



# Developing Deliberate Pedagogical Thinking with Technology in STEM Teacher Education

**Dr. Marina Milner-Bolotin**

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- Generously supported by the Advanced Innovation Centre for Future Education at BNU
- **Future Schools 2030 Project –**



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# Scientific Innovation in China



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## China to boost scientific and technological innovation

Updated: Aug 8, 2016 5:01 PM english.gov.cn

The State Council issued a national scientific and technological innovation plan in a bid to build China into an innovative country and a scientific and technological power.

As the world's second-largest economy undergoes economic transition for further development, technology innovation has never been more significant, the plan said.

Based on the idea that innovation is the prime development driving force, the plan is a blueprint designed for technological innovation development during the period of the 13th Five-Year Plan (2016-2020).

The plan aims to substantially improve China's technology and innovation capabilities, and lift the country's comprehensive innovation capabilities to the world's top 15.

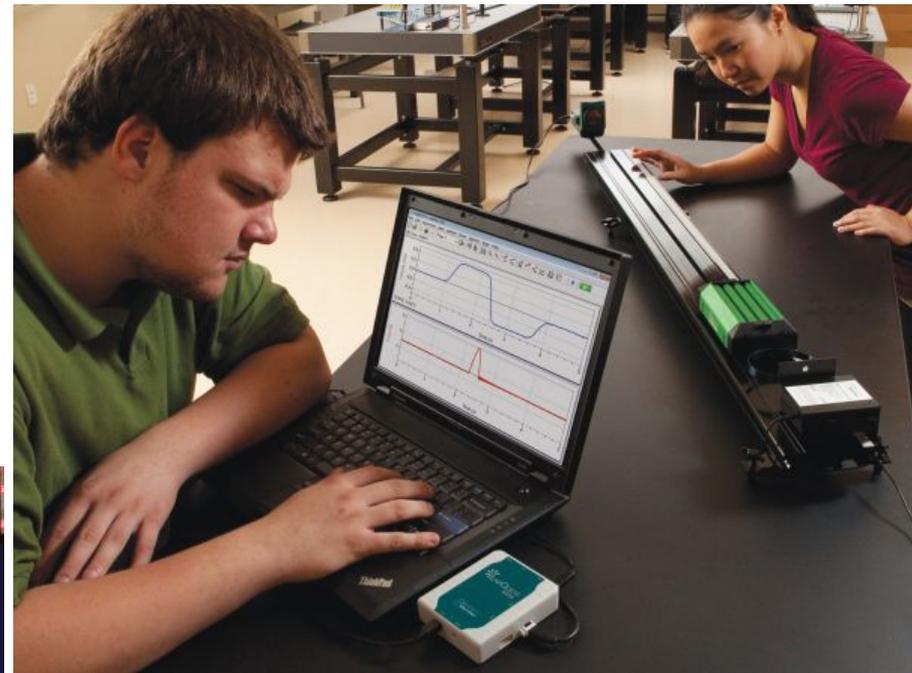
China has witnessed major developments in technology, including manned space flights and lunar probes, manned deep-sea exploration, super computers and quantum computing.

China today is the 2<sup>nd</sup> most innovative country in the world

% mentioned in top three

United States	46
China	34
Germany	22
United Kingdom	17
India	14
Japan	14

# Teachers in China and Canada Use Technology



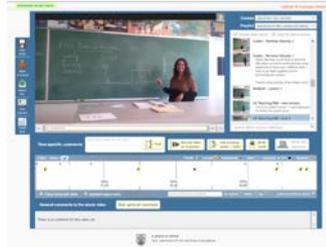
# Deliberate Pedagogical Thinking with Technology

