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High School Physics Textbooks, Resources and Teacher Resourcefulness

Results from the 2012-13 Nationwide Survey of High School Physics Teachers

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REPORTS ON HIGH SCHOOL PHYSICS

High School Physics Availability (4/2014)

High School Physics Courses & Enrollments (7/2014)

Textbooks, Resources and Teacher Resourcefulness (7/2014)

Who Teaches High School Physics (*forthcoming*)

What textbooks are physics teachers using? How highly do they rate those textbooks? What other types of materials do teachers use? The textbooks and other resources used by high school physics teachers in the US have evolved along with the changing demands of physics classes and the evolving set of options available to teachers. In this report, we identify the most widely used textbooks for each type of physics class and share the teachers' ratings of the textbooks they use. We then take a closer look at the other types of resources teachers are using for their classes.

Figure 1

Teachers' Ratings of Textbooks for Regular Physics, U.S. High Schools, 2012–2013.

Course: Regular Physics	How well did this textbook work for this course? Quite well %	Somewhat well %	Not very well or Not well at all %
Conceptual Physics (Hewitt / Addison-Wesley) *(n=326)*	39	44	17
Physics: Principles with Applications (Giancoli / Prentice Hall) *(n=90)*	31	51	18
Holt Physics (Serway, Faughn / Holt McDougal) (n=71)	36	45	19
Physics Principles and Problems (Zitzewitz / McGraw Hill) *(n=316)*	29	50	21

Ratings based on a four-point scale: Quite well, Somewhat well, Not very well, Not well at all

Differences are not statistically significant

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THE 2012-13 NATIONWIDE SURVEY OF HIGH SCHOOL PHYSICS TEACHERS

During the 2012-13 academic year, we collected data from a representative national sample* of over 3,500 public and private high schools across the U.S. to inquire about physics availabilities and offerings. This and future reports describe our findings.

*Hawaii opted out.

"It's hard to find a textbook for 'regular' physics." – Physics Teacher

Table 1

Most Widely Used Physics Textbooks for Regular Physics, U.S. High Schools, 1987-2013.

	Percent of Regular Physics Teachers Using Text							
	2013	2009	2005	2001	1997	1993	1990	1987
Holt Physics (Serway, Faughn, Holt McDougal)	30%	32%	25%	13%	---	---	---	---
Conceptual Physics (Hewitt / Addison-Wesley)	27%	23%	16%	13%	13%	9%	*	*
Physics Principles and Problems (Zitzewitz / McGraw Hill)	26%	32%	40%	49%	53%	44%	42%	33%
Physics: Principles with Applications (Giancoli / Prentice Hall)	7%	6%	5%	---	---	---	---	---

Based on 1213 teachers of Regular Physics in public and private high schools in the U.S.

*** Less than 5%**

--- Not separately rated

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Regular Physics

Physics Principles and Problems (Zitzewitz) has been the most widely used textbook since we started tracking textbook use in regular physics classes in 1987 (**Table 1**). In recent years however *Holt Physics* (Serway et al.) and *Conceptual Physics* (Hewitt) have gained popularity and may now be more widely used than the Zitzewitz text. A smaller, but steady proportion of teachers use *Physics Principles with Applications* (Giancoli). Of these three dominant regular physics texts, none was rated significantly higher or lower than the others (**Figure 1, front page**). About four-fifths of teachers reported that the textbook they used worked quite or somewhat well for their classes, and the other-fifth reported that the textbook they used didn't work very well or didn't work at all.

Regular physics classes can include a wide variety of students with different levels of preparation. As one teacher explained: "I struggle with finding the right level of text complexity and problem set." Many teachers address the challenges of their particular classes with other materials that they use either in addition to their textbooks or altogether in place of a class textbook. These materials are discussed in greater depth later in this report.

