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Schools in Balance: Comparing Iowa Physics Teachers and Teaching in Large and Small Schools

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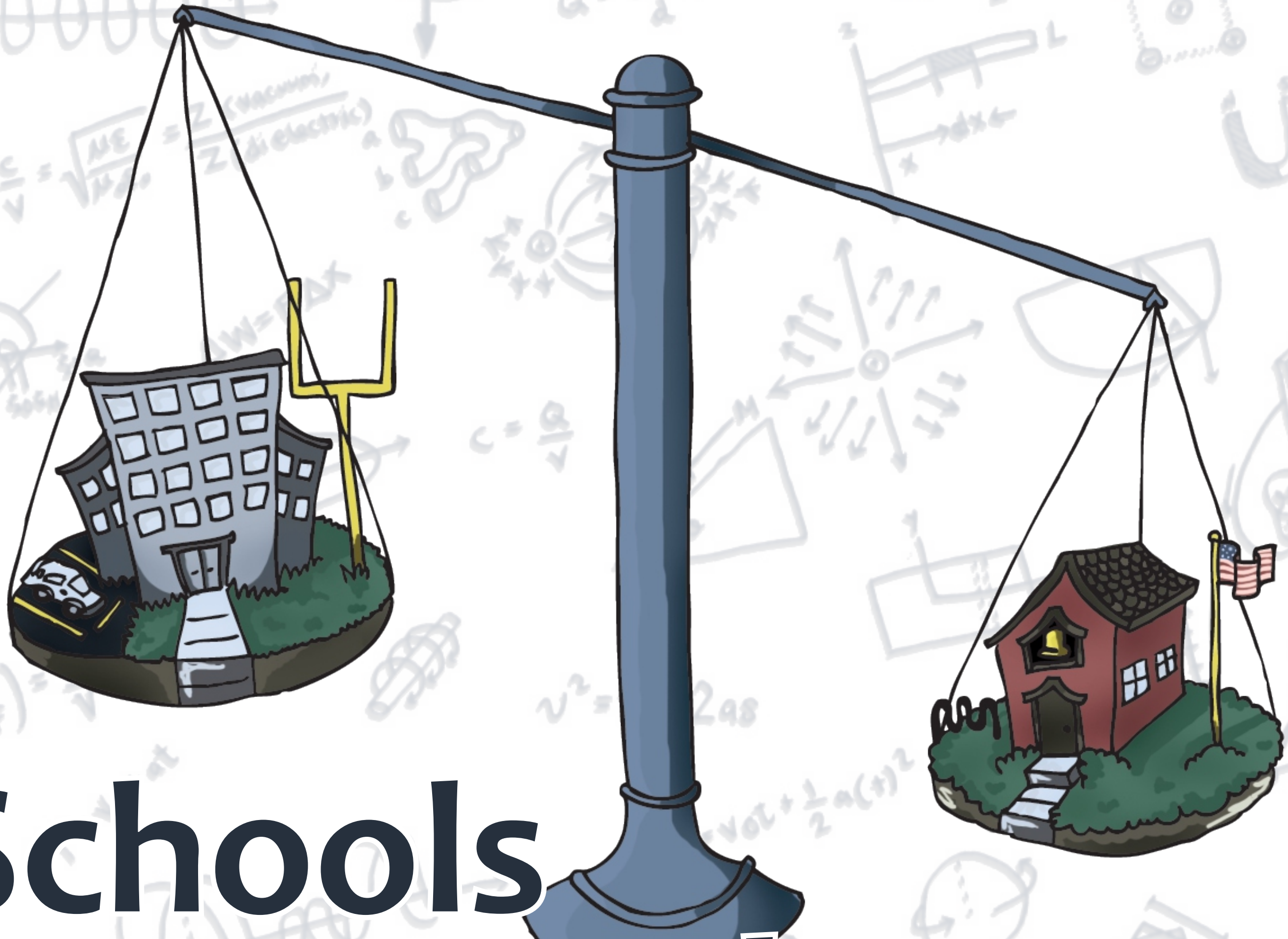

Schools In Balance

Graphic Work by Tori Wheeler

COMPARING IOWA PHYSICS TEACHERS AND TEACHING IN LARGE AND SMALL SCHOOLS

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ABSTRACT: In 2009 we surveyed all known Iowa high school physics teachers to gain insight into their educational backgrounds, instructional styles, content coverage, and available resources. Based upon a suggestion made at a subsequent presentation, we reexamined the collected data, comparing the responses of teachers from small and large schools to see if there were notable differences between the two populations. We found that teachers at larger schools teach a wider variety of physics courses, including more advanced and "physics first" style courses, and report stronger educational backgrounds in physics. While larger schools also have more financial resources allocated for physics teaching, the larger enrollments in physics courses at these schools means there is roughly the same amount of available money per student at all schools.