Do we know how to use technology  
to **IMPROVE STEM LEARNING?**



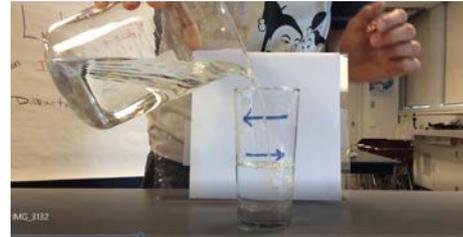
# Examples: UBC STEM Teacher Education

1) Peer Instruction and PeerWise



2) CLAS

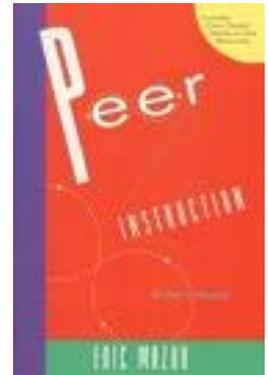
3) Videos of Experiments



4) Live data collection and analysis



5) Computer Modeling and simulations

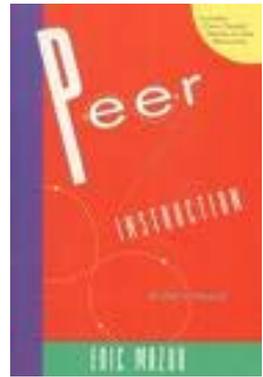


1

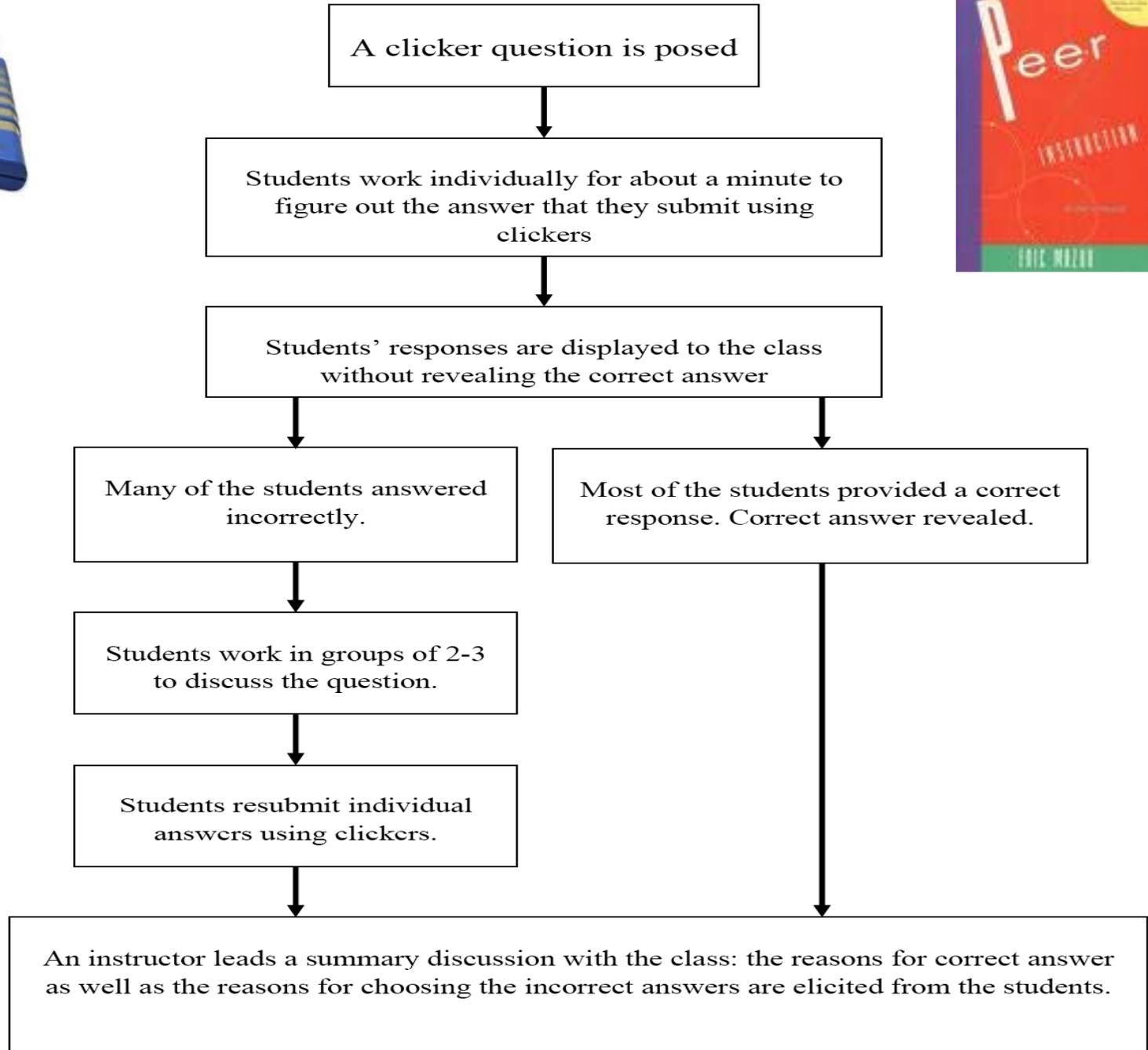
# Peer Instruction & PeerWise

Electronic response systems (clickers) in K-12 classrooms...