Conceptual Physics

As you can see in **Table 2**, the most widely used book for Conceptual Physics courses is *Conceptual Physics* (Hewitt). *Conceptual Physics* (Hewitt) is used by 73% of Conceptual Physics classes. Three other textbooks are also common, although they are much less widely used. These include: *Holt Physics* (Serway, Faughn), *Physics Principles and* Problems (Zitzewitz) and *Active Physics, It's About Time* (Eisenkraft).

There is quite a variety to high school physics classes, and textbooks work better for some courses than others. Although the Hewitt book worked well for Regular Physics courses (**Figure 1**), it worked better for Conceptual Physics courses (**Figure 2**). Of the teachers using Hewitt, almost half reported that it worked quite well for their classes, and nearly 90% reported that it worked either somewhat or quite well for their classes. There were not enough teachers reviewing any of the other textbooks to report reliably.

Although the math in Conceptual Physics is less advanced than the math in Regular Physics, teachers still have to adjust to the preparation level of the students in their classes. Some teachers needed to add math to their

Table 2

Most Widely Used Physics Textbooks for Conceptual Physics, U.S. High Schools, 1987-2013.

	Percent of Conceptual Physics Teachers Using Text							
Course:	**2013**	**2009**	**2005**	**2001**	**1997**	**1993**	**1990**	**1987**
Physics First*								
Conceptual Physics (Hewitt / Addison-Wesley)	53%	74%	---	---	---	---	---	---
Conceptual Physics or Physics for Non-Science Students								
Conceptual Physics (Hewitt / Addison-Wesley)	73%	80%	76%	75%	74%	79%	75%	27%
Holt Physics (Serway, Faughn / Holt McDouglas)	9%	5%	---	---	---	---	---	---
Physics Principles and Problems (Zitzewitz / McGraw Hill)	5%	7%	*	6%	7%	8%	7%	28%

Based on 200 teachers of Conceptual Physics and 93 teachers of Physics First in public and private high schools in the U.S.

--- Physics First was explicitly included in the list of courses for the first time on the 2008-09 survey

*** Less than 5%**

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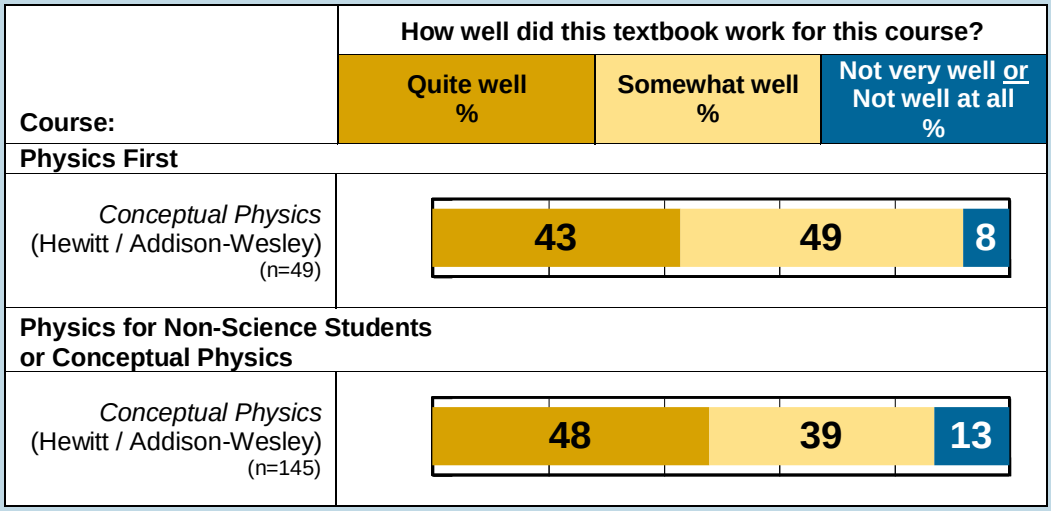
"The book used in the general class is too basic and the book used in my AP class assumes a level of background knowledge that my students lack." – Physics Teacher

"I like Hewitt's books because I can add in as much math as my kids can handle and the concepts are explained very well. It is by far the very best physics program" – Physics Teacher

Figure 2

Teachers' Ratings of Textbooks for Conceptual Physics
U.S. High Schools, 2012-2013.



