of teachers:

Detailed personal characteristics63
Gender, from response or imputed from name ..... 98

| Table B-7. Response Rates for Teachers by School Background Characteristics |
| :--- | :---: | :---: |

$\dagger$ Response rates significantly different at the .05 confidence level

| Table B-8. Response Rates by Personal Characteristics Known or Imputed for Entire 2001 Sample |  |  |
| :---: | :---: | :---: |
|  | Respondents | Non-respondents |
| Gender (\%) |  |  |
| Female | 64 | 36 |
| Male | 64 | 36 |
| Number of courses taught $\dagger$ |  |  |
| 1 | 59 | 41 |
| 2 | 68 | 32 |
| 3 | 64 | 36 |
| 4 or more | 72 | 28 |
| AIP Statistical Research Center: $2000-01$ High School Physics Survey |  |  |

general), at Southern schools, at K-12 schools, and at schools that teach physics in alternate years. In general, given the vast array of possible differences, response rate discrepancies by school background characteristics have been few and relatively muted throughout all the rounds of this study.

Equally critical in understanding response biases are possible contrasts in individual attributes between teachers who responded and those who did not. Table B-8 looks at response rates by personal characteristics known for the entire sample. Teachers who only taught one course responded at a lower rate than those who taught two or more. As previously stated, teachers who only teach one course, and by definition teach the majority of their courseload in other
subjects, may not be as "plugged in" to physics and are likely not to be as interested in completing a survey dedicated to physics. No significant differences in response were found by gender.

As a result of the new sample draw, other personal characteristics of respondents and non-respondents were impossible to compare directly because there is no current information for non-respondents. In 1997, the longitudinal character of the study did permit an indirect comparison that included a subset of non-responders, namely those who had been in the sample and had responded in earlier rounds. Of course, there is no guarantee that findings for this subset are generalizable to all 1997 non-respondents, or to non-respondents in 2001, but the analysis did provide us some critical personal data for a significant portion of this group and supports a weaker argument that those who responded some of the time have attributes that fall somewhere between those who always participated and those who never responded and that similar characteristics would be found among non-respondents in 2001.

In 1993, when we performed a similar analysis of personal characteristics of teachers, we found that non-respondents who had responded in 1990 were less likely to hold graduate degrees, were less likely to be AAPT members, and were more likely to say that insufficient funding for equipment and supplies was a serious problem for them. For 1997 (see Table B-9), the only significant difference we could find was in
the percentage of teachers who had previously said that insufficient funding for equipment and supplies was a serious problem.

Overall, there were few indications of major response bias in all of these analyses. In light of this, we would argue that the findings discussed in this report provide a
reasonably accurate picture of our sample. However the suggestions of response bias that were found, coupled with sampling, poor question wording, and other sources of potential inaccuracies, require that the findings still be interpreted with some caution, and dictate that our results continue to be scrutinized for inconsistencies and compared where possible with findings

| Table B-9. Comparison of Respondents and Non-Respondents in 1997 on the Basis of Personal Information Supplied in 1993 |  |  |
| :---: | :---: | :---: |
|  | Respondents (1232) | Non- Respondents $(210)$ |
| Median years teaching | 18 | 14 |
| Median years at school | 10 | 10 |
| Median years teaching physics | 10 | 8 |
| Median age | 44 | 44 |
| Median salary | \$33,000 | \$30,000 |
| Median \% of seniors who take physics at school | 26 | 25 |
| \% who would not again choose teaching as a career | 21 | 24 |
| \% female | 20 | 17 |
| \% with graduate degrees | 64 | 59 |
| \% with physics or physics education degrees | 32 | 27 |
| $\%$ at schools with 2 or more teachers | 26 | 25 |
| \% who are AAPT members | 32 | 26 |
| \% planning to stay until retirement | 86 | 85 |
| $\%$ who say that insufficient funding for equipment \& supplies is a serious problem $\dagger$ | 34 | 46 |
| \% who consider physics their specialty | 45 | 40 |
| \% who are: specialists | 29 | 24 |
| career teachers | 43 | 46 |
| occasional teachers | 28 | 30 |

[^3]from similar studies. More detailed examination of response bias will be possible after we obtain follow-up data on the next survey round, scheduled for the 2004-05 academic year.

