Survey of Indiana High School Physics Teachers

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Introduction

The growing awareness of our country's crisis in math and science education has focused attention on the state of science and, particularly, physics education. A special concern is the increasing shortage of qualified physics teachers. As little data is readily available on exactly what is happening in physics classrooms, this survey was designed to collect data on high school physics classes in Indiana.

The Survey

The specific objectives of the survey were:

1. to assess the general conditions in the Indiana high school physics classroom
2. to gather data on the experience and needs of the physics teachers.

To encourage response, the survey was held to 20 questions on one page. This eliminated an in-depth study in any area, and the questions gathered only general data on class size, text, lab facilities, teacher educational background, *etc.* The survey is shown in Table I.

Table 1.

School Name _____ Enrollment _____
Address_____

1. Approximately what % of your graduates attend college or technical schools?____
2. Is physics currently offered at your high school? _____ yes _____ no
   If the answer is no, please answer the next two questions and return to Ball State.
   If yes, please answer questions 5-20 and return.
3. Physics was last offered _____ years ago. Physics was never offered _____
4. If it was offered, why was it dropped?
   _____ lack of student interest _____ lack of qualified teacher
   _____ lack of funds/equipment _____ other
5. How many semesters of physics are offered? _____
6. How many students are currently enrolled in physics? _____ How many are female? _____
7. Which of the following topics do you cover?
   ____ mechanics ____ E & M ____ optics ____ nuclear
   ____ thermodynamics ____ relativity ____ quantum mechanics ____ sound
8. What textbook is used? _____
9. How would you describe your lab facilities? ____ excellent ____ above average
   ____ average ____ inadequate ____ outdated ____ poor ____ nonexistent
10. What is your yearly budget for lab equipment and expendables other than paper?
    _____
11. How may semesters of math are a prerequisite for physics? _____
12. Does your high school offer computer classes? ____ yes ____ no
    How many semesters? _____

TABLE 1.—Continued

13. How many years of teaching experience do you have? _____
14. How many years experience teaching physics? _____
15. Indicate your highest college degree. _____
16. Indicate for your highest degree your major(maj) and minor(min)
    ____ physics ____ other science ____ math or computer science ____ other
17. If your major was not in physics, how many hours of physics do you have? (Total for all degrees held.) _____
18. Do you have a permanent teaching license ____ or are you working on one? ____
19. If you are working toward your permanent license and need to take physics classes, do you have problems finding them? ____ Where are you taking these classes? _____
20. Which of the following (you may check any number of them would help you the most?
    ____ night classes ____ summer classes ____ weekend workshops in physics
    ____ workshops on lab experiments ____ summer workshops in physics
    ____ workshops on repairing equipment other_____
    Any comments you would care to add:

A copy was sent to every public and private high school in the state, a total of 447 surveys. At this time 165 have been returned. At least one response was received from 71 of the 92 counties in the state. The southern third appears to be more sparsely represented than the upper two thirds but this may be due to the population distribution of the state.

Results

School enrollments varied from 100 to 4500 students: 46 responses were from schools with fewer than 500 students, 58 from schools with 501 to 1000 students, 46 from schools with 1001 to 2000 students, and 4 from schools with enrollments greater than 2000. Only two schools responded that they do not offer physics and they were dropped from the analyzed data. Sixteen of the remaining schools were private schools.

1. *Physics Classes*

One hundred thirty nine or 85.3% of the schools offer two semesters of physics. Twenty or 13.5% offer three or four semesters and one school offers six semesters. All schools with an enrollment of less than 500 offer only two semesters. Ten percent of all schools with enrollments between 500 and 1000 students offer three or more semesters and 33% of all larger schools offer three or more semesters of physics.

2. *Class Enrollment*

The total number of physics students represented by the survey was 5,023 with 1,491 (30%) girls. This projects a state total of 13,600 students enrolled in physics or 3.8% of all high school students. This is approximately 30 students per school.

3. *Topics Covered*

It appears that the average physics class is very traditional with a heavy emphasis on mechanics, optics, electricity, and magnetism, sound, and thermodynamics. It is disturbing to see that only half of the physics classes cover nuclear physics at all. With current heated discussions about nuclear power and weaponry, this is a vital topic. Lack of coverage is probably due to lack of time or inadequate materials.

