

Classroom Philosophy: What is SCALEUP?

Prior to a several years ago, all introductory physics classes at Miami were taught in a lecture format where students listened and took notes as the instructor covered the material and did example problems. The most frequent student comment that the department received during this time was, *“I understand everything that you do in lecture, but when I try to do the homework problems, I don’t know where to start.”* This represented a real problem for both the instructors and students; exams consist entirely of problem solving – if students don’t know where to begin their homework problems, they surely will struggle with exams.

If there is a single universal truth in physics it is this:

Learning physics is very similar to learning how to play a sport or a musical instrument. If your goal is to learn how to hit a nine-iron shot in golf or play a Mozart sonata on the piano, you can read books and watch videos that describe the proper technique, and you can watch experts do it properly. However, until you actually try it and work on it yourself, you have made very little progress. Physics is the same way. You can read your text and watch your instructor solve problems, but until you pick up your pencil and try it yourself, you can't say that you are learning physics.

SCALEUP stands for *“Student Centered Activities for Large Enrollment University Physics.”* The original version of SCALEUP was invented and pioneered by Dr. Robert Beichner at North Carolina State University. Many schools have adopted this format of teaching for introductory physics.

The Miami version of SCALEUP is based on the two premises: (1) learning physics is hard for most students, and (2) most students learn best by active participation in hands-on activities, especially problem solving. Our approach to SCALEUP is divided into three activities:

1. **Reading Assignments.** Students are assigned to read a few sections from their textbook before class. We realize that most students won’t completely understand what they have read – it is the rare student or professor for that matter, who can understand a new topic in science or engineering with the first reading. But, it is the necessary starting point.

2. **In Class Work.** The instructor briefly lectures on the most important topics from the assigned reading, concentrating on those ideas that are essential for applying the material to problems. Students then work in groups of three to solve problems on whiteboards. Only after the students have attempted the problem, does the instructor go over a complete solution of the problem and how it should be approached. The purpose of this is to address the student comment *“I understand everything that you do in lecture, but when I try to do the homework problems, I don’t know where to start.”* We bring this step into the classroom where students who are confused can get help from their classmates, teaching assistants, and the instructor. This pattern of short lectures followed by a student activity is repeated for the entire class. All of the instructors have noticed that students are typically baffled with the first few whiteboard problems, but as the class goes on, most are showing definite signs of beginning to understand the material.

3. **Homework.** Several problems covering the material from class and similar to the whiteboard problems are assigned for homework. Students may work on these independently or in groups. If students have questions about the homework, our graduate teaching assistants staff a drop in help center where students can ask questions, and all of the instructors have office hours and are available by email.

Does the Miami version of SCALEUP work better than our old lecture based format? That is a difficult question to answer. It would be nice if we had a set of students who could take the entire course in the lecture format. Then, we could wipe their minds clean, and have them repeat the course under the SCALEUP format and see if they do better. To date, we have had no volunteers to participate in this study.

Is SCALEUP a Harry Potter-like magic wand that can be used to wave over students’ heads and they will magically become educated in physics? No. Physics has always been and always will be very difficult to learn. There are no magic wands, only hard work. Our hope is that SCALEUP is a better way to attack the hard work part.

MIAMI PLAN PILLARS AND LEARNING OUTCOMES

PHY181 and 182 are Miami Plan Perspective courses in the Natural Sciences area. The courses embody the Four Pillars as follows:

1. Through learning physical concepts, building quantitative models, and problem solving, you will develop the ability to apply physical principles to real world situations and problems. You will build foundational knowledge around which civic engagement and service can be informed. In this way, the course fulfills the **Civic-Mindedness and Social Engagement pillar** of the Miami Plan.
2. The course is built around a group-oriented, active-learning structure where class activities alternate between lectures, group problem-solving activities, and real or computer-simulated demonstrations. You will develop the skills to work both individually and in groups. In this way, the course fulfills the **Collaboration and Innovation pillar** of the Miami Plan.
3. The course introduces you to not only physical concepts and mathematical tools but asks you to combine these types of knowledge to solve problems. You will also reflect and act on problem solutions (Is the solution reasonable? Was the solution expected?) and you must integrate the approach into context (Does the solution hold if the situation is changed?). In this way, the course fulfills the **Critical and Integrative Thinking pillar** of the Miami Plan.
4. Throughout the course, you will communicate both orally and in writing in order to solve problems. You will learn to communicate complicated and complex ideas through mathematical and abstract reasoning. You will apply these communication skills during assessment activities, e.g., physical reasoning on an exam problem must be clearly communicated to receive credit. In this way, the course fulfills the **Communication and Expression pillar** of the Miami Plan.

As a Natural Sciences course, you will identify, use, and critically evaluate basic facts, principles, and theories used in physics through solving quantitative problems individually and in groups. Through demonstrations and computer simulations, you will apply scientific methods to draw conclusions. And by solving problems based on real-world examples, you will see how science is applied to technology and how scientific knowledge changes and evolves.

Additional learning outcomes for PHY181 & PHY182 include:

1. Applying the basic concepts of introductory mechanical, wave, and quantum physics to solve problems;
2. Creating and working with various representations of these problems – word descriptions, diagrammatic descriptions, graphical representations and equations;
3. Selecting the appropriate mathematical method to solve these problems, drawing from algebra, trigonometry, and calculus;
4. Drawing sound conclusions from problem solving exercises;
5. Comparing and assessing models used to solve problems.