The University of Northern Iowa offers numerous professional development opportunities to science teachers throughout the state. In order to ascertain the current state of physics teaching in Iowa, and allow us to tailor our physics education programs to the needs of practicing teachers, we invited all known high school physics teachers in the state to complete a survey that asked questions about their educational background, current teaching practices, and future plans (Morgan and Kittleson, 2009). Forty percent of invited teachers completed the survey, and the results allowed us to develop a picture of the current condition of high school physics instruction in the state. We found, among other things, that while most schools employ teachers who meet the state's minimum requirements for certification in physics teaching, only 1 in 5 physics teachers has a degree in physics.

In addition to reporting the responses to each of our survey questions, we cross-referenced responses to multiple questions to glean additional information about Iowa's physics teachers and teaching. During a presentation of our initial findings to the university community in which we included a limited number of comparisons by school size, an attendee asked whether or not the data suggested that physics teachers at larger schools were better trained – that is, those physics teachers probably had more physics courses in their background. At the time, we had not examined this relationship, and decided to examine more of the survey responses with respect to school size.

To compare the sizes of schools in easily manageable categories, we used athletic divisions based on the Iowa High School Athletic Association's divisions of boys' basketball (IAHSAA, 2012), as more state schools compete in this sport than any other. The IAHSAA separates the state into four basketball divisions: 1A, 2A, 3A and 4A. 1A is defined as the 148 schools in the state with the lowest student populations. 2A is the next 126 schools, 3A the next 64 schools, and 4A is all of the remaining schools. Unless otherwise noted, when we say "small" schools in the subsequent discussion, we mean schools with enrollments less than approximately 300 students, which generally includes 1A and 2A schools. 3A and 4A schools will similarly be referred to as "large" schools.

First, we examined what courses respondents reported teaching. Because we purposefully surveyed high school physics teachers, it's not surprising that the overwhelming majority of respondents (91%) reported teaching a traditional physics course. We also asked them which other science courses they taught, including physical science, typically considered a lower level, more foundational course, and advanced physics courses, such as AP courses or courses offered for college credit through a partnership with an area post-secondary institution. Physics teachers at small schools are far more likely to teach a lower level physical science course – 60% of 1A teachers and half of 2A teachers do so, compared with about 1 in 8 of their peers at larger schools. By contrast, advanced physics courses are much more likely to be taught at a large school. Our data shows that AP physics classes are almost exclusively taught in 4A schools. Figure 1 shows the types of other physical science or physics courses taught by responding teachers.

In the majority of secondary schools in the US, science courses are taught in the sequence of biology, chemistry, and finally physics. Recently, there has been a push in some schools to get away from the traditional sequence. Advocates of physics first argue that as physics is foundational to many ideas in chemistry and biology, physics should be taken first in the sequence, followed by chemistry and then biology. In Figure 2, one can see that large 4A schools are more likely than smaller schools to teach either physics or physical science first in the high school science sequence.