## Sampling Error

One further source of error which is typically described in great detail is sampling error, the extent to which the sample as selected does not accurately reflect the characteristics of the population from which it was drawn. Despite all the attention usually devoted to it (undoubtedly because of the relative precision with which it can be estimated), sampling error in a large study like this one tends to be only a modest contributor to overall error, compared to other error sources that are more difficult to measure but potentially far more threatening. Nevertheless, especially when considering and comparing smaller subgroups of the sample, sampling error can potentially weigh in strongly and must be taken into account when interpreting findings.

Most of the findings discussed in this report are presented in the form of simple proportions of schools or teachers. The estimated size of the sampling error of a proportion for a simple random sample varies with the magnitude of the particular proportion in question and the size of the sample or sub-sample under examination, and is given by the formula:

$$
S=\left(\frac{P(1-P)}{n}\right)^{1 / 2}
$$

Where $P$ is the proportion of the sample in a category and $n$ is the sample size.

For example, with a simple random sample, the estimate of sampling error for our finding that $76 \%$ of our sample schools offer physics every year would be given by:

$$
S=\left(\frac{.76(1-.76)}{3329}\right)^{1 / 2}
$$

The confidence interval for this estimate is given by $\pm Z S$, where $Z$ is the confidence coefficient. At the $95 \%$ confidence level used in this study, $Z=1.96$ and the confidence interval for the finding that $76 \%$ of the schools offer physics every year would be $\pm 1.5 \%$. In other words, if we drew repeated samples of schools and posed the same question to principals each time, we would expect that $95 \%$ of the time we would come up with a proportion offering physics every year that fell within the range of $76 \%$ $\pm 1.5 \%$, or 74.5 to 77.5 .

The stratified random sampling procedure used here yields error estimates that will vary slightly from those generated by a simple random sampling design and described by the above formula. Stratification prior to sampling by itself generally reduces sampling error slightly, whereas disproportionate sampling of strata tends to heighten it, relative to a
proportional sample of the same size (varying, of course, with the degree of disproportionality). The same holds true for findings involving means, where the $95 \%$ confidence interval is defined by $\pm 1.96 s / n^{1 / 2}$, where $s$ is the standard deviation of the distribution. (The finite population correction factor will be negligible due to the relatively large sample and low sampling rate, and has been omitted from the calculations above.) Finally, it should be noted that differences in proportions and means between groups (or lack of differences where large contrasts were expected) were generally made the focus of discussion in the body of the report only when they were substantial, in addition to being merely statistically significant.

The level of sampling error present in our estimates for findings derived from teacher responses is likely to be further compounded by the clustered sampling approach we employed, in which we sampled schools and then took a census of physics teachers at those schools. The increased error, relative to the levels likely if we had been able to sample from a pre-existing list of all physics teachers across the country, derives from the potential effect of a higher degree of homogeneity for many of our key variables among respondents at multi-teacher schools. Since the bulk of respondents were the only physics teacher at their school, the overall impact of the heightened homogeneity of responses is likely to be small, but where we focus in our analysis on multi-teacher schools, the impact may be
somewhat greater. In addition, there is higher risk of contamination at these schools as well, with teachers having more opportunity to discuss the survey and responses to specific questions with colleagues.

## Other Errors

Other sources of error are also likely to be present in the survey, and some of these may be as great or greater than the kinds of error already discussed. Such other sources include:
a) Errors arising from poorly worded questionnaire items;
b) errors from poorly constructed or unduly complex questions;
c) errors in interpretation of questions or recall of answers by teacher respondents;
d) errors due to coder carelessness or mistakes in interpretation for both closed-ended and open-ended questionnaire items; and
e) errors in data entry and in statistical computation.