Ratings based on a four-point scale: Quite well, Somewhat well, Not very well, Not well at all

Differences are not statistically significant

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courses, and others needed less math. The Conceptual Physics teachers responded positively to Hewitt, but they are also addressing these challenges by integrating other types of materials into their classes. One teacher described the way they used the text: "We are not textbook based. We have a classroom set of Hewitt, but students do not take a book home." Another teacher said, "While I pull material from many many textbooks and online sources, I generally make my own note sheets, my own assesments, and my own practice [classwork / homework] to most appropriately address the ability level, interest, and time restrictions of my classes."

Physics First

Physics First is a type of conceptual physics class in which physics is offered first in the sequence of high school science courses. *Conceptual Physics* (Hewitt) is used by 74% of the Physics First teachers (**Table 2**), and the teachers rate it very highly (**Figure 2**). *Foundations of Physics* (Hsu) and *Physics Principles and* Problems (Zitzewitz) are less widely used for Physics First classes.

Physics First teachers sometimes encounter challenges trying to accommodate differing sets of standards, and these challenges can be addressed by adding supplemental resources to the curriculum. One teacher integrates other resources into their class because she "found that textbooks don't match up with simultaneously doing Physics First and current California State Standards."

First Year Honors, Accelerated, or Gifted and Talented Physics

Holt Physics (Serway et al.) continues to be the most widely used book for Honors physics (**Table 3**). About a third of Honors teachers use it. *Physics Principles and Problems* (Zitzewitz) and *Physics: Principles with Applications* (Giancoli) are also commonly used by teachers of Honors physics.

Table 3

Most Widely Used Textbooks for First Year Honors and Accelerated, or Gifted and Talented Physics, U.S. High Schools, 1987–2013.

	Percent of Honors Physics Teachers Using Text							
	2013	2009	2005	2001	1997	1993	1990	1987
Holt Physics (Serway, Faughn, Holt McDougal)	33%	28%	26%	9%	---	---	---	---
Physics: Principles with Applications (Giancoli / Prentice Hall)	19%	20%	17%	16%	19%	14%	10%	7%
Physics Principles and Problems (Zitzewitz / McGraw Hill)	18%	21%	18%	30%	25%	18%	*	*
Conceptual Physics (Hewitt / Addison-Wesley)	11%	8%	6%	*	*	*	*	*
College Physics (Serway, Faughn, Vuille / Brooks / Cole)	6%	8%	8%	9%	*	---	---	---

Based on 445 teachers of Honors Physics in public and private high schools in the U.S.