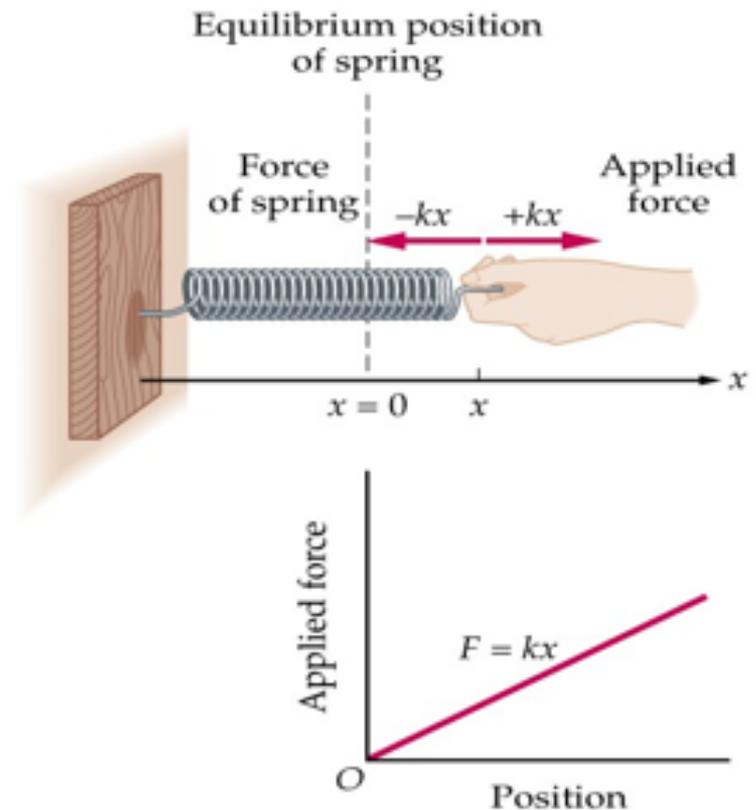
# Peer Instruction



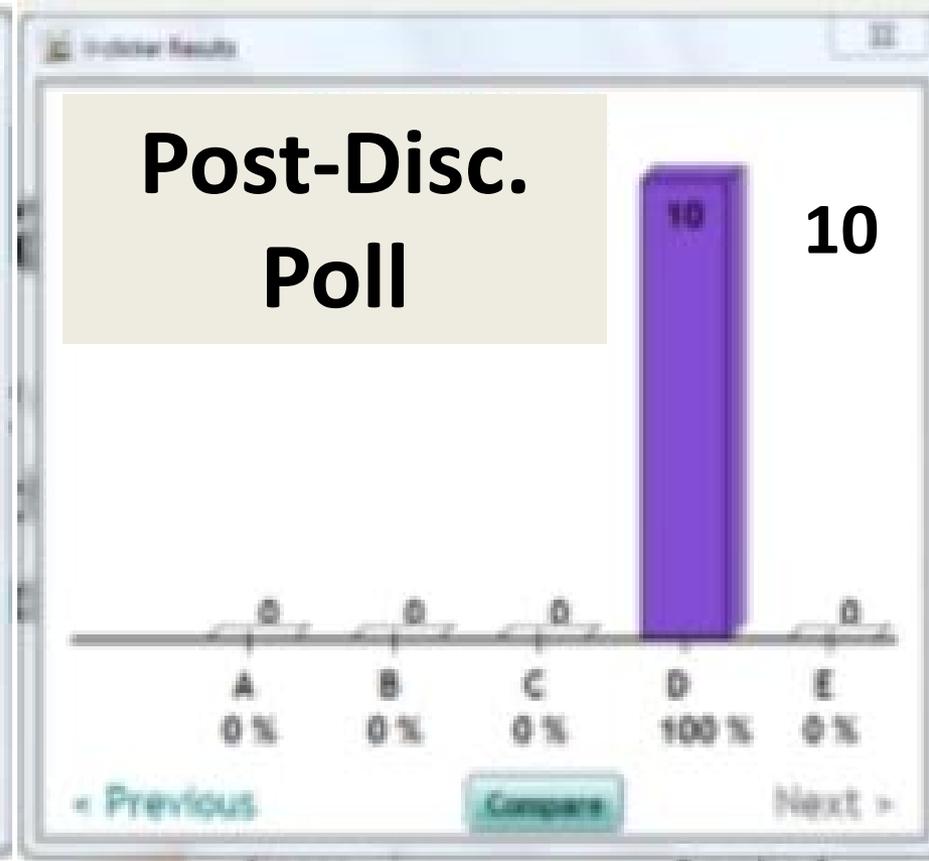