Of course, every effort has been made to double check responses against independent internal and external sources of data wherever possible, and to seek additional
clarification or corroboration wherever discrepancies have arisen. For example, listings of physics teachers by principals were compared to teacher reports on the number of colleagues with physics assignments at the school. Any differences prompted a check of other teachers' responses and an immediate phone call to the school. Similar follow-up was undertaken in the case of discrepancies in the estimates of total number of seniors, number of physics classes and students taught by each instructor, and for several other key variables, as well. Other safety measures to guard against error included double entry verification of data, and comparison of entered data to a scattered selection of survey instruments. These tests yielded a data entry error rate well below one-tenth of one percent.

Nevertheless, despite all such efforts, error from all the sources mentioned above is undoubtedly present in the data from which the findings were derived. In most instances, the final accuracy of the answers was impossible to cross-check. Overall error rates can thus never be determined with accuracy, and this requires that all findings be interpreted with suitable caution. While stability of findings among the 1986-87, 1989-90, 1992-93 and 1996-97 studies increases the sense of confidence in a number of the conclusions drawn above, it will take repeated replication in future studies to permit a more accurate measure of the overall reliability of most of the findings discussed in this report. The results of the 2000-01 study have moved us one step further in that direction.

## APPENDIX C. STATES GROUPED BY GEOGRAPHIC REGION

New England
Connecticut
Maine
Massachusetts
New Hampshire
Rhode Island
Vermont
Middle Atlantic
New Jersey
New York
Pennsylvania

## South Atlantic

Delaware
Florida
Georgia
Maryland
North Carolina
South Carolina
Virginia
West Virginia
District of Columbia
East North Central
Illinois
Indiana
Michigan
Ohio
Wisconsin

## East South Central

Alabama
Kentucky
Mississippi
Tennessee

West North Central
Iowa
Kansas
Minnesota
Missouri
Nebraska
North Dakota
West South Central
Arkansas
Louisiana
Oklahoma
Texas
Mountain
Arizona
Colorado
Idaho
Montana
Nevada
New Mexico
Utah
Wyoming

## Pacific

Alaska
California
Hawaii
Oregon
Washington

## APPENDIX D. SURVEY INSTRUMENTS

1. Principal query form
2. 8-page physics teacher questionnaire

## AMERICAN INSTITUTE OF PHYSICS 2000-01 HIGH SCHOOL PRINCIPAL SURVEY

## Even if your school is not offering courses in physics please answer all applicable questions.

1. Does your school offer a$\square \mathrm{No} \rightarrow$ If No, what was the primary reason why not? $\square$ Not enough students want to take it separate course in high school $\square$ $\square$ We teach it in alternate years $\square$ Enough students, but no qualified teacher physics this year (2000-01)?Not an appropriate course for our schoolOther
2. Please list ALL of the teachers with physics classes THIS YEAR, along with their e-mail addresses, if known.

## Name

E-Mail Address

1. $\qquad$
$\qquad$
$\qquad$
$\qquad$
2. $\qquad$
$\qquad$
3. $\qquad$
$\qquad$
4. $\qquad$
$\qquad$
5. $\qquad$
$\qquad$
6. Did your school offer a physics course last year (1999-2000)? $\square$ Yes $\square$ No
7. The physics courses at my school are:
$\square$ Regular Periods (40-60 minutes/day)
$\square$ Block Scheduled $\rightarrow$ Will the same physics courses be offered anew this coming spring?YesNo
$\square$ Not Applicable. My school does not offer a separate physics course.
8. How would you describe your school? (check one)
$\square$ Private School
$\square$ Regular Public School
$\square$ Public Charter School
$\square$ School-Within-A-School (Public)
$\square$ Public Vocational School $\}$
Do your students also attend a separate "regular" high school simultaneously?Yes $\square$ Alternative/Ungraded Public School
$\square$ BIA/Native American School
$\square$ Public Magnet School $\rightarrow \square$ General
$\square$ Specific area of magnet program $\qquad$
9. What proportion of last year's graduates at your school:

| Went Directly on to Four-Year College |  |
| :--- | :--- |
| Went Directly on to Two-Year College |  |
| Did Not Go Directly on to College | $\%$ |
| $\%$ |  |
| $\%$ |  |

