# An Instructor Toolkit of Resources for Improving Student Success in Introductory Biology

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## Abstract

Transforming a traditional lecture course to an active learning format can be daunting. Over the past six years, we developed a Comprehensive Student Success Program which resulted in an average 15% improvement over multiple semesters in our successful course completion rates for our Introductory Biology 1 and 2 courses (250-500 students per section). We have created a toolkit of tested hands-on activities, skits, and demonstrations for the lecture hall and supplemental peer-facilitated instruction. Our toolkit is freely available via a website (http://cssphhmi.nsm.uh.edu/) that includes: (1) videos of skits, demonstrations, models to use in the lecture hall and instructor notes for implementing them, (2) model-building and problem solving activities designed specifically for peer led team learning sessions, (3) materials used in student advising (both training material for advisors and materials provided to students, (4) training modules for peer facilitators, (5) materials used in faculty professional development activities, and (6) videos of interviews in which our STEM graduates describe their undergraduate experiences and current careers.

## Comprehensive Student Success Program in Freshman Biology

- A Comprehensive Student Success Program was developed in Biology to address the low successful course completion rates. The key elements of the program are shown in Figure 1.
- Students are placed into recitations based on a diagnostic that assesses their ability to interpret data and think critically about passages they are given to read. Recitations are required for students scoring below a determined threshold and available to anyone that wants to attend.
- Faculty have developed curriculum for recitations, clicker questions, and case studies to emphasize critical thinking and quantitative reasoning skills. A departmental final was developed to assess student mastery of material across sections. Questions were classified using Bloom's taxonomy to insure that approximately 50% of the exam questions are at the level of analysis or higher on the triangle.
- The program was expanded to physics in Fall 2014 through an HHMI Science Education grant. A modified version of the program was implemented in Calculus.

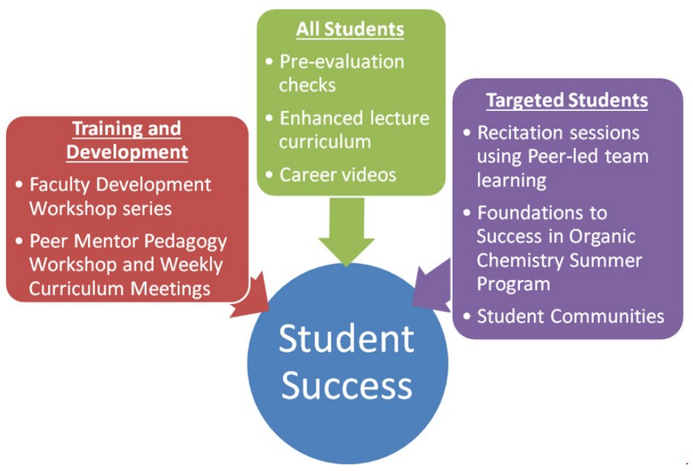



**Figure 1.** Components of the Comprehensive Student Success Program.

**Successful Course Completion Rates**

| Course | Fall 2011 | Fall 2012 | Fall 2013 | Fall 2014 | Fall 2015 | Fall 2016 | Fall 2017 |
|---|---|---|---|---|---|---|---|
| Introductory Biology 1 | 62% (n=1527) | 77% (n=1436) | 76% (n=1058) | 77% (n=1254) | 77% (n=1255) | 72% (n=1301) | 71% (n=1473) |
| | Spring 2012 | Spring 2013 | Spring 2014 | Spring 2015 | Spring 2016 | Spring 2017 | Spring 2018 |
| Introductory Biology 2 | 64% (n=1473) | 78% (n=1377) | 76% (n=1230) | 79% (n=1211) | 81% (n=1306) | 78% (n=1348) | 80% (n=1324) |

**Figure 2.** Successful course completion rates in Introductory Biology I and II after implementation of the Comprehensive Student Success Program in Fall 2012. Fall 2011 and Spring 2012 are the base years for comparison.

## Skits, Models, and Demos

The key to student success lies in engaging students in their own learning. Skits and demonstrations in the lecture hall can be used as a way to clear up student misconceptions and as a platform for teaching study skills in the context of the curriculum. These activities can be paired with a think-pair-share approach in combination with "clickers" or similar response tools to ensure full class engagement and probe the level of understanding of the students. Including activities of this nature livens up the classroom and makes it a smaller, friendlier environment than a straight lecture approach. Included here are examples of demonstrations and skits we have created for use in our Introductory Biology courses. While you can use the videos in your class, we highly recommend you run them live in your classroom for maximum impact. Instructor's notes are included with information on materials preparation and directions for implementing the activities.