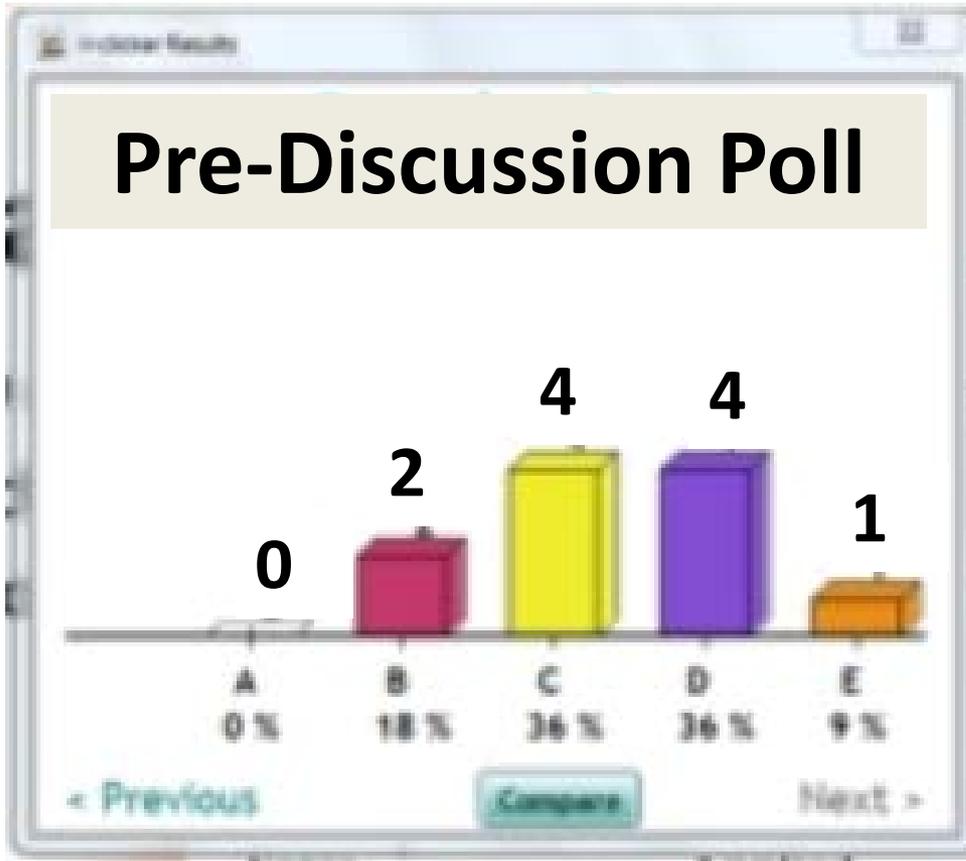
# Example: Hook's law