4. *Text*

Texts in use are listed in the second table.

TABLE 2.—TEXTBOOK

Text	Authors	Publisher	Percentage
Modern Physics	Williams, Trinklein	Holt, Rinehart & Winston	49.0%
Physics Principles & Problems	Murphy, Smoot	Charles E. Merrill	15.0%
Physics Its Methods & Meanings	Taffel	Allyn & Bacon	9.2%
Physics	Giancoli	Prentice Hall	7.2%
Physics (PSSC)	Haber-Schaim, Cross, Dodge, Walter	Heath	5.2%
Project Physics	Rutherford	Holt, Rinehart & Winston	4.6%
Concepts of Physics	Miller, Dillon, Smith	Harcourt Brace Jovanovich	4.6%
Physics Fundamentals & Frontiers	Stollberg, Hill	Houghton Mifflin	2.0%
Physics	Genzer, Houser	Silver Burdett	2.0%
college texts			1.3%

Modern Physics is a traditional, well balanced text, suited for a basic college bound class. *Project Physics* and *PSSC* were NSF funded and very popular a few years ago but have recently lost favor. It should be noted that *Project Physics* is no longer on the Indiana textbook adoption list. Giancoli is a new text directed toward filling the gap between high school and college level texts. It is currently being used in several advanced classes. The college texts, by Halliday & Resnick and Sears & Zemansky, are also used in advanced classes.

5. *Lab Facilities*

Teachers were asked to rate their laboratory facilities on a five part scale from excellent to poor to nonexistent. Twenty eight percent of the teachers felt that their facilities were "inadequate, outdated or poor". On the other hand thirty five percent felt their facilities were "excellent or above average". Limited survey space precluded a detailed definition of an "ideal" high school lab so these data indicate teacher's perceptions of their own facilities and do not measure actual conditions in the high school labs.

6. *Budget*

With the current economic situation, supply and equipment budgets have been deeply cut. As physics is an area requiring occasional large expenditures for some equipment and where equipment is soon outdated, adequate lab equipment has always been a problem for high school teachers.

Twenty schools have no money available for equipment. This is 13% of all schools responding to this question. Nine schools responded that there was no budget, and they simply requested what they needed. Some indicated that they might or might not receive their requests; some indicated that approval was almost automatic. The average

supply and equipment budget is less than $400 per school year or approximately $11.66 per student per year.

7. *Math Requirements*

The average requirement is four semesters of math as a prerequisite to physics. Approximately one third of the schools require two semesters or less, and one third six semesters or more. Four percent (6 schools) have no requirements at all, although they appear to make some recommendation. This is obviously an attempt to encourage more students to take physics, but this may seriously affect the ability of the student to learn the more rigorous physics topics. It may also force the physics teacher to become a math teacher.

8. *Computers*

One hundred thirty nine schools responded that they do offer computer classes. All others intend to offer classes beginning this year. Eighty seven percent offer one or two semesters. Four teachers mentioned that they are incorporating computers into their class or are actively seeking to do so. There is a disturbing negative correlation between students taking computer classes and those taking physics which is significant beyond a .005 level ($r = -.2985$). Care must be taken that capable students are not faced with a choice of taking either a physics course or a computer class.

9. *Teacher Experience*

The average number of years of teaching experience for physics teachers was 16.7 with 13.5 of those years actually teaching physics. Ninety-one percent of the teachers hold a degree above a bachelors. Seventy-five or 46% listed physics as the major for their highest degree while another thirty-three or 22% have a minor in physics. This implies that at least 32% of responding teachers could not be certified to teach physics. Permanent licenses are held by 131 or 80% of the responding teachers. At least 12% of those with a permanent license could not be certified to teach physics. Of those without a major or minor in physics, the average number of semester hours of physics was 21.5. Seven of the responding physics teachers had no physics background at all and 10% had one year or less of college physics. The new graduation requirements will increase demand for teachers. As there are virtually no physics teachers in the education pipeline, it is clear that the problem of unqualified teachers will increase as tenured teachers from crowded areas are shifted into physics classrooms.