FIGURE 1
Related classes taught by physics teachers

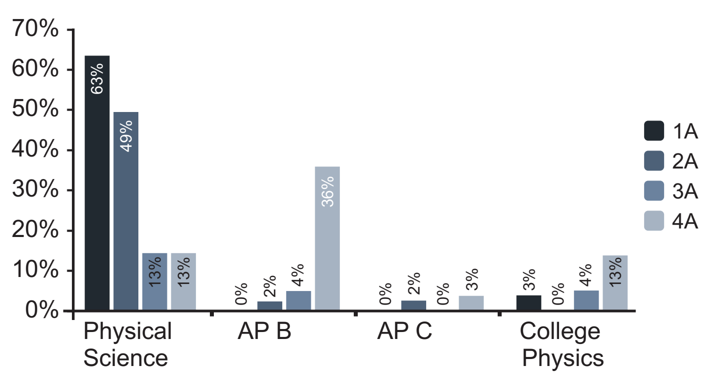
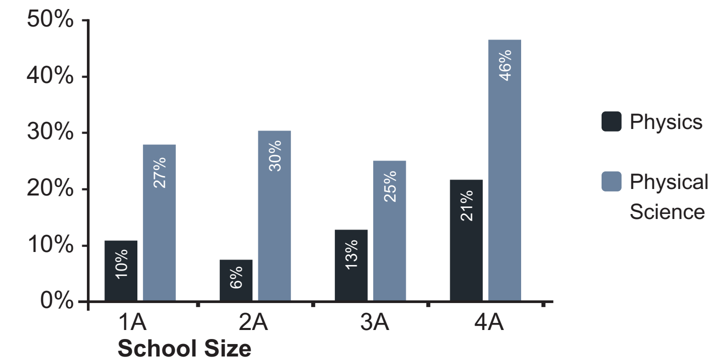
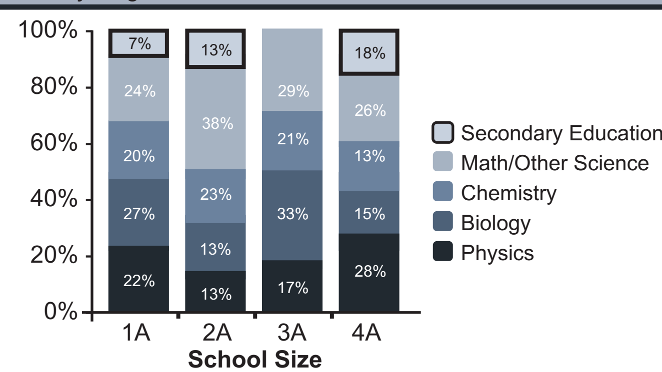


FIGURE 2
Schools teaching physics or physical science first



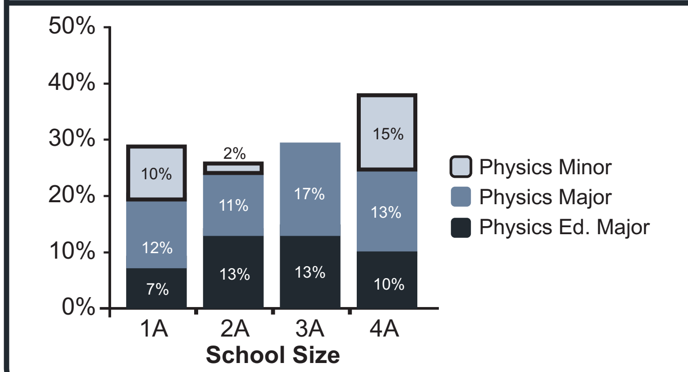
Next, we cross-referenced the primary degrees and educational backgrounds of the teachers with school size. In our original work, we found that, state-wide, about 1 in 5 physics teachers has a degree in physics, 1 in 5 has a background in each of biology and chemistry, and the remaining 40% earned primary degrees in mathematics, education, or some other field. Figure 3 separates the educational background of teachers using these same categories by school size. Although teachers with physics degrees are most likely to be found at large 4A schools, the percentage of teachers with this background is not dramatically higher than other school size categories. Although there are some interesting data points (1 in 3 3A physics teachers has a biology degree, while nearly 40% of 2A physics teachers have backgrounds in math or a science other than physics, biology, or chemistry), there seems to be no clear trend when comparing the school sizes and teachers' primary degrees.

FIGURE 3
Primary Degrees



One does observe a trend in background, however, if we slightly expand our criteria to include earning a minor in physics. As Figure 4 illustrates, nearly 40% of physics teachers at the largest 4A schools earned a major or minor in physics or physics teaching. In general, the larger the school, the stronger the average physics background of the physics teacher(s).

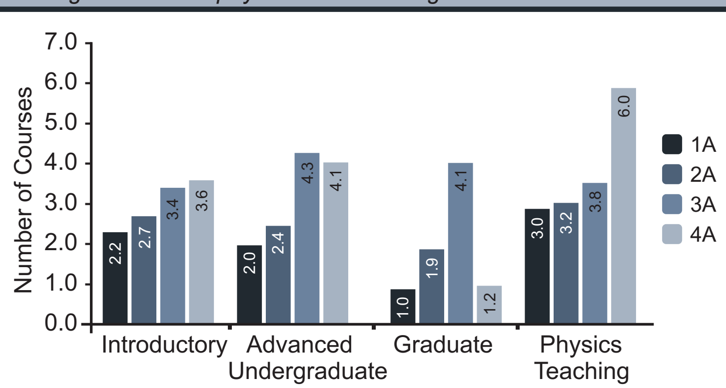
FIGURE 4
Training in Physics



The survey also asked teachers how many college courses they completed, both in physics content at the introductory, advanced undergraduate, and graduate levels, as well as courses in physics or science education. Again, as illustrated in Figure 5, we see that on average, teachers at large schools have more physics and physics teaching training at the undergraduate level than their peers at smaller schools. (We express some skepticism at the number of reported *physics* teaching courses. At our institution, physics teaching majors complete a three-course science teaching methods sequence, and it seems unlikely that many teachers would have taken 6 courses specific to physics teaching. It's possible that some respondents counted general education courses in this category.)

