Studio Physics: A Best Practice in First Year Science Teaching

S.D. Johnson and N. Alberding
Simon Fraser University

First Year in Focus 2009

An introduction to a Workshop-format first year physics course at a large Canadian university.

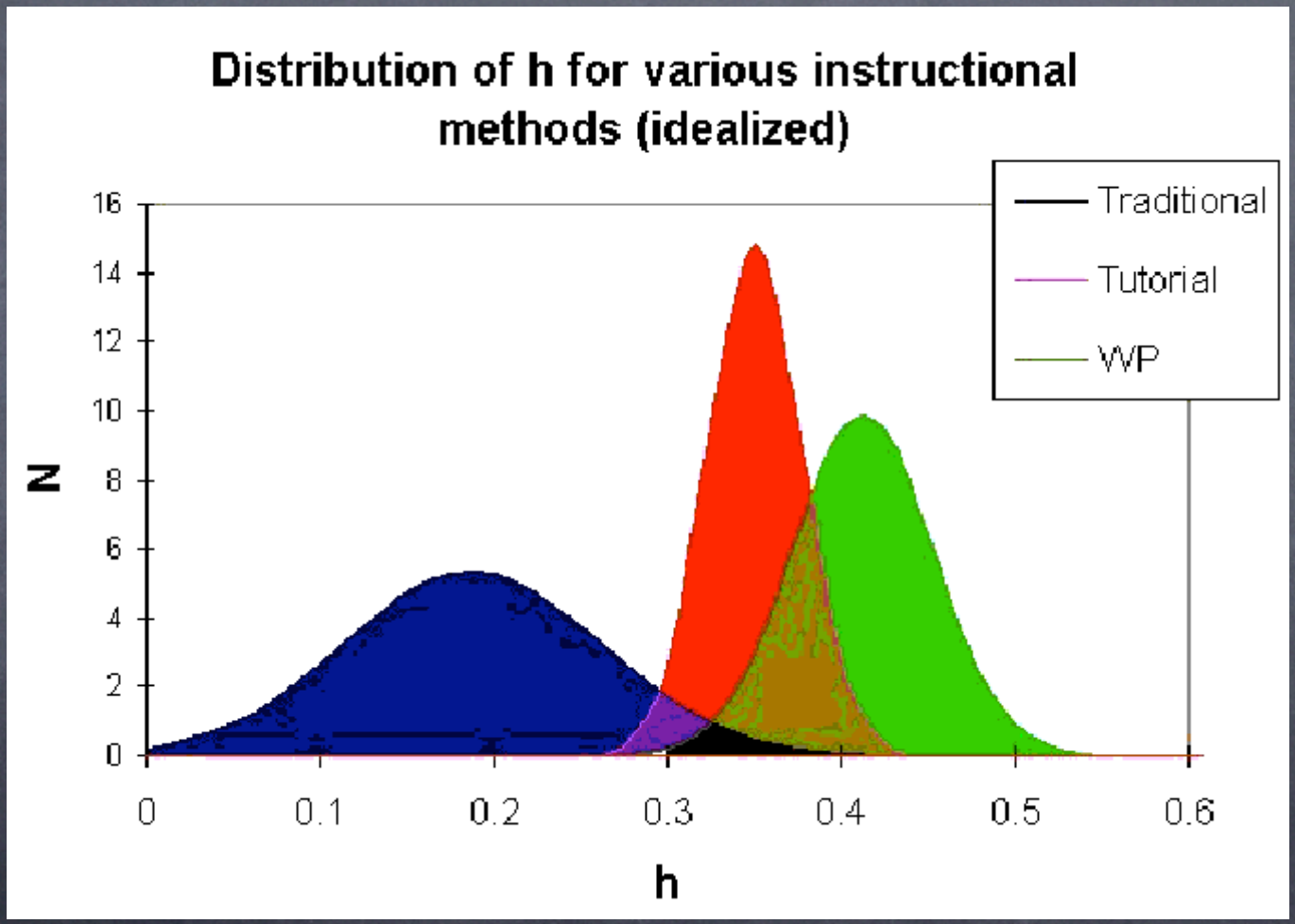
- What is Workshop Physics?
- How we got started.
- Curriculum.
- Facilities and Equipment.
- Initial SFU Results.