7. Compared to the other high schools in your entire metropolitan area (or county, if you are located outside a metropolitan area), how would you rank the economic circumstances, on average, of your school's student body?
$\square$ much better off than average $\square$ somewhat better off than average $\square$ about average $\square$ somewhat worse off than average $\square$ much worse off than average
8. The final report for this study will be available online at www.aip.org/statistics/trends/hstrends.htm. Would you also like us to mail you a printed copy when it is published (scheduled for 2002)?Yes
9. What is your school's e-mail address? $\qquad$

## 2001 NATIONAL SURVEY OF HIGH SCHOOL TEACHERS OF PHYSICS

Dear Teacher,
Thank you for participating in the American Institute of Physics' National Survey of High School Physics Teachers. We are interested in hearing from all teachers with class assignments in physics this term, regardless of what field you may specialize in or how often in the past you may have taught physics.

If you are NOT teaching any physics classes this term, PLEASE CHECK HERE $\square$ and return this questionnaire blank in the enclosed envelope.

This questionnaire consists of four sections, and should take you about 20 minutes to complete. In SECTION A, we ask you to describe your past experiences and current assignment as a teacher.

## SECTION A: TEACHING EXPERIENCE AND RESPONSIBILITIES

1. How many years (counting this year) have you taught:
a. at the HIGH SCHOOL level? $\qquad$ years
b. in THIS school? $\qquad$ years
2. How many years (counting this year) have you taught one or more HIGH SCHOOL courses in the following subjects?

| Subject | Years Teaching | Subject | Years Teaching |
| :---: | :---: | :---: | :---: |
| a. Physics | ( ) | e. 9th Grade Level Physical Science | ( |
| b. Chemistry | ( ) | f. Mathematics / Computer Science. | ( ) |
| c. Biology. | ( ) | g. Other Subjects |  |
| d. Other HS-le | ( ) | (specify | ( |

3. What would you describe as your PRIMARY subject area of specialization up to this point of your teaching career? (Please check only one.)PhysicsChemistryOther ScienceMathOther Non-Science
4. How many CLASSES and STUDENTS are YOU teaching this term (SPRING 2001). Please include only the classes you yourself are teaching. Do not count labs as a separate class.

If you teach a full-year-equivalent Block Scheduled course to a different group of students each semester, please check here $\square$ and give the number of classes and students for the two semesters combined.
Number of
classes you

have this term $\quad$| Number of |
| :---: |
| students in |
| those classes |

a. Physics

| ( ) | ( ) |
| :---: | :---: |
| ( ) | ( ) |
| ( ) | ( ) |
| ( ) | ( ) |
| ( ) | ( ) |
| ( ) | ( ) |
| ( ) | ( ) |
| ( ) | ( ) |
| ( ) | ( ) |
| Classes | Students |

## SECTION B: PHYSICS INSTRUCTION AT YOUR SCHOOL

5. Approximately how many students are taking a physics class in your school this year? (Please count all physics classes, including those taught by other teachers.)
6. How many other teachers (NOT COUNTING YOURSELF) $\begin{array}{lllllllllllll} & \text { Just } & 1 & 2 & 3 & 4 & 5 & 6 & 7\end{array}$ are teaching physics at your school THIS term? (circle one)

| White | \% | Seniors | \% | Male | \% |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Black | \% | Juniors | \% | Female | \% |
| Hispanic | \% | Sophomores |  |  | = 100\% |
| Asian | \% | \& Freshman | \% |  |  |
| Other | \% |  |  |  |  |