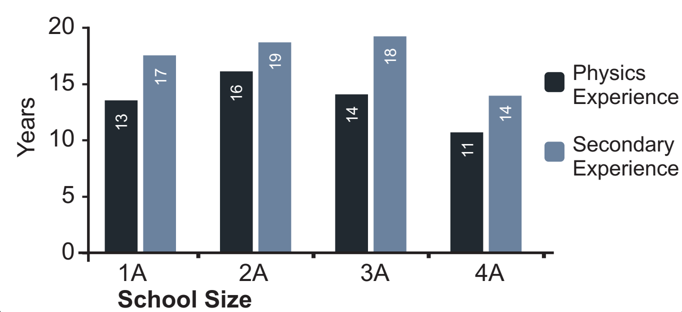
With reports of a shortage of physics teachers not only in Iowa (Campbell, 2005), but nationwide (Volkmann, 2008; U.S. Department of Education, 2012), we asked teachers how long they anticipated remaining in the secondary classroom. One-third of responding physics teachers reported that they plan to leave secondary education within the next 10 years. While on the surface this might seem alarming, it should not be so. Assuming an average teaching career of 30 years and a relatively uniform distribution of teachers at various points in their career, one would expect a third of existing teachers to retire within any one decade.

FIGURE 5
Average number of physics and teaching courses



We also asked teachers about their years of classroom experience, both in teaching physics and teaching in general. We once again cross-referenced this data with school sizes to see whether large schools, in addition to having teachers with more physics courses in their backgrounds, also had more experienced teachers. We found, to the contrary, that on average the teachers at large 4A schools were more likely to have less experience than their peers at smaller sized schools, though the difference is not dramatic. Figure 6 shows the average years of experience, both in teaching physics and teaching in general, for respondents at various sized schools.

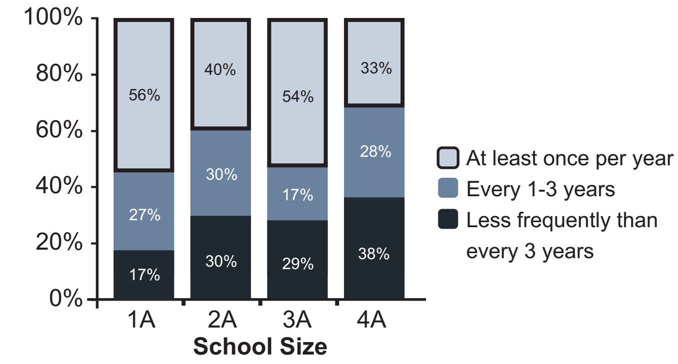
FIGURE 6
Average years of teaching experience



Of course, educational backgrounds or years of teaching experience are only two of many factors that contribute to teacher quality. Most teacher education programs encourage graduates to become "life-long learners" and regularly participate in professional development. As part of the survey, we asked teachers how frequently they participated in some form of professional development. As shown in Figure 7, teachers at larger schools are generally more likely to participate in regular professional development. Perhaps most striking is that nearly 60% of teachers at the smallest schools reported participating in professional development less than once every three years.

Resources, including available money, may contribute to the quality of the instructional environment as well. We asked teachers how much money was available for purchasing supplies and equipment for their physics class (or classes) during the current academic year. As Figure 8 illustrates, in general larger schools have more financial resources available to them. We also note that about 80% of teachers

FIGURE 7
Frequency of professional development participation



at small 1A and 2A schools have $500 or less available for purchases, and over 50% of larger 3A and 4A schools have more than $500 available.

However, this disparity may not be as great as perceived. Our data indicate that more students take physics classes at larger schools, and classes tend to be larger, as illustrated in Figure 9. (By contrast, the average number of students per physical science class is about the same regardless of school size.) If one assumes a median amount for each option listed for the available money question (for example, a median amount of $50 for the $1-$99 category) and multiplies by the percentage of teachers reporting that level of funding, one can calculate the average available money for each school size – as expected the larger schools have more available funds. However, when one divides the available money by the average class size, it's evident that the level of funding per student is fairly equitable among schools of various sizes, as illustrated in Figure 10.