What is Workshop Physics?

- Developed by Priscilla Laws at Dickinson College in 1987, in collaboration with David Sokoloff, U of Oregon, and Ronald Thornton, Tufts University
- Replace traditional lectures with learning by inquiry
- Method: examination of preconceptions, qualitative observations, reflection and discussion, development of definitions and mathematical theories, quantitative experimentation
- http://physics.dickinson.edu/~wp_web/wp_homepage.html

Workshop Physics Results

$$h = \frac{\text{gain}}{\text{possible gain}} = \frac{\text{post average \% - pre average \%}}{100 - \text{pre average \%}}$$



Gaussian fit to histogram of FCI gains in traditional, tutorial, and WP classes at 8 institutions.

A new Simon Fraser University campus in Surrey provided an opportunity to try a new approach to the curriculum.

- Studio Physics was "sold "to the Surrey administration as a cutting-edge new curriculum and so a great recruiting tool for the new campus.

SFU Surrey Campus

Curriculum

Based on Workshop Physics I&II by Laws etal

Physics 140 (4 credits)

- Computerized data acquisition and analysis
- Forces, Mass and Motion
- Gravity
- Projectile motion
- Collisions
- Energy
- Rotational Motion
- Oscillations
- Relativity*

Physics 141 (4 credits)

- Electric Fields and Potentials
- DC Electric Circuits
- AC Circuits*, Capacitors
- Magnetism
- Optics, Lenses & Mirrors*
- Diffraction*
- Quantum Physics*
- Formal Written Report
- Lab Practical Exam

Physics 140 & 141 are eqivalent to two 3-credit lecture courses (PHYS 120 and 121) and one 2-credit laboratory course (PHYS 131).

* Activity Guides for these topics developed at SFU.

Typical Class

(Three 110 minute classes per week.)

- Introduction, questions and daily organization (5-10 min)
- Mini-lecture (15 min)*
- Hands-on small group activities following "Activity Guide" handouts (60-80 min)
- Large Group Activity or Demo (20 min)
- Wrap-up Discussion (5-10 min)

* Very occasionally a longer lecture (up to 50 min)

Collecting Data on Pitching Speeds

In order to measure your pitching speed, you'll need:

- A timer (accurate to 1/100th of a second)
- A mitt (or a slow partner or an iron hand)
- A baseball (or other ball in case of bad weather).

In this activity, you should use a pre-measured series of distances. You should work with a partner and each of you should pitch a baseball three times at a comfortable distance. The other partner can time the flight of the baseball. (To save time, you may co-operate with another group of students.) Some of you pros might want to try pitching from a full 20 metre distance, which is longer than the standard 18.4 metre distance used in the major leagues. *Please warm up a bit. Don't kill your arm!*