8. How many years of high school science are required for graduation at your school? $\qquad$ years
9. Are any of the following classes taught in your school, by any teacher? (check all that apply) $\square$ Principles of TechnologyAP-B PhysicsAP-C Physics
10. Compared to the other high schools in your entire metropolitanMuch better off than average area (or county, if you are located outside a metropolitan area),Somewhat better off than average how would you rank the economic circumstances, on average,About average of your school's student body?Somewhat worse off than averageMuch worse off than average
11. How well prepared are your students to take physics when they first enter the class in terms of:

| Poorly | Adequately | Very Well |
| :---: | :---: | :---: |
| Prepared | Prepared | Prepared |

a. Math background

1
2
3
b. Physical Science background

1
c. Ability to think and pose questions scientifically . . . . . . . . . . . . . . . . . 1
d. Familiarity with general laboratory methods

1
e. Use of computers in science

1

23
23
23
23
12. How has the overall preparation of your entering physics students changed compared to four years ago?
$\square$ ImprovedStayed about the same
$\square$ Declined
13. Now we would like to turn to the specific physics courses that you yourself are teaching this term.

Enter total number of classes and students for each type of physics course. (Please do not include labs as a separate course.) Indicate texts by code \# from the list below, up to 2 per course, and rate your satisfaction with them, from 1=poor to 5=excellent.

## Type of Physics Course

| \# of Classes | \# of Students | Text Code \# | Rating 1-5 | Text Code \# | Rating 1-5 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ( ) | ( ) | - |  | - |  |
| ( ) | ( ) | - |  |  |  |
| ( ) | ) | - | - | - |  |
| ( ) | ) | - | - | - |  |
| ( ) | ) | - | - | - |  |
| ( ) | ( ) | - | - | - |  |
| ( ) | ( ) |  |  | - |  |
| ( ) | ( ) |  |  |  |  |

14. For each of the textbooks you rated above, do you use a bundled lab manual, activity manual, computer software or other multimedia? If yes, please rate from 1=poor to 5=excellent.

| Text Code \# | Lab Manual | Rating 1-5 | Activity Manual | Rating 1-5 | Computer Software | Rating 1-5 | Other MultiMedia | Rating 1-5 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| a. \# | $\square$ |  | $\square$ |  | $\square$ | - | $\square$ |  |
| b. \# | $\square$ | - | $\square$ | - | $\square$ | - | $\square$ |  |
| c. \# | $\square$ |  | $\square$ | - | $\square$ | - | $\square$ | $-$ |
| d. \# | $\square$ | - | $\square$ | - | $\square$ | _ | $\square$ |  |

## Physics Textbook Code \#s

1. Active Physics (Eisenkraft)
2. College Physics (Sears et al.)
3. College Physics (Serway and Faughn / Harcourt Brace)
4. College Physics (Wilson / Prentice-Hall)
5. Conceptual Physics [HS] (Hewitt / Addison Wesley)
6. Conceptual Physics [College] (Hewitt)
7. Fundamentals of Physics (Halliday and Resnick / Wiley)
8. Heath Physics (Martindale / Heath)
9. Holt Physics (Serway and Faughn / Holt)
10. Physics (Cutnell and Johnson / Wiley)
11. Physics: Methods and Meanings (Taffel)
12. Physics: Principles and Problems (Zitzewitz / Merrill Glencoe)
13. Physics (Giancoli)
14. PSSC Physics (Haber-Schaim et al. / Kendall-Hunt)
15. University Physics (Sears et al.)
16. Other text \#1
17. Other text \#2
18. Academic software
19. Academic videos $\qquad$
20. Your own materials
21. Over the last four years, have any of the following changes been initiated by your school district or state and if so, how has your physics teaching been impacted?
a. Increased graduation requirements in science
b. National education standards in science No Recent
Changes
b. National education 0
c. State-mandated standardized testing 0
d. District- or school-mandated standardized testing 0
e. Other similar changes (specify $\qquad$ ) 0