*** Less than 5%**

--- Not separately rated

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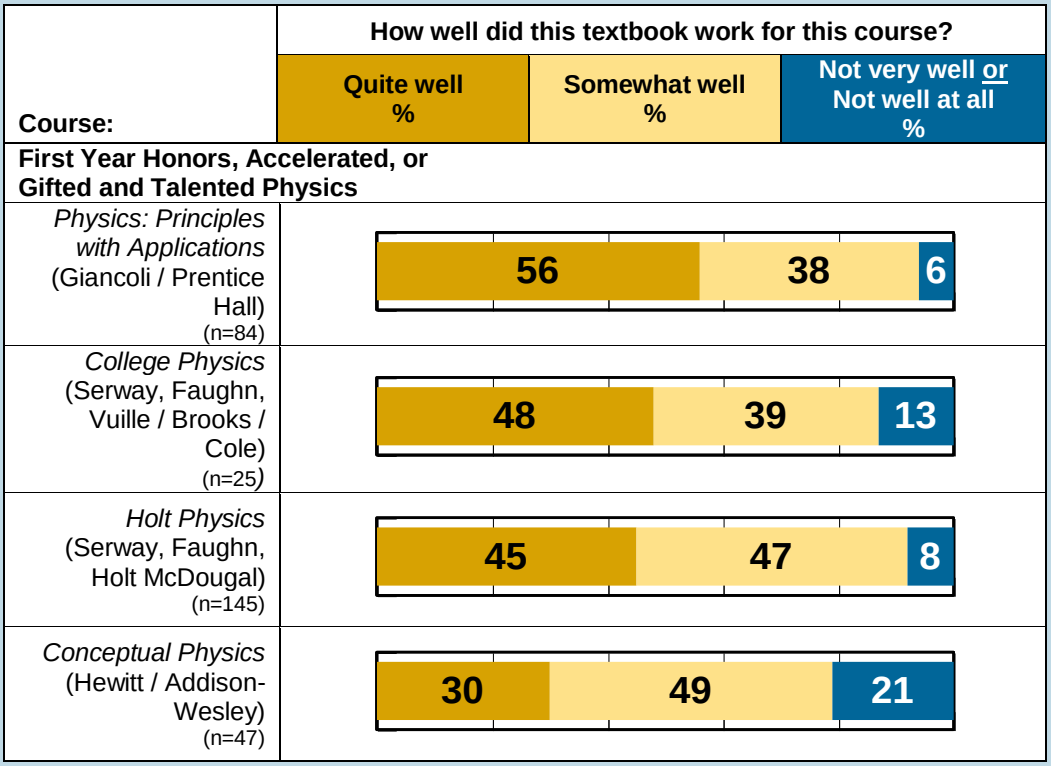
Figure 3

Teachers' Ratings of Textbooks for First Year Honors, Accelerated, or Gifted and Talented Physics, U.S. High Schools, 1987–2013.



Ratings based on a 4 point scale: Quite well, Somewhat well, Not very well, Not well at all

*** Giancoli's text rated significantly higher, and Hewitt's text rated significantly lower than the other texts listed. Other differences were not statistically significant.**

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"I supplement each course with materials from the book for the other course. This helps me emphasize concepts for the Honors and mathematically challenge the Regular" – Physics Teacher

Giancoli's text was very highly rated (**Figure 3**). Not only did 56% of teachers say that this textbook worked quite well for their courses, only a small percentage (6%) said that it worked not very well or not well at all. Two more books, *College Physics* (Serway et al.) and *Holt Physics* (Serway, Faughn) were quite highly rated by the teachers who used them. *Conceptual Physics* (Hewitt) was not rated as highly for Honors Physics classes, as it appeared to be better suited for Conceptual and Regular Physics classes.

"We are shifting to ipad instruction, and the Zitzewitz textbook is available " – Physics Teacher

Many teachers, including those who rated their textbooks highly, said that they have integrated more supplemental materials, some of which were part of their textbook packages or e-texts, into their curriculum. One teacher reported: "Giancoli has excellent PowerPoints, clickers and test resources."

Advanced Placement Classes

Advanced Placement Physics classes rose in prevalence and prominence in the 1990s. AP Physics B is an introductory course that relies on algebra and trigonometry, and AP Physics C relies heavily on calculus. The two most widely used textbooks for AP Physics B continue to be *Physics: Principles with Applications* (Giancoli) and *College Physics* (Serway et al.) (**Table 4**). AP Physics teachers rated both books quite highly, although Giancoli rated particularly high (**Figure 4**).

AP Physics C texts focus on solutions to challenging problems in both mechanics, and electricity and magnetism. The most widely used text for AP Physics C was *Fundamentals of Physics* (Halliday et al.). *Physics for Scientists & Engineers* (Serway et al.), *Physics for Scientists & Engineers* (Tipler, Mosca) were also commonly used.

Table 4

Most Widely Used Textbooks for Advanced Placement Physics Classes, U.S. High Schools, 1987-2013.