**Figure 3.** (a) Faculty set up a demonstration to help students appreciate the relevance of the high specific heat of water to living organisms. Students make a hypothesis in class and predict the order in which the balloons will pop. (b) Students walk through Linus Pauling's Nobel Prize winning exercise in alpha helix modeling after watching a brief video of Linus Pauling explaining how he discovered one of the most common structures found in proteins while in bed with a cold.

## Available Skits, Models and Demos

- Lecture Hall Etiquette 101
- Meiosis Skit
  - Larger than Life Meiosis Lecture Hall Script (PDF)
- Modeling an Alpha Helix Instructor's Video
  - Alpha Helix Teacher Instructions (PDF)
  - Alpha Helix Template (PDF)
- A Primer on Enzymes and Inhibitors
- Specific Heat of Water
- **Cellular Respiration**
  - Cellular Respiration Video
  - Directions for Instructors
- **Fluid Mosaic Model (Lipid Bilayers)**
  - Fluid Mosaic Model Video
  - Directions for instructors
  - Condensed Instructor's Guide for Lipid Skit (PDF)
- **Muscle Contraction**
  - Muscle Contraction Instructor's Video
  - Dancing Your Science-Integrating Dance as a Teaching Strategy to Illustrate Scientific Concepts Video
- **Transcription and Translation**
  - Transcription and Translation Video
  - Directions for Instructors

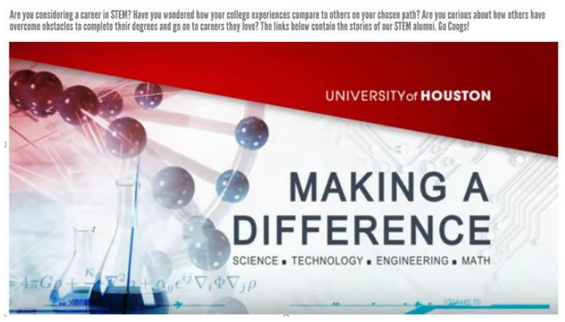
## Biology Recitation Activities

Recitation sessions are led by a team of two peer facilitators. Students work in small groups to complete each activity. Hands-on activities using or building models are used as often as possible (figure 4). The curriculum has been designed to provide students an opportunity to practice critical thinking skills and to develop their skills in data analysis and interpretation. Our activities are included on the website as well as teaching notes for the peer facilitators and course instructor. The notes often include explanations about *why* we are presenting the material in a particular format which is often helpful for the peer facilitators to understand so that they do not revert to the "sage on the stage" method which they may see as more "efficient" even though evidence suggests it is ineffective. Explaining the "why" to the class is also helpful in reducing resistance to the activities. It should be noted that answer keys are not provided on the website. We firmly believe that all peer facilitators and instructors should do the activity themselves before implementing it in class. In fact, all of our peer facilitators participate in weekly meetings where they complete the exercise for the next week. This ensures that they are comfortable with the activity and know what to expect. It also allows us to correct any misconceptions they may have or shore up their knowledge on the topic if there are weaknesses that need to be addressed.

**Figure 4.** Students work together to solve problems. Hands-on manipulatives are used whenever possible to master difficult concepts in biology.

## STEM Career Videos

As students enter college, they often feel alone and overwhelmed. Eight videos were created, in collaboration with Houston Public Media, in which alumni from the College of Natural Sciences and Mathematics and the College of Engineering were interviewed. The alumni share information about their current STEM careers and also their experiences as undergraduates. Their family circumstances and transitioning from a small rural community to a big city campus are highlighted. Issues they faced as students such as supporting themselves financially, family situations, failing their first class, and changing majors are touched upon as well as things they wish they had done differently earlier in their academic careers, and tips for success in academics and professionally. We hope by sharing their stories, future students will connect with the themes presented and be encouraged to persevere. We use the videos in our freshman introductory courses.