Yes, and the impact has been:

| Positive | No Significant <br> Impact | Negative |
| :---: | :---: | :---: |
| 1 | 2 | 3 |
| 1 | 2 | 3 |
| 1 | 2 | 3 |
| 1 | 2 | 3 |
| 1 | 2 | 3 |

16. Please use this space to elaborate on your experiences with any of the above.
17. Do you use the following approaches or instructional tools in any of your physics classes?

|  | No | Yes, For How Long? | Positive | No Significant Impact | Negative |
| :---: | :---: | :---: | :---: | :---: | :---: |
| a. Active Physics | 0 | _ yrs | 1 | 2 | 3 |
| b. Calculator-Based Laboratories (CBL). | 0 | __yrs | 1 | 2 | 3 |
| c. $C^{3} \mathrm{P}$ (Comprehensive Conceptual Curric. for Physics) | 0 | __yrs | 1 | 2 | 3 |
| d. CPU (Constructing Physics Understanding). | 0 | __yrs | 1 | 2 | 3 |
| e. Interactive Physics. | 0 | __yrs | 1 | 2 | 3 |
| f. Interdisciplinary Instruction. | 0 | __yrs | 1 | 2 | 3 |
| g. Microcomputer-Based Laboratories (MBL) | 0 | __yrs | 1 | 2 | 3 |
| h. Modeling Instruction | 0 | __yrs | 1 | 2 | 3 |
| i. Physics by Inquiry. | 0 | __yrs | 1 | 2 | 3 |
| j. Real Time Physics | 0 | __yrs | 1 | 2 | 3 |
| k. Workshop Physics | 0 | __yrs | 1 | 2 | 3 |
| I. Other "New Approaches" (specify $\qquad$ | ) 0 | __yrs | 1 | 2 | 3 |

18. Please use this space to elaborate on your experiences with any of the above from Q17.
19. Over the past four years, have you changed the topics covered in your regular first-year physics course?
$\qquad$
20. Over the past four years, have any brand new physics courses been added to your school's physics program?Yes-
(please name and describe) $\qquad$
21. Have there been any other notable changes in your physics program in the last four years?No $\square$ Yes (please describe) $\qquad$
22. Have any of the following impacted your physics teaching? (If yes, please explain briefly in the space to the right.)
a. Block Scheduling $\quad \square$ No $\square$ Yes $\qquad$
b. TIMSS (3rd Int'I Math \& Science Test)
c. Collaboration with a college or university $\square$ No $\square$ Yes
d. Physics education research $\square$ No $\square$ Yes $\qquad$

| 23. Which of the following are problems that affect your physics teaching? | Not a Problem | Minor Problem | Serious Problem |
| :---: | :---: | :---: | :---: |
| a. Inadequate space for lab or lab facilities outmoded | 1 | 2 | 3 |
| b. Insufficient funds for equipment and supplies | 1 | 2 | 3 |
| c. Difficulties in scheduling classes and labs | 1 | 2 | 3 |
| d. Not enough time to plan lessons | 1 | 2 | 3 |
| e. Not enough time to prepare labs | 1 | 2 | 3 |
| f. Insufficient administration support or recognition | 1 | 2 | 3 |
| g. Students do not think physics is important | 1 | 2 | 3 |
| h. Inadequate student mathematical preparation . . . . . . | 1 | 2 | 3 |


| 24. Please circle the extent to which you agree with each of the following statements. | Agree Strongly | Agree Somewhat | Neither Agree Nor Disagree | Disagree Somewhat | Disagree Strongly |
| :---: | :---: | :---: | :---: | :---: | :---: |
| a. I prefer teaching physics to teaching other subjects. | 1 | 2 | 3 | 4 | 5 |
| b. Conceptual physics enrollments in my school have grown at the expense of algebra / trig physics. | 1 | 2 | 3 | 4 | 5 |
| c. I have ample opportunity to share ideas with other physics teachers. | 1 | 2 | 3 | 4 | 5 |
| d. Only people who majored or minored in physics in college should be allowed to teach it in high school. | 1 | 2 | 3 | 4 | 5 |
| e. If I had it to do over again, I would still choose high school teaching as my career. | 1 | 2 | 3 | 4 | 5 |
| f. The sequence of high school sciences should be reversed, so that students take physics first, before chemistry or biology | 1 | 2 | 3 | 4 | 5 |

25. How much money for physics equipment and supplies was available to you for just your own physics classes and labs from all school sources for the current academic year?
26. Is any of the following equipment available to the students in your physics course? If yes, how adequate is the supply, and how well-prepared are students to use it when they begin your courses?