	Percent of AP Physics Teachers Using Text					
Course:	**2013**	**2009**	**2005**	**2001**	**1997**	**1993**
Advanced Placement Physics B						
Physics: Principles with Applications (Giancoli / Prentice Hall)	37%	36%	35%	33%	27%	28%
College Physics (Serway, Faughn, Vuille / Brooks / Cole)	24%	26%	20%	25%	24%	10%
College Physics (Wilson, Buffa, Lou / Prentice Hall)	6%	6%	---	---	---	---
Physics (Walker / Pearson)	10%	6%	---	---	---	---
Advanced Placement Physics C						
Fundamentals of Physics (Halliday, Resnick, Walker / Wiley)	36%	7%	45%	47%	41%	39%
Physics for Scientists & Engineers (Serway, Jewett / Cengage Learning)	15%	19%	---	---	---	---
Physics for Scientists & Engineers (Tipler, Mosca / WH Freeman)	14%	---	---	---	---	---

Based on 382 teachers of AP B and 202 teachers of AP C Physics classes in public and private high schools in the U.S.

*** Less than 5%**

--- Not separately rated

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Figure 4

Teachers' Ratings of Textbooks for Advanced Placement Physics, U.S. High Schools, 2012–2013.

Course:	How well did this textbook work for this course? Quite well %	Somewhat well %	Not very well or Not well at all %
Advanced Placement Physics B			
Physics: Principles with Applications (Giancoli / Prentice Hall) (n=138)	58	36	6
College Physics (Serway, Faughn, Vuille / Brooks / Cole) (n=90)	47	44	9
Physics (Walker / Pearson) (n=38)	55	42	3
College Physics (Wilson, Buffa, Lou / Prentice Hall) (n=24)	54	42	4
Advanced Placement Physics C			
Fundamentals of Physics (Halliday, Resnick, Walker / Wiley)	67	33	
Physics for Scientists & Engineers (Serway, Jewett / Cengage Learning) (n=31)	71	26	3
Physics for Scientists & Engineers (Tipler, Mosca / WH Freeman) (n=29)	52	31	17

Ratings based on a four-point scale: Quite well, Somewhat well, Not very well, Not well at all

*** Differences for texts within each type of physics class are not statistically significant**

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Textbooks for AP Physics classes tend to be rated quite well by the teachers who use them.

A Closer Look at Textbooks and Resources in the Modern Physics Classroom

We have been asking teachers for decades about the books they use for their classes, but this is the first year that we were also able to gain a more nuanced understanding of how teachers use their textbooks. We asked the teachers about the resources they use to supplement their classes, and to our surprise, many teachers, including teachers who rated their books highly, told us that they use their textbooks as one of many classroom resources, or they simply keep the books in the classroom as a reference, or they don't use a textbook at all for their classes.

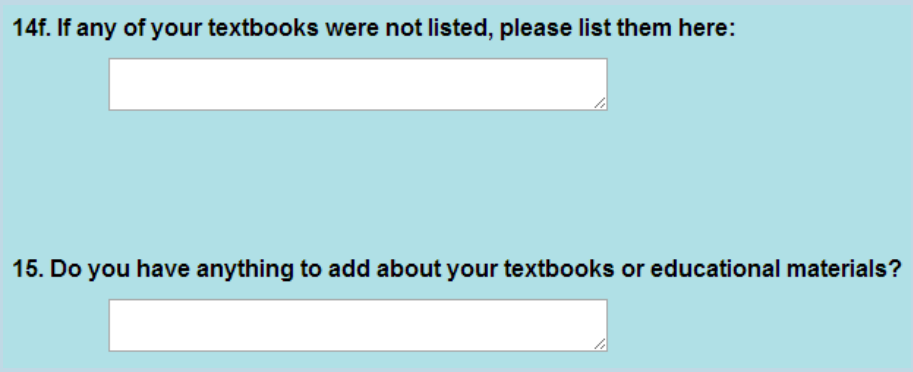
Teachers demonstrate quite a bit of initiative, creativity and resourcefulness

In this section we describe the resources teachers use and how they integrate them into their curricula. Teachers demonstrate quite a bit of initiative, creativity and resourcefulness. Instead of simply using the texts that are supplied to them, they use a wide variety of resources in order to create a curriculum that works well with the needs of their students and the requirements of their schools.