✍ **Activity 1-2: Pitching Speed Data (groups of 3)**

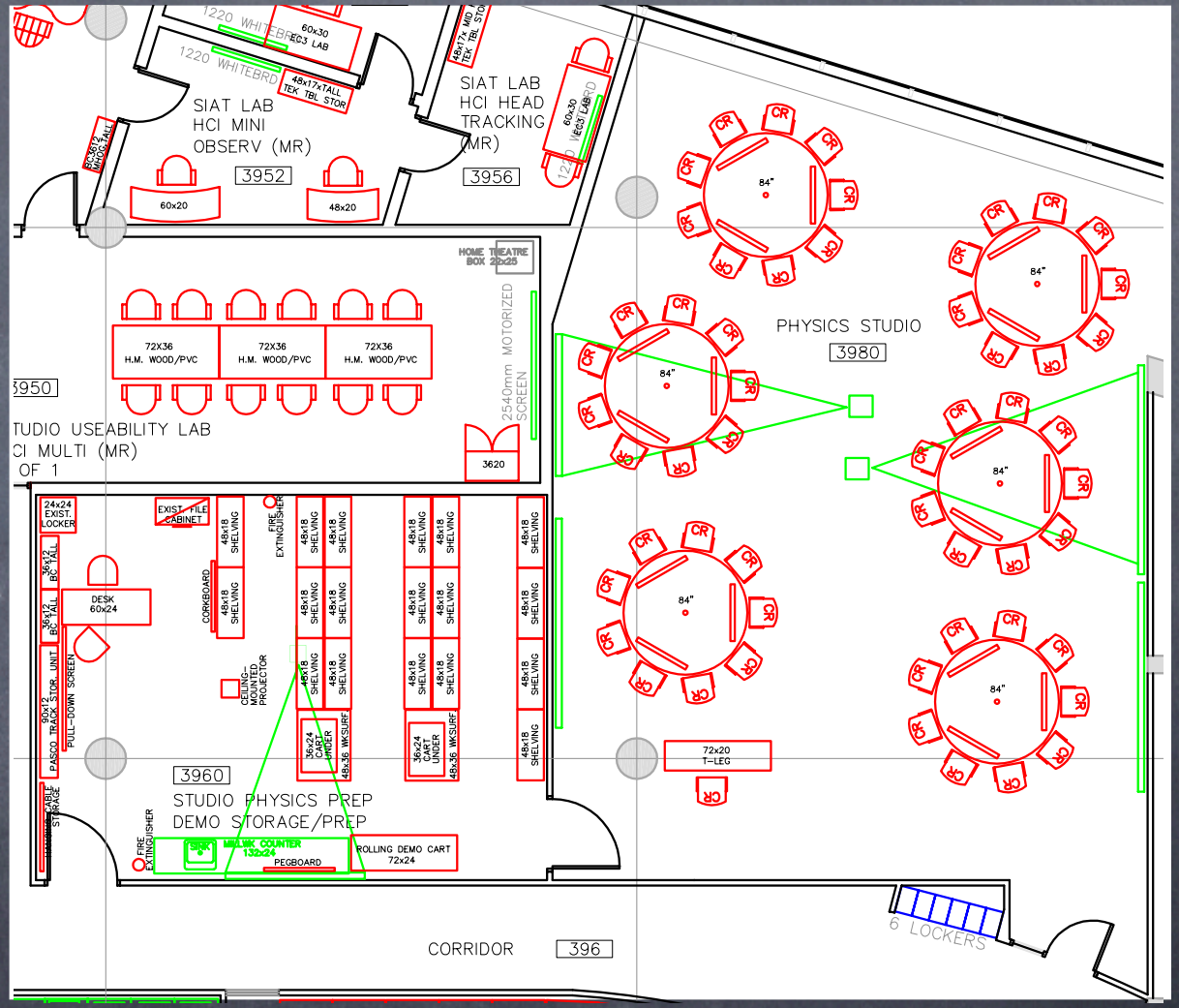
(a) Fill in the data table in the space below for yourself and two *other* classmates and calculate the average time and speed for each person to two decimal places.

(b) Calculate the average speed in kilometres per hour you measured for your own pitch . Show all the steps in your calculation. How good was your prediction?!

Name	Distance (m)	t_1 (s)	t_2 (s)	t_2 (s)	Average t (s)	Average Speed (m/s)