10. *Teacher Needs*

The last portion of the survey dealt with what the teachers felt they needed in and out of the classrooms. Their comments gave a strong indication of our system's failures and of their discontent. The comments fell into three categories; classroom assignments, money and personal education.

As physics classes comprise a small portion of the total student body, most physics teachers must teach several subjects, usually other lab sciences, creating a tremendous workload. For example they said: "I am currently teaching physical science, integrated science, PSSC and algebra. What kind of physics teacher could you guess that I am?" "Teaching five classes each day involving three different preparations and maintaining and setting up lab equipment is quite demanding—almost overwhelming."

As Indiana requires a masters degree for a life license, physics teachers find themselves in a position that is particularly unattractive. Their technical skills would be better compensated elsewhere; they must give up summer or night employment to take classes and they must pay for a required education which many industries provide for employees. They said: "Engineers are currently starting at $25,000. I have topped

out at less than $19,000 with 20+ years and MS. There is your problem and you know it." "Money problems make summer programs impossible. Few of us can afford to pay the prices asked to go back to school."

Continuing their education poses a problem for the scattered handful of teachers than can obtain their masters. Universities offer courses directed toward the physics MS and PhD candidate which contain little information that a high school physics teacher can directly utilize in his classroom. Education courses tend to slight physics content. A mixture seems to be unavailable. Teachers said: "I find it very difficult to take courses in physics. They just aren't available!" "Teacher education in the sciences is the pits. Virtually no one teaches how to teach and finding physics courses at a graduate level that are not aimed at PhD candidates is an exercise in frustration!"

The teachers surveyed stated a need for classes directed toward lab related work such as developing new labs, incorporation of computers in labs, learning to repair equipment and sharing experiences with other teachers.

Recommendations

There are many suggestions for improving the physics teacher's condition. Only a few of them are mentioned below and they are classified in two broad categories. Concerns for the state legislators and school boards include:

1. Higher teacher salaries and supply budgets to counteract drain of teachers into industry.
2. Teaching loads requiring fewer preparations since most physics teachers are simultaneously teaching several subjects.
3. Special consideration needs to be given to teachers of laboratory courses either in the form of reduced extracurricular duties or of extra monetary compensation.
4. The state needs to consider revising its requirements for a permanent teaching license or perhaps eliminating the lifelong license.

The Universities need to do the following:

1. Offer more short term courses and workshops especially for teachers.
2. Develop advanced courses and degrees designed for teachers of high school physics.
3. Revise degree programs for teachers to encourage more students to become physics teachers.
4. Upgrade admissions standards to increase enrollment in high school physics.

Conclusions

In general, conditions in Indiana high school physics classrooms warrant immediate concern.

1. The lab facilities in our schools appear to be adequate but cannot remain so for long with small or nonexistent budgets.
2. Even if adequate texts and labs are available, 10% of the teachers are totally unprepared to utilize them. Another 22% may not be certified.
3. As high technology increasingly pervades our society, we will need more and more citizens who understand basic physics yet we do not have teachers to meet current demands for high school physics classes.

4. Physics teachers have few incentives to keep them in the classroom other than a dedication to their profession, lack of other employment, or a three month summer vacation.

5. Due to the small number of physics teachers, relevant advanced classes in physics ar hard to find.

The results of this survey present a grim picture of conditions in Indiana high school physics classrooms which can only grow worse unless conditions are changed quickly. We fear that this survey, if anything, presents too rosey a picture of conditions throughout the state. Many of our surveys were not returned, and although some were undoubtedly lost due to teachers' heavy work loads and reluctance to fill out surveys, many missing surveys represent schools which lack well-qualified physics teachers. Certainly this seems to be the case in those few schools where we can check survey results by independent means.

In our increasingly complex technological society, we will need many more high school graduates who understand physics. We must therefore make every effort to design more high school physics courses at varying levels of difficulty and to actively recruit students to take them, perhaps by raising high school and college science requirements. We must increase equipment budgets, decrease the workload of the physics teacher, recognize his/her technical value with monetary or other rewards and design advanced courses for her/his specific needs. To do these things will require the cooperative efforts of the schools and universities, the community, industry and local, state and national governments. Only then can we hope to bring the excitement of physics to more students and to provide Indiana with the technically literate citizens she will need to face the challenges of the twenty first century.

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