We will hear directly from the teachers about the textbooks and resources they use for their classes. The resources we list and comments that we will share in this section are taken directly from the verbatim responses to two open ended questions that were side by side in the questionnaire. These responses have been minimally processed (spelling corrections only).

Figure 5

Open Ended Questions about Physics Textbooks in Teacher Survey, U.S. High Schools, 2012–2013.



http://www.aip.org/statistics

"As a profession we need to think very carefully about how to educate a modern student in this material" – Physics Teacher

Why not simply rely on the textbooks?

Teachers must take into account a wide variety of factors while planning and teaching their classes. Not only is every student different, but each class is different. In addition to the challenges of the classroom, teachers face sets of standards set by their schools, districts and states. The diversity of their challenges reflects the tremendous variance in preparation among the physics students and the lack of standardization among legislative goals in the US. The challenges that teachers face in accommodating curricular and student needs inspire them to think creatively and strategically about curriculum.

"The supplemental Holt Physics textbook is from 1999 and we borrow it from a neighboring school" – Physics Teacher

One common obstacle that teachers cited in working with textbooks was funding. Schools have limited funds, and they are often forced to make difficult decisions about the allocation of those funds. As one teacher explained: "In cash strapped education, textbooks are a luxury. We went with department computers over textbooks last curriculum cycle." The lack of funding meant that some schools were unable to issue textbooks to each student, some schools shared textbooks with neighboring schools, and some schools were altogether unlikely to purchase replacements for out-of-date texts. Given tightening school budgets and the students' engagement with digital and online media, we may see an increase in the variety of teaching resources used in physics classes.

In some cases teachers relied less on textbooks not because of the books themselves, but because of the mindset of the students. One teacher explained that "While I really liked the textbooks for both my classes, the students rarely used them."

Advantages of Online Resources

Adjusting the level of math or the number of demonstrations in a course is not new to teachers, but the vast array of high quality resources is. Teachers are drawing from a wide variety of materials and resources in conjunction with the traditional textbooks, and sometimes in place of traditional textbooks. Many have decided to use online or interactive curriculum materials, and some have curated their own set or resources or use other curated resources.

Adjusting the level of math or the number of demonstrations in a course is not new to teachers, but the vast array of high quality resources is.

Teachers used these supplemental resources in a variety of ways. Some used comprehensive online courses or assembled their own resources using online tools- a very popular example of which is a class management system called Moodle.(1) Some used supplemental materials to target specific problems or challenges, and some used them to guide or even "flip" their classrooms- asking their students to watch lectures at home and come to class with questions, ready to do homework problems together.

In some cases, online resources were a way of accommodating students who are increasingly well versed in the digital world.

Teachers used online resources in response to changes in student expectations.

In their own words…

"For the style of learning and level of my students, I found that supplemental Internet materials worked best."

"My students prefer the Internet resources to the textbook 99% of the time."

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The Resources Teachers Use

Some of the online materials for physics courses are quite comprehensive, including everything from video demonstrations, labs and lectures to practice problems and lesson plans. Teachers find these comprehensive course materials in a wide variety of places online. What follows below is a listing and exploration of the materials that teachers reported using.