Facilities and Equipment

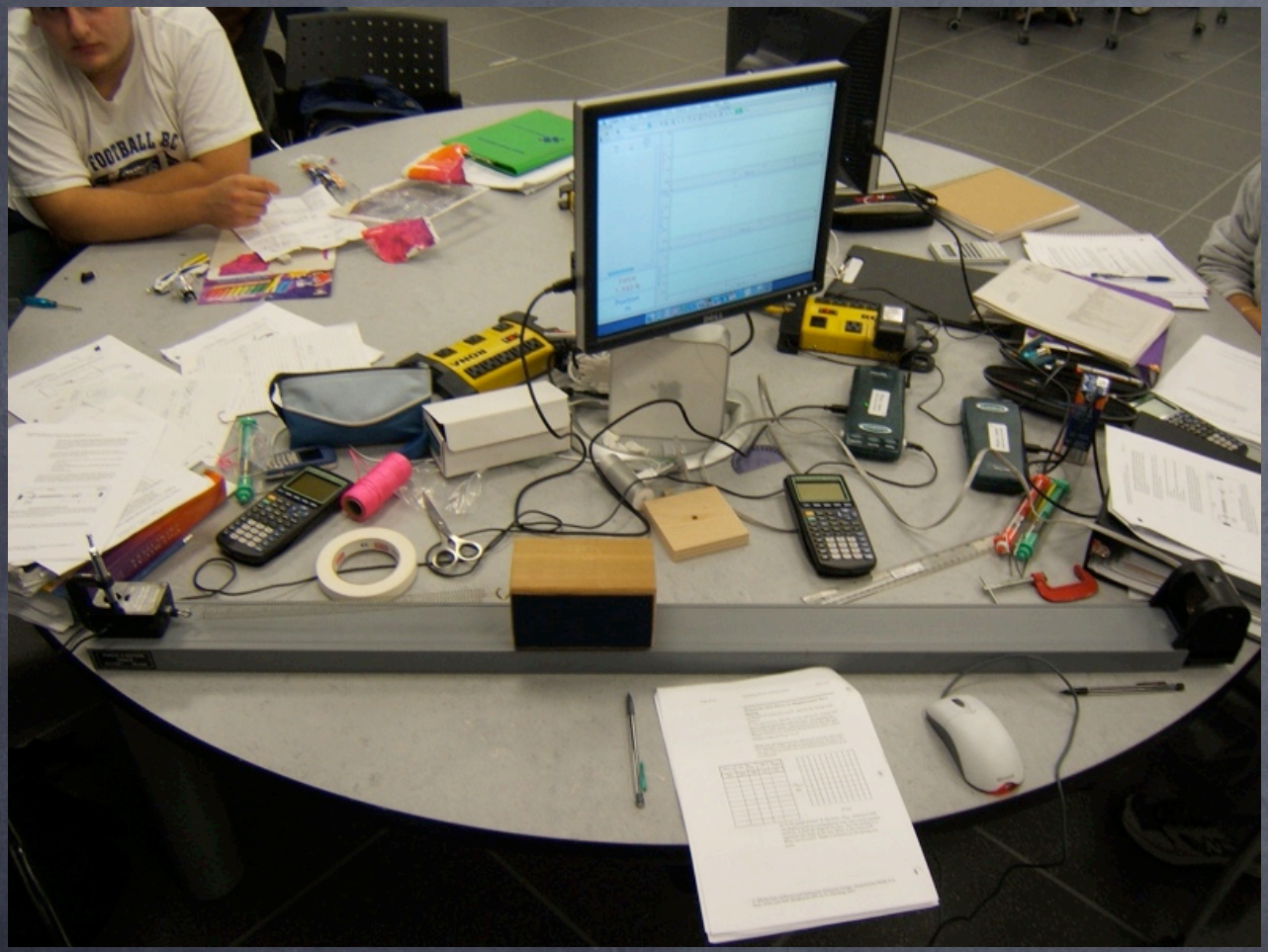
- 1500 sq ft room
- 6 7ft diameter round tables which seat nine
- Dual projectors
- Adjacent prep room
- Center aisle for motion experiments
- multiple whiteboards



