Online hands-on introductory learning in a flipped classroom context

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Introduction

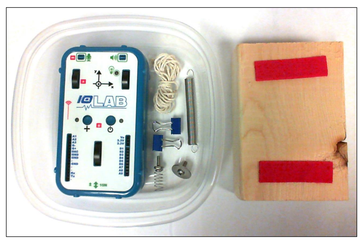
Moving hands-on experience online
In this program, we have explored a "flip" of the microcomputer-based laboratory (MBL) in an introductory mechanics course (Physics 211) with flipped lecture and homework components. This flip is achieved using the Interactive Online Laboratory (IOLab) device and software coupled with the smartPhysics platform to include hands-on learning at the pre-lecture phase of instruction.

Pilot Program Goals

This program was designed to investigate the unique approach of having students do hands-on activities at the time of introduction to a new topic and before attending lecture.

Additionally, specific aims of the program include:

- Development of a collection of video lessons covering the scope of introductory mechanics
- Curation of hands-on activities that students can complete with a simple kit (pictured below) and objects at hand
- Development and validation of conceptual assessment questions related to the topics covered in the video lessons



Kit given to students.

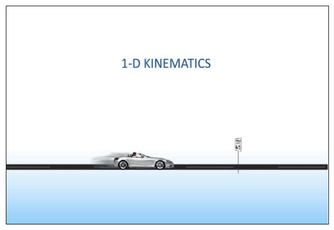
Hands-on Prelecture Pilot Program

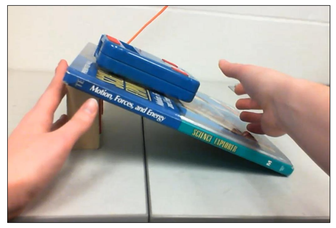
Participants
In Spring 2014, 30 students from the introductory calculus-based mechanics course (Physics 211) at the U of I participated in the program.

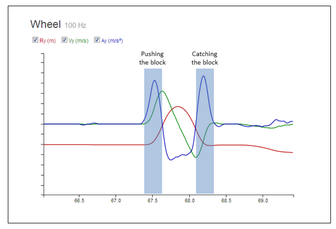
Students completed all the online lessons in their dorm rooms or other location of their choice prior to attending the lecture on the relevant topic.

Topics
Ten supplements were created, covering a selection of topics in the course:

- 1D Kinematics
- Friction
- Normal Force
- Systems of Blocks
- Collisions & Impulse
- Torque
- Rotational Statics
- Angular Momentum
- Fluids
- Simple Harmonic Motion







After viewing a video introduction to the relevant topics, participants were given video instructions for 1-3 hands-on activities, including demonstrations and discussion of the quantities graphed by the IOLab hardware.

Assessment Tool

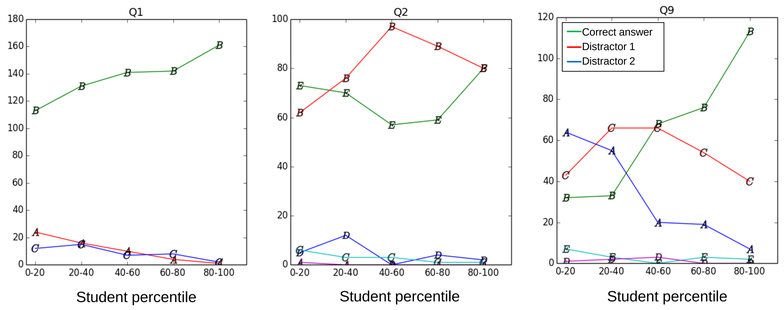
Exam Review Online Homework

80 high-level conceptual questions were given to students in Physics 211 as online homework in Fall 2013 and Spring 2014. All questions were multiple choice.

These questions were designed to identify students' ability to correctly activate relevant physics concepts in the presence of one or more strong distractor answer choices.

Why use these questions?

Previous clinical studies with supervised IOLab lessons have helped steer low-performing students away from attractive distractor answer choices.



Answer choice analysis for a weak distractor (left), weak question (center), and strong distractor (right).

Observations

Running this pilot program on a small scale has revealed the importance of several items that will be addressed in future iterations.

System compatibility
Some students had difficulty running the IOLab software and/or viewing the videos on their personal computers.

Student analysis of data
Graphed and measured quantities require a greater variety of analysis tools in the IOLab software and alternate answer submission capabilities in smartPhysics.

Lesson design
Lessons should clearly express learning goals to students and include activity-related questions with immediate feedback so students can know they are on the right track rather than feeling confused.

Next Steps

The video lessons and IOLab software are being revised based on observations from the pilot program.

The revised program will be repeated in the Fall 2014 semester of Physics 211 with a larger group of students using our validated assessment tool for measurements of long-term learning gains.

More information

For more information, including an example prelecture supplement, please visit http://goo.gl/6mCBsV

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