Comprehensive Class Resources
Classroom Materials Used by High School Physics Teachers in the U.S., 2012-2013 Academic Year:

ComPADRE
http://www.compadre.org/

The Physics Classroom (including Minds on Physics)
http://www.physicsclassroom.com/

Modeling Physics
http://modelinginstruction.org/

MIT Physics Online
http://ocw.mit.edu/courses/physics/

Bloomfield- How Things Work
http://www.howeverythingworks.org/

Cinch Science
https://www.mheonline.com/program/view/2/5/2725/CINCH2012/

cK-12
http://www.ck12.org/teacher/

CPO Physics
http://www.cposcience.com/home/Home/tabid/119/Default.aspx

Dolores Gende
http://www.dgende.net/

Energizing Physics
https://sites.google.com/site/epcourse/

Light and Matter
http://www.lightandmatter.com/

Mastering Physics
http://www.pearsonmylabandmastering.com/northamerica/masteringphysics/

Physics in Context- Cord Communications
http://www.cordcommunications.com/store/Contextual_Science/Physics_in_Context.asp

Physics Union Mathematics
http://pum.rutgers.edu/

Sapling Learning
http://www2.saplinglearning.com/physics

SmartPhysics
https://www.smartphysics.com/

http://www.aip.org/statistics

Not all of the online resources that teachers used for their classes were comprehensive. A few teachers reported that they were taking advantage of the tutorials on the Khan Academy website.(2) One of these teachers is using the Khan Academy tutorials to "flip" their class: "I've been 'flipping' class. The students watch assigned Khan Academy videos and then come to class with questions." All of the comprehensive resources listed on the previous page have lectures and tutorials, but the Khan Academy and other websites, such as the Perimeter Institute(3) and SEPUP(4) have only the lectures and tutorials.

Another teacher cited a big obstacle to textbook problems: "ALL questions/problems in physics books have the answers posted on the internet. All you have to do is to type the question into Google and the rest pops up from somewhere. Many teachers found problems on the comprehensive sites we listed, but others found problems at testing sites and sites like the CAPA website.(5)

One teacher used new hybrid cite that was built by a major publishing house, an e-book called WileyPlus,(6) and another teacher purchased materials from a Physics specific online vendor called Science Joy Wagon. (7)

Some teachers used resources, including those listed below, for video demonstrations, simulations and labs to bring physics teachings to life.

Video Demonstrations, Simulations and Labs
Classroom Materials Used by High School Physics Teachers in the U.S., 2012-2013 Academic Year:

Real Time Physics
http://www.matthiasmueller.info/realtimephysics/

SloMo Guys on Youtube
https://www.youtube.com/user/theslowmoguys

PhET Interactive Simulations
http://phet.colorado.edu/

NOVA
http://www.pbs.org/wgbh/nova/physics/

Bill Nye videos
https://www.youtube.com/user/TheRealBillNye

Georgia Public Broadcasting
http://www.gpb.org/chemistry-physics/term/physics

CLEA
http://www.gettysburg.edu/academics/physics/programs/project-clea.dot

CP3
https://cp3.irmp.ucl.ac.be/

Hyperphysics
http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

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Teachers used online resources to meet specific standards for their states, including tests like the New York State regents[8] tests, for which teachers collected practice problems from past exams. Some teachers reported local resources that host teacher training events, such as The Science House in North Carolina.[9] Other resources, such as the Ohio Modeling Materials site[10] and Texas C-Scope[11] echoed wider learning initiatives but focused them in more local, state-based ways. The New Jersey Center for Teaching and Learning[12] offers professional development classes for teachers as well as course-specific materials.

Some of the teachers did not list specific on-line resources, but did share other types of creative strategies that they employ in their classes. A selection of those strategies is listed below:

Class Materials not Found Online
Used by High School Physics Teachers in the U.S.,
2012-2013 Academic Year:

In their own words…

"Much of the material I use I have developed myself."

“I am working on creating my own textbook, videos, and resource material for my students. I am designing a program to fit all the different learner types…I'll do the programming myself and distribute it to my students as a point and click executable file.”

"We use teacher generated videos."