Available \begin{tabular}{c}
Supply <br>
Adequate

 

Supply <br>
Inadequate

$\quad$

Students <br>
Generally <br>
Prepared

 

Students <br>
Generally <br>
Unprepared
\end{tabular}

27. What aspect of your work as a high school physics teacher do you find most satisfying?
28. What aspects of your work as a high school physics teacher do you find least satisfying?

## SECTION C: YOUR BACKGROUND AND EDUCATION

29. Please indicate ALL college degrees you have earned, the year each degree was awarded, and the code letter from the list on the right for your major area of study (and minor, if any) for each degree.
If you had a full double major, list as two separate degrees earned in the same year.

If you are currently pursuing a degree, please check here and enter the expected degree date in the year earned space.

| Year | Major | Minor |
| :---: | :---: | :---: |
| Earned | Code | Code |

Bachelors

2nd Bachelors

Masters

2nd Masters

Doctorate

## SCIENCE / MATH MAJORS

A. Physics (NOT Physics Education)
B. Chemistry (NOT Chemistry Education)
C. Biology / Life Science (NOT Biology Education)
D. Other Science (NOT Science Education) (specify
E. Mathematics / Engineering

## EDUCATION-RELATED MAJORS

F. Physics Education
G. Chemistry Education or Physical Science Education
H. General or other specific Science Education
I. Math Education
J. Other Education / Administration / Counseling
K. Other Major \#1
(specify $\qquad$ _)
L. Other Major \#2
(specify $\qquad$
30. To the best of your recollection, how many full college / university semesters (not credit hours) of physics have you taken? If your undergraduate institution operated on the quarter system, check here $\square$ and give \# of quarters below. If your graduate institution operated on the quarter system, check here $\square$ and give \# of quarters below.

$$
\begin{gathered}
\text { \# of undergraduate } \\
\text { semesters of physics }
\end{gathered}
$$

\# of graduate semesters of physics
$\qquad$
\# of non-degree college semesters of physics
$\qquad$
31. Have you ever (check any that apply):taken a physics course at a two-year collegetaken a course other than physics at a two-year college
32. Many teachers are given teaching assignments in physics although their State Teaching Certificate is in another field. Please check all the boxes below which describe your current certification.Full State Certification specifically in PhysicsTemporary State Certification in PhysicsFull or temporary State Certification in general high school scienceFull or temporary State Certification in a specific science field other than physics (field = $\qquad$Full or temporary State Certification in a high school subject outside of science (field = $\qquad$No state high school teaching certification at present
33. How well-prepared do you feel you are in each of the following aspects of physics teaching?
a. Basic physics knowledge . Not Adequately
Prepared Adequately
Prepared

## Very Well Prepared

b. Recent developments in physics

1
2
3
c. Other science knowledge.

1
2
3
c. Other science knowledge. . . . . . . . . . . . . . . . . . . . . . . . . . 1

23
d. Instructional laboratory design and demonstrations

2
3
e. Use of computers in physics instruction and labs

1
23
f. Application of physics to everyday experiences

1
2
3
34. What is your regular teaching salary for this school year?
\$
Please include your base salary only. Exclude any supplemental earnings or bonuses for extracurricular duties.
If you are working only part-time, please check here $\square$.
If you are receiving room and / or board or a "religious salary," please check here $\square$.
35. Are you a member of any professional organizations? If yes, please indicate at which level(s) you belong.