## Peer Facilitator Training

Undergraduate peer facilitators are responsible for assisting with activities in the lecture hall and for leading our weekly recitation sessions. Peer facilitators participate in an initial eight hour workshop and in weekly one hour training sessions during the semester. The initial workshop focuses on pedagogy and classroom management. Interactive sessions led by a faculty member with degrees in both education and biochemistry address cultural competence, the psychology of learning, how learning and memory occur, student motivation, classroom dynamics, discussion skills, and cooperative learning. We have also created videos of classroom scenarios to facilitate training. Many of the videos are filmed in segments so that the workshop leader can show the scenario, stop the video for discussion, and then continue to see how the facilitator actors handled the situation. Several of the videos have multiple versions of responses so that students can discuss the positive aspects of the interactions and what could be done better.

## Available Peer Facilitator Materials and Training Videos

Peer Facilitator Materials

- UTA Orientation_The Basics 2014 (PPT)
- Understanding Cultural Competence 2013 (PPT)
- The Psychology of Learning (PPT)
- Student Motivation (PPT)
- How Learning and Memory Occur (PPT)
- Ice Breaker Activity (PPT)
- Classroom Dynamics (PPT)
- Discussion Skills and Quality Questions (PPT)
- Cooperative Learning 2014 (PPT)
- Peer Facilitator Self-Evaluation (PDF)

Peer-Led Group Learning Scenario Videos

- The Bossy Leader
- The Incorrect Know-It-All
- The Loner
- What You Say and How You Say It Matter: Part I
- What You Say and How You Say It Matter: Part II
- Organizing Students Into Groups
- The Review Session

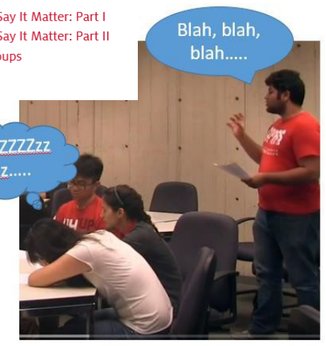




**Figure 5.** (a) Lecture Hall Etiquette video. (b) The Review Session peer facilitator training video.

## Faculty Development Materials

Our faculty development workshop series was created to provide training in teaching and pedagogy. It serves as a means for our faculty to share best practices in the classroom and has served to stimulate conversations on teaching and learning across the STEM departments on campus. Beginning the conversation is often the spark that leads to change away from the "sage on the stage" teaching model to the implementation of more active teaching methods. Included on the Toolkit site are slides for most of our sessions and some video recordings which can be used to lead professional development workshops for graduate teaching assistants and faculty.

Faculty Development Materials

- Using Case Studies to Teach Science
- Concept Mapping
- Engaging Students in Large Lecture Classes
- Grading Philosophies
- Teaching Students How to Take Exams and Evaluate Their Own Performance
- Assessment of Student Learning (PPT)
- Understanding Cultural Competence in the Classroom (PPT)
- Rubric Design (PPT)
- Teaching Students How to Take Exams and Evaluate Their Own Performance (PPT)
- Just-in-Time (JIT) Teaching (PPT)
- Incorporating Primary Literature into Science Teaching (PPT)
- Inquiry Based Labs (PPT)
- Research in Education (PPT)
- Science Literacy K-12 Benchmarks and Standards (PPT)
- Evaluating Information on the Internet (PPT)
- Technology Enriched Learning Environment (PPT)
- Peer Instruction (PPT)
- Writing Using Multiple Choice Questions NSM template (ZIP)
- Using Technology to Enhance Teaching and Tips for Teaching Large Classes (PPT)
- Creating an Engaging Online Learning Environment (PDF)
- Information Literacy (PPT)
- Understanding Our Students: Considerations and Best Practices for Developing an Inclusive Teaching Environment (
- Quantitative Reasoning in Biology Courses (PDF)
- Freshman Research Immersion Program; Dr. Nancy Stamp, Binghampton University-SUNY (PDF)
- **Faculty Development Workshop Series Videos:**
  - A Research Intensive Undergraduate Course: Trials, Tribulations and Practice - Dr. Tim Cooper
  - Using Interactive Lecture Demonstrations in Traditional Lecture Hall - Dr. Rebecca Forrest
  - Flipping the Classroom 101 - An Introduction to Flipped Learning - Dr. Julie Schell
  - Stimulating Genuine Teamwork in a Large Enrollment Core Course - Dr. Ann Cheek and Dr. Ana Medrano

# Website

# http://cssphhmi.nsm.uh.edu/

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