

The two flavors of Physics 121

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Beginning in Spring 2014, engineering and physical-science majors at UR can take introductory physics in either of two ways:

- In the UR-**traditional** format involving about 5 hours per week of lectures and workshops, with students assessed by performance on homework, midterm and final exams. In Spring 2014 this flavor is called PHY 121.
- In the **mastery/self-paced format**, involving more extensive workshop experience, up to 40 hours per week, and with the course content divided into distinct **modules**. Students progress through the course by demonstrating **mastery** in the modules, one at a time and **at their own pace**; they are assessed by the number of modules mastered, and by performance on a final exam. In Spring 2014 this flavor is called PHY 121P.

For convenience, we will call this format **Self-Paced** in the following.

Both flavors involve the same laboratory experience, in which students are assessed by performance on lab reports which count as a portion of the course grade.

Why do we offer Self-Paced physics?

The format of self-paced instruction we are using has been tested extensively for the last four decades in university classes, and has been demonstrated to be **significantly more effective** than the traditional lecture/recitation format, by controlled experiments based upon both final-exam performance and persistence, after the semester, of student command of the subject.

- These studies have shown that, on the average, students improve by **tens of percentile points**. For example, students who would be in the 50th percentile in a lecture-recitation class improve to 75th percentile, on the average, in the equivalent Self-Paced class. On the average, C grades turn to B, B grades to A, in Self-Paced courses.

Note that this is *on the average*. Your mileage may vary, of course.

- The reasons for these improvements seem to be the requirement of mastery in topics taught in the course's modules; the fact that individual students can spend more time, or less time, than average in mastering the modules; and the large amounts of individual help provided to students by Self-Paced instructors.

Those interested in the details will find references to the published studies below.

What's it like? What do students do, in Self-Paced physics?

Here's an outline of how the course functions.

- The course material is divided into **modules** – perhaps 16 per semester, for each of which the instructors provide a study guide, textbook-reading and video-viewing assignments, and

homework problems to use to prepare for the module's **quiz**.

- Students can study in the **workshop**, in small groups or individually, with instructors facilitating and coaching. The workshop, which is in the same room all semester long, is usually staffed long hours by faculty, graduate and undergraduate TAs. In Spring's PHY 121P the current plan is for the workshop to be open 2-10 PM, M-F. Students can go to workshop whenever they want, for however long they want, to work on preparatory problems, to receive individual instruction, or to take quizzes.

There are **no regularly scheduled lectures** in PHY 121P. Students in this class are, however, free to attend the lectures in PHY 121, at their option.

- When a student feels prepared to demonstrate **mastery** in a module, s/he asks an instructor to take a quiz. The instructor issues a quiz -- which will be new to the student, even if the student has previously taken a quiz on that module -- and sends her/him to the nearby **quiz room**.
- The student takes the quiz immediately. These tests are designed to be finished in 15-30 minutes, and are proctored. No notes or electronic devices are allowed to be brought into the quiz room; calculators are provided.
- Upon completion, the instructor grades the quiz immediately, in the presence of the student. In PHY 121P it takes a score of at least 90% to demonstrate mastery. The instructors retain the quiz, pass or fail.
- If the student does not pass, the instructor – using this as a prime teachable moment – discusses the concepts behind the quiz problems with the student, guides the student in avoidance of the mistakes s/he just made, and recommends practice problems...
- ...whereupon the student retreats to the workshop and uses the advice just received to prepare for another attempt: a different quiz on the same module.
- There is **no penalty for failing a quiz**.
- When a student passes a quiz, s/he moves on to the next module: studying, solving problems, and preparing again to demonstrate mastery in that material.
- Students repeat this process for each module, **moving at their own pace**, until either they have finished each module or the end of the semester arrives. They all take a comprehensive final exam.
- Students who begin to fall behind a pace that would lead to passing all the modules by the end of the semester will have to face increasing encouragement by -- and offers of additional help from - the instructors.
- Students who finish all the modules before the end of the semester are free until the final exam; such students will thus have lots of extra time to devote to end-of-the-semester work such as papers and design projects.

Self-Paced physics FAQs

- *Is PHY 121P an online course? I didn't come here to take online courses!*

No it's not, and we wouldn't ask you to take one. In many ways Self-Paced classes are the *opposite* of online classes, as they offer practically as many hours per week of face-to-face, individual attention as one could want. PHY 121P will have a website (under BlackBoard) on which will be found many course resources, but this is no MOOC.

- *If I lack the self motivation wouldn't this class be harder?*

Self-motivation is crucial to success in *all* classes, not just self-paced ones. If you mean "won't this class be harder on me since I won't be forced by the lectures to stay on pace?", we would say No. If you attend the Workshop frequently the instructors will bug you to keep up.

- *Self-paced instruction sounds a lot like "flipped classroom" teaching. Is it?*

It looks "flipped" primarily in the lack of lectures and the role of the instructors as guides and coaches in problem-solving sessions. The mastery and self-paced aspects are not native to the Flipped Classroom.

- *You mean to tell me that you would allow students to pass such classes without passing all of the modules?*

Yes we would. And, as the studies show, such students *still* do better on the final than the students in the Traditional course, because in Self-Paced courses students master what they pass.

- *What if a student exhausts the bank of quizzes for a module?*

This is very rare, due to the personal guidance provided when a quiz is flunked. But the instructors would just make up additional quizzes.

- *Does your department have any experience in the teaching of Self-Paced courses?*

Yes, and we have created a lot of appropriate, well-tested material (quizzes, study guides) to use as well, in a variety of our courses. Here are some testimonials from students in the self-paced PHY 113, taught at UR this past summer by Fred Moolekamp:

I just wanted to tell you how much I enjoyed this course. Ever since high school, I thought that physics was just something I would never understand, and that I would just have to struggle through it and hope for the best. This course completely changed that. With your comprehensible [self-paced] teaching style, along with the user-friendly text-books, I actually feel like I understand it ... I sincerely hope that you continue it, or that you pass your methods on to another instructor.

Thanks for a great class. I really appreciated how in control and responsible I was for my own grade.

... I really liked your [self-paced] method of teaching physics. I felt that the unit exams [i.e. quizzes] allowed me to focus more in depth on each topic, helping me more fully to understand each topic.

- Which faculty are teaching the two flavors of physics? Does the self-paced course get a professor?

In Spring 2014, PHY 121 will be taught by Prof. John Howell, and PHY 121P by Prof. Arie Bodek. Each will be assisted by a large team of graduate-student teaching assistants and undergraduate teaching interns. They will collaborate on the writing of the final exam; the two flavors will take the same final.

- Where can I find these controlled studies of which you speak, and the data which show that mastery and self-paced instruction work?

To get you started, here is a paper in which is discussed 72 controlled studies of college classes taught simultaneously in our Self-Paced format and the traditional lecture-recitation format:

C.C. Kulik, J.A. Kulik & R.L. Bangert-Drowns 1990, *Effectiveness of mastery learning programs: a meta-analysis*, [Rev Educ Res 60, 265](#).

"Our" particular form of mastery/self-paced instruction is called the Personalized System of Instruction (PSI), and is even better known in educational circles as the Keller Plan. Here is the article which describes the original course design and experimental studies:

F.S. Keller 1968, *Good-bye, teacher...*, [J Appl Behav Anal 1, 79](#).

And here is an article on the same method, as employed in primary schools (not universities!), from the *New York Times* a couple of weeks ago:

T. Rosenberg 2013, *In 'Flipped' Classrooms, a Method for Mastery*, http://opinionator.blogs.nytimes.com/2013/10/23/in-flipped-classrooms-a-method-for-mastery/?_r=0