|  | Member |  | National | State or Local |
| :---: | :---: | :---: | :---: | :---: |
| a. AAPT (American Association of Physics Teachers). | Yes | No | $\square$ | $\square$ |
| b. NSTA (National Science Teachers Association) | Yes | No | $\square$ | $\square$ |
| c. Other (specify |  | _) | $\square$ | $\square$ |

36. Are you currently part of: (check any that apply)
$\square$ A formal group of science teachers that meets regularly to discuss classroom issues
$\square$ An Internet list-serve or Internet discussion group for physics or science teachers
$\square$ Other forum for discussing physics education (specify $\qquad$
37. If you have a question about physics content, where do you go for an answer? Please rank the top 3 (1 to 3) in terms of where you are most likely to go ( $1=$ most common place to go, $2=$ next most common, $3=$ third most common).
$\qquad$ a. High School Physics Textbooks $\qquad$ f. World Wide Web
$\qquad$ b. College Physics Textbooks $\qquad$ g. Internet Group (e.g. list-serve)
$\qquad$ c. Other High School Physics Teachers $\qquad$ h. I do not go anywhere
$\qquad$ d. College or University Teachers $\qquad$ i. Other (specify $\qquad$
$\qquad$ e. Research Scientist Acquaintances
38. Did you attend any of the following during calendar year 2000? (Please count only those events lasting at least one full day.)

| Not <br> in 2000 | Yes, <br> One Time | Yes, More <br> Than Once |
| :---: | :---: | :---: |
| 0 | 1 | 2 |
| 0 | 1 | 2 |
| 0 | 1 | 2 |
| 0 | 1 | 2 |


| a. Workshop on physics classroom instruction techniques . . . . . . . . . . | 0 | 1 | 2 |
| :--- | :--- | :--- | :--- | :--- |
| b. Workshop on physics lab design or delivery . . . . . . . . . . . . . . . . | 0 | 1 | 2 |
| c. Professional association local or national meeting . . . . . . . . . . . | 0 | 1 | 2 |
| d. Other (specify_n | 0 | 1 | 2 |

39. What year were you born? $\qquad$ 40. Are you:FemaleMale
40. What racial or ethnic group do you belong to?WhiteBlackHispanicAsianother (specify
$\qquad$ _)

## SECTION D: YOUR PLANS FOR THE FUTURE

42. How many more years do you expect to teach high school? (check one)This is my last year
$\square 1$ to 5 years6 to 10 years11 to 19 years20 or more years
43. Do you plan to remain in high school education until retirement or are you hoping to change careers prior to that point?Planning to remainHoping to change
44. Do you have Internet access:at home-E-mail address $\qquad$ $\square$ at school $\Rightarrow$ E-mail address $\qquad$
45. Would you like to receive a paper copy of the Final Report from this survey when it is released? (Both highlights and the full report will also be available on the AIP website at www.aip.org/statistics/trends/hstrends.htm)No
$\square$ Yes $\quad>$
Send to me at school (address correction below only if our label was incorrect)Send to me at home (please provide address below)

| Name / school address |
| :--- |
| corrections from label or |
| address to send report if |
| different from label. |

Name $\qquad$
Address $\qquad$ address to send report if different from label.

City $\qquad$ State $\qquad$ Zip $\qquad$
46. Please indicate whether you would also like to receive the following other materials.AIP Report on Physics in the Two-Year CollegesAIP Report on Physics Enrollments and Degrees at Four-Year Colleges and Universities
We would appreciate any additional comments you might have on your experience as a physics teacher, as well as any comments on this survey. Please use an additional sheet of paper if necessary.

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[^0]:    *Teachers reporting physics as their primary area of specialization thus far in their teaching career.

[^1]:    AIP Statistical Research Center: 1986-87, 1989-90, 1992-93, 1996-97 \& 2000-01 High School Physics Surveys

[^2]:    $\dagger$ Response rates significantly different at the .05 confidence level

[^3]:    $\dagger$ Percentages significantly different at the .05 confidence level