The work needed to stretch a spring **10 cm** from equilibrium (from  $x_1 = 0$  m to  $x_2 = 0.1$  m) is **10 J**. How much work needs to be done to stretch the spring additional **10 cm** (from  $x_2 = 0.1$  m to  $x_3 = 0.2$  m) ?

- A. 5 J
- B. 10 J
- C. 20 J
- D. 30 J
- E. 40 J



# Example: Results



**Respondents:** Physics Teacher-Candidates

# PeerWise

PeerWise

Ask | Share | Learn

## Welcome to PeerWise

To log in, select your school / institution from the list below

Go »

*Just type the first few characters...*

PeerWise supports students in the creation, sharing, evaluation and discussion of assessment questions.



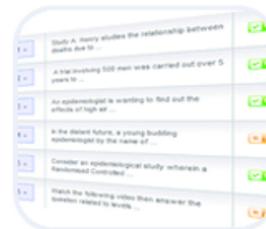
### What is PeerWise?

Students use PeerWise to create and to explain their understanding of course related assessment questions, and to answer and discuss questions created by their peers.



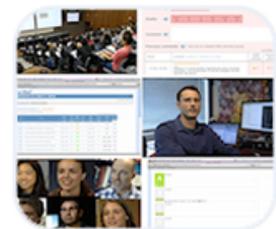
### Any subject

PeerWise is used in a wide range of subjects, including Anthropology, Biology, Chemistry, Computer Science, Physics, Population Health, Pharmacology, Medicine, and many more...



### Free and easy to use

PeerWise is free and very easy to use. Students are presented with a simple, intuitive interface and instructors can easily view student content and monitor participation.



### Find out more

Want to get started? View student and instructor guides, watch screencasts of PeerWise in action, and hear what students and instructors think in the [Information about PeerWise](#) section.

JOIN NOW

Get started!

Follow @peerwise

# PeerWise: Online Collaboration on Multiple-Choice Questions



The University of British Columbia

You are logged in as **marinamb** [Logout](#)

Home

Email: [marina.milner-bolotin@ubc.ca](mailto:marina.milner-bolotin@ubc.ca) [update](#)  
Password for "marinamb": [update](#)

## Welcome home

Welcome to PeerWise. Simply choose one of your courses or you might like to activate the pending course below. If you like, you can also create a new course or join an existing course.

## Pending courses

The following courses are not yet active. To activate a course, simply upload the identifiers that your students will use to access the course by clicking on the "Upload student identifiers to activate this course" link. Each student will be asked to provide their identifier to join the course (either when they register a new account or join the course with their existing account).

### EDCP357\_2017

Course ID  
14628

[➔ Upload student identifiers to activate this course ➔](#)

[Manage access](#) | [Administration](#)

## Your courses

You are currently a member of the following courses. Simply click on the course name to begin.