In summary, when comparing the characteristics of physics teachers at large and small schools:

- Students at large schools are more likely to take physics or physical science courses early in their high school careers.
- Students at large schools have more access to various levels of physics courses, including AP courses and courses offered for college credit through partnering institutions.

FIGURE 8
Money available for physics supplies

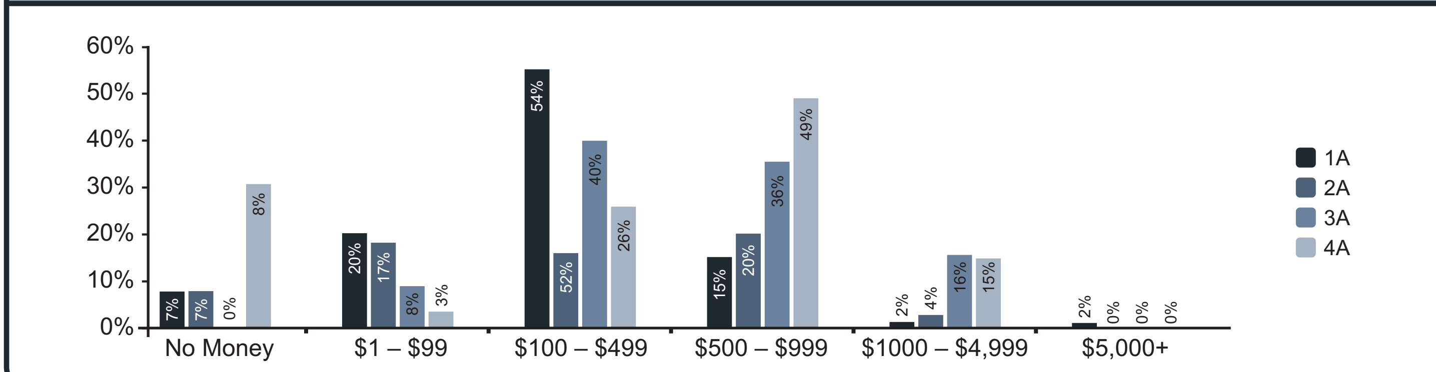


FIGURE 9
Average class enrollment

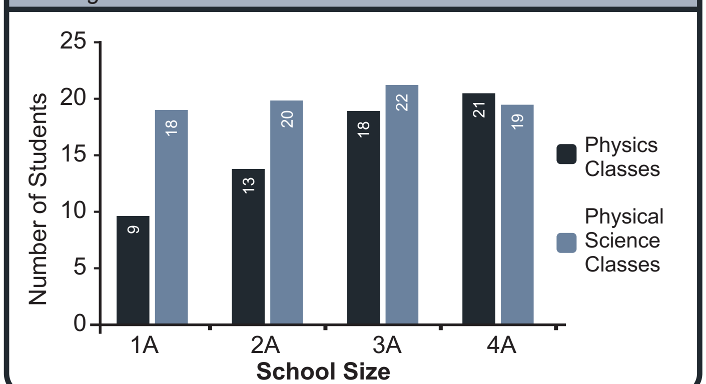
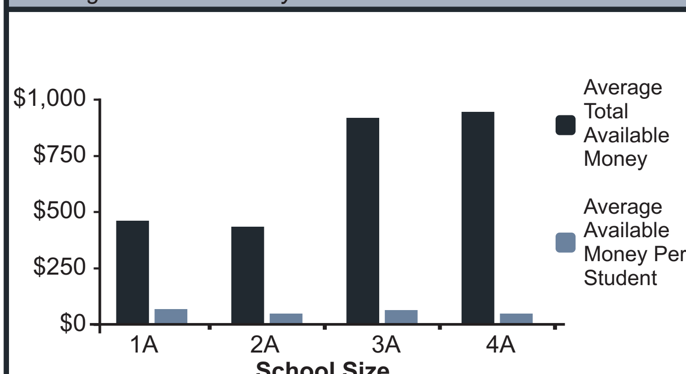


FIGURE 10
Average available money



- Physics teachers at large schools have, on average, slightly more education relevant to high school physics teaching, including more physics content courses and physics teaching courses.
- Physics teachers at small schools have slightly more teaching experience, both in general and in teaching physics. If there is a looming increase in the shortage of qualified physics teachers, it may in turn have a larger impact on smaller schools.
- Physics teachers at larger schools participate more regularly in professional development.
- There are more financial resources available for physics at larger schools, but when divided by the average number of physics students, all levels of school size have roughly the same amount of available money.

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