Physics Studio Room

First Year in Focus 2009

Individual Stations

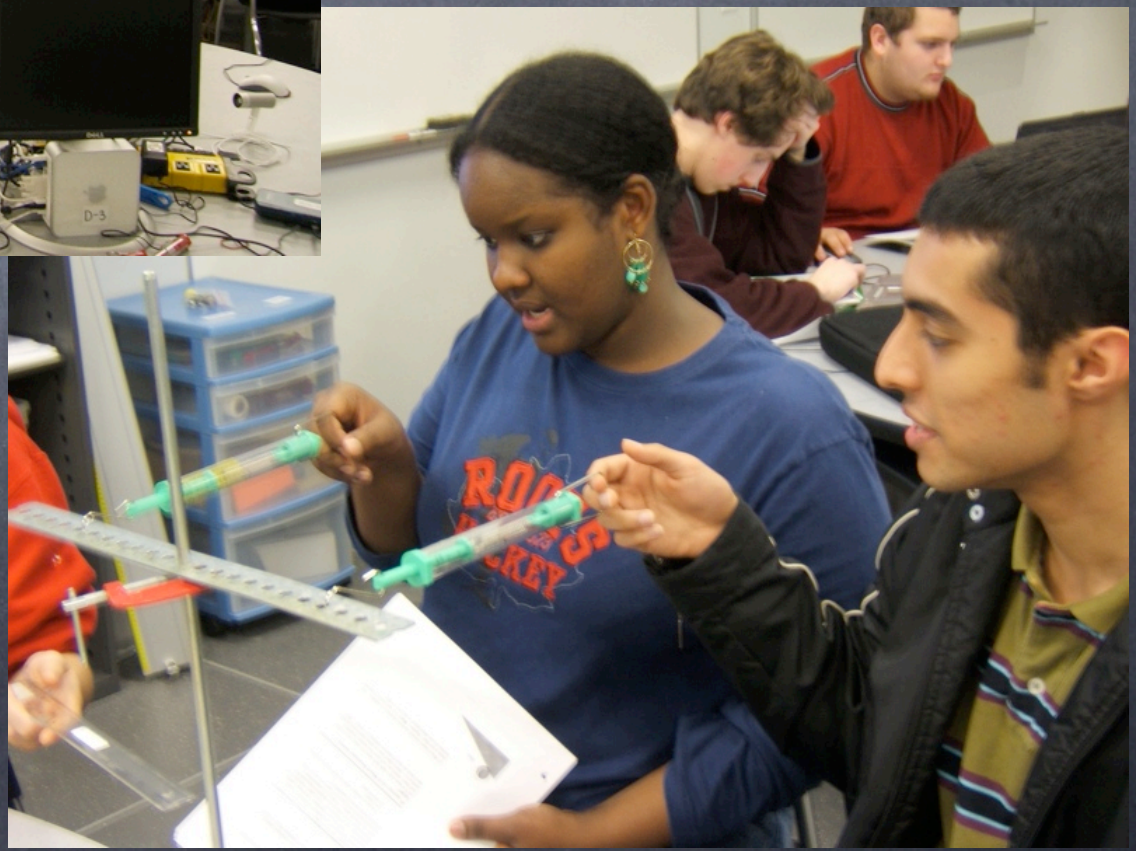


One Individual Station

- Students work in groups of three at each station.
- Mac Mini computer, flat screen display, Vernier LabPro interface, various LabPro probes, iSight camera, etc...
- CAD $7000/Station

Physics Studio

Force Activity



First Year in Focus 2009

Initial Results

Force Concept Inventory (FCI) Exam Scores 2007 (out of 30):

Workshop Format PHYS 140 Pre-test: 18.4 Post: 22.9 Gain: 0.40

Lecture Format PHYS 120 Pre-test: 18.2 Post: 20.7 Gain: 0.21

Retention Rates (Final Grade > D)

	Fall 08	Fall 07	Fall 06
PHYS 140	86%	79%	76%
PHYS 120	78%	71%	72%

Initial Results

Force Concept Inventory (FCI) Exam Scores 2007 (out of 30):

Workshop Format PHYS 140 Pre-test: 18.4 Post: 22.9 Gain: 0.40

Lecture Format PHYS 120 Pre-test: 18.2 Post: 20.7 Gain: 0.21

Retention Rates (Final Grade > D)

	Fall 08	Fall 07	Fall 06
PHYS 140	86%	79%	76%
PHYS 120	78%	71%	72%

Student Evaluations - Typical Positive Comments:

"I really appreciate the studio method as opposed to just aceppting(sic) a formula as it comes, it really helps to enhance the physics learning experience by learning experimentally where formulas come from and how to derive them."

"the fact that we can discuss each other about the subjects that we are learning everyday is a lot better in learning than other classes where we just sit and listen to the lecture."

"please and please, keep the way it is right now. i liked it very much."

Student Evaluations - Typical Negative Comments:

"If I had a choice, I think I would have chosen the standard lecture method over the studio method. I find it easier to understand a particular concept if I had someone explaining it rather than reading the textbook which I found confusing."

"Of course, I can't say from experiance(sic) other than for other courses. I found the studio method to rely TOO much on the student learning things by themselves, and using it, even though it may very well be incorrect. The activity guides were not a resouce(sic) i considered valuable, because it consists of my own derivations and work, that may not be fully sound."

"A few more lectures on concepts that are totally new would make the material easier to learn."