### EDCP357 (Winter 1, 2013)

Course ID	Identifiers active	Questions	Answers	Comments	Last correct answer
7904	10 / 10	525	2055	1246	11:00pm, 03 Dec

[Manage access](#) | [Administration](#)

### EDCP357\_2014

Course ID	Identifiers active	Questions	Answers	Comments	Last correct answer
9453	12 / 12	303	1476	914	8:35pm, 30 Jul

[Manage access](#) | [Administration](#)

### ChaoyangSTEM\_2015

Course ID	Identifiers active	Questions	Answers	Comments	Last correct answer
11156	1 / 70	1	0	0	---

[Manage access](#) | [Administration](#)

### EDCP357\_2015

Course ID	Identifiers active	Questions	Answers	Comments	Last correct answer
11423	13 / 15	423	2123	1103	10:08am, 14 Feb

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### EDCP357\_2016

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**Mathematics and Science Teaching & Learning through Technology**  
Marina Milner-Bolotin<sup>1</sup>, Heather Fisher<sup>2</sup>, Al...  
<sup>1</sup>Assistant Professor, EDC  
<sup>2</sup>Graduate Student, EDC  
<sup>3</sup>Undergraduate Student, I...

**Background**  
**Centred Pedagogies**  
Engagement (E) in Mathematics & Science Classrooms  
designed to promote conceptual understanding of the subject  
(ways) and hands-on (often) activities which yield  
through discussions with peers and/or computers.  
**Examples of IE/Paw Instruction:** using Electronic Response  
Systems (clickers), Interactive inquiry-  
driven lessons using ISART Boards

**Program @ the Faculty of Education**  
Inquiry in Teacher Education!  
Narrative pedagogies and reflective practices

**For MSTLT Resource**  
Lack of research-proven mathematics and science resources  
classrooms linked to BC K-12 Curriculum  
have little input on textbook choices; supplemental  
helps them incorporate student-centered teaching and  
set them into their classrooms

**The Gap**  
Inquiry in science and mathematics methods courses  
more to apply inquiry in real-world contexts  
or technology options

**The Resource**

- Available online
- Downloadable PPT slides
- Sequences of questions within a topic: from recall to complex knowledge transfer
- Emphasis on concepts
- Topics based on BC IRPs

**The Pilot Project**

- Piloted in the Physics Methods course for B. Ed students

**Developing the Resource**

- Questions developed for K-12 mathematics and science

**Using the Resource**

- Created a user-friendly Database for lesson and

**Feedback from teacher-educators (r...)**  
"I have found the conceptual clicker questions from (the file probably the most useful and illuminating part of my class provides an environment in which the class feels comfortable investigating and exposing their prior knowledge about physics."  
—Adam  
"These sets of conceptual questions are clickers in very engaging intellectually stimulating. The clicker creates a safe learning where students do not have to fear about an incorrect answer"

**TLEF Showcase Presentation**  
Our team had an opportunity to present our TLEF project to the larger UBC community during the 2012 TLEF Showcase that took

Read More

2 / 10

**MATH & SCIENCE TEACHING & LEARNING THROUGH TECHNOLOGY**



# 2

# CLAS

Instructions for this course

upload & manage videos

save video

share & embed

import URL

back channel

usage data

0:00/4:01

Course: EDCP357 301 2015W

Playlist: everyone in this course (42 items)

Autoplay entire playlist

Loop this video or playlist

Caitlin - Terminal Velocity 2

Caitlin - Terminal Velocity 1

Better late than never! Due to technical difficulties we had to switch phones at the beginning so there are 2 different parts. I tried to put them together but I'm technologically useless.

There's some overlap in the videos sorry!

Nadereh - Lesson 1

Irit Teaching FBD - new version

This is an edited version - I have attempted to correct the quality issue.

Irit Teaching FBD - part 2

search videos across collections

Video will pause as you type.

Post

Record video as response

Use existing audio / video

Book mark

Hide my identity

Filter: mine / all

Private

Unread

Anonymous

Mine

Instructor or TA's

Student's

25% 01:00

50% 02:00

75% 03:00

Follow along with video

Highlight tagged posts

search comments & annotations

by content

author

tag

hover on words to search

General comments to the whole video

Add general comment

There is no comment for this video yet.

UBC a place of mind THE UNIVERSITY OF BRITISH COLUMBIA

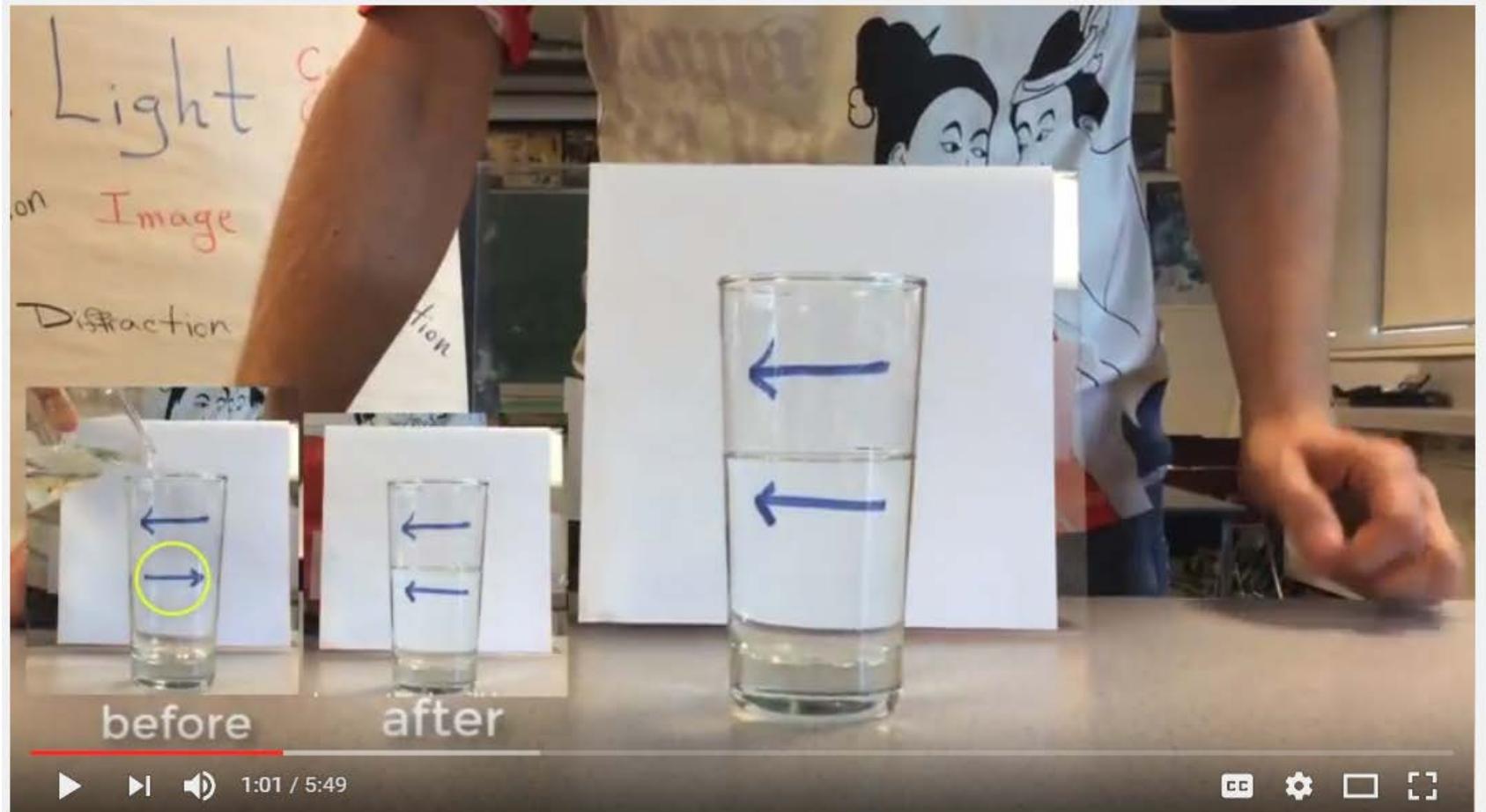
- Upload & manage videos
- Annotate them
- Collaborate
- Share
- Learn from each other
- Improve

# 3

# Collection of Videos of STEM Experiments

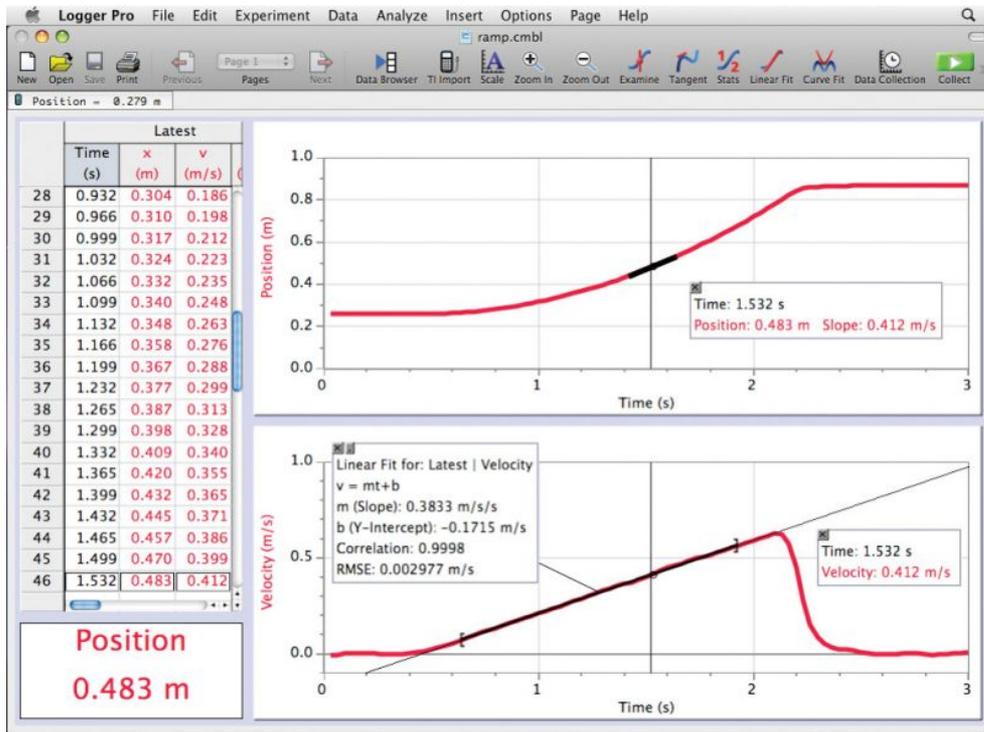
The screenshot shows a YouTube channel page. At the top left is the YouTube logo with 'CA' next to it. A search bar is located to the right of the logo. Below the search bar, the channel name 'Science & Math Education Videos for All' is displayed, along with '14 subscribers', '464 views', and a 'Video Manager' icon. A large banner image shows a mountain valley with a rainbow. Below the banner, there is a 'Subscribe' button with '14' subscribers. A description below the banner reads: 'This channel is created to support future and practicing mathematics, science and technology educators who want to have more engaging les... Show more'. Under the 'Uploads Public' section, there are four video thumbnails: 1. A woman in a classroom with a whiteboard that says 'Electro...'. 2. A man in a white lab coat in a classroom. 3. A person pouring water into a glass jar with a green text box overlay. 4. A diagram titled 'Law of Refraction (Snell's Law)' showing a light ray passing from air to water, with labels for 'Normal', 'Refracted Rays', and the equation  $\sin \theta_1 = \frac{v_1}{c} = \frac{\lambda_1}{\lambda_2} = \frac{n_2}{n_1} \sin \theta_2$ .

# Reversing Arrows Experiment



# 4

# Data Collection and Analysis



# 5