"Some of the best text I've read is actually in the old Project Physics text, which I still have a class set of."

"I supplement with material from college level courses and industry experience."

“I supplement with construction projects (kites, hot air balloon, roller coasters, towers, and circuits).”

"I used many other sources for my students, such as writings by David Bodanis, Internet, *Discover* magazine, *Science Illustrated* magazine, TOPS, and projects from other teachers."

“I incorporate published findings from magazines and websites to further the material in the text and give it a more data oriented focus.”

“I have materials from the last 15 years of teaching physics that I use.”

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A few teachers took the liberty of dreaming up the future of educational resources. One teacher mused: “I am constantly adding practice problems[.] I would give my eye teeth for a book that combines the conceptual and math based approaches as well as includes … inquiry based learning.” Another teacher summed up the wishes of many: “I need a responsive online homework system that adjusts the level of difficulty and provides hints as required according to the student responses.” This and many other visions of future class materials may be a reality when we next report on the textbooks and resources used in physics classrooms!

Footnotes:

(1) Moodle: http://www.moodle.org
(2) Khan Academy: https://www.khanacademy.org/science/physics
(3) Perimeter Institute: http://perimeterscholars.org
(4) SEPUP: http://sepuplhs.org/index.html
(5) CAPA: http://webwork.maa.org/wiki/CAPA_Physics_Problems#.U494dPldUsc
(6) WileyPlus: https://www.wileyplus.com/WileyCDA/catalog/physics.html
(7) Science Joy Wagon: http://www.sciencejoywagon.com/physicszone
(8) New York State Regents: http://www.nysedregents.org/physics
(9) The Science House: http://www.thesciencehouse.org
(10) Ohio State Modeling Materials: http://education.ohio.gov/getattachment/topics/academic-content-standards/science/hsscience_model_curriculum_april2014.pdf.aspx
(11) Texas C-Scope: http://www.tcmpc.org
(12) New Jersey Center for Teaching and Learning: https://njctl.org

Survey Methodology

This study is based on a sample of one-sixth of the public and private high schools in the U.S. Data collection for this round began in the fall of 2012. Although in past years we began the study by surveying all of the schools in our sample, we changed our methodology this round in order to lower the burden on high schools in our sample, many of which are already heavily surveyed. We began with web searches for each of the 3,858 schools in our sample. If we could identify a physics teacher at the school, we collected the contact information for that teacher. If not, we collected contact information for the principal or science chair. We then contacted each of the schools where we had not identified a physics teacher by phone and e-mail to determine whether or not physics was offered at the school and, if so, who taught it. We collected data on whether or not physics was offered from 3,553 of our 3,858 sampled schools (92%). We compared demographics for the non-responding schools with those of the responding schools and found no evidence to suggest that the two groups differed significantly. Thus, we believe we have a representative sample of schools.

During the spring of 2013, we contacted each of the 3,702 teachers we had identified in the fall to learn more about physics in each of the high schools. We heard back from 56% of the teachers.

Without the help of the principals, teachers, and staff at our sampled schools, we could not provide this information. We offer a sincere thanks to each of you.

Physics in Hawaiian High Schools

For the first time in the history of our study, the Superintendent of Schools for the State of Hawaii refused to allow us to contact schools in Hawaii. Thus, the data in this report covers all high schools – both public and private – in every state in the U.S. except Hawaii. Hawaii public schools account for less than one-half of one percent (<0.5%) of seniors enrolled in all U.S. public schools; likewise, schools in Hawaii account for less than one percent (<1%) of seniors enrolled in private schools. The exclusion of these schools should not significantly affect the national results.

e-Updates

You can sign up to receive e-mail alerts which notify you when we post a new report. Visit http://www.aip.org/statistics/e_updates to sign up. You can indicate your area(s) of interest; we will send you an e-Update only when we post a new report that includes data of interest to you. If you sign up for every possible notification, you should receive no more than twenty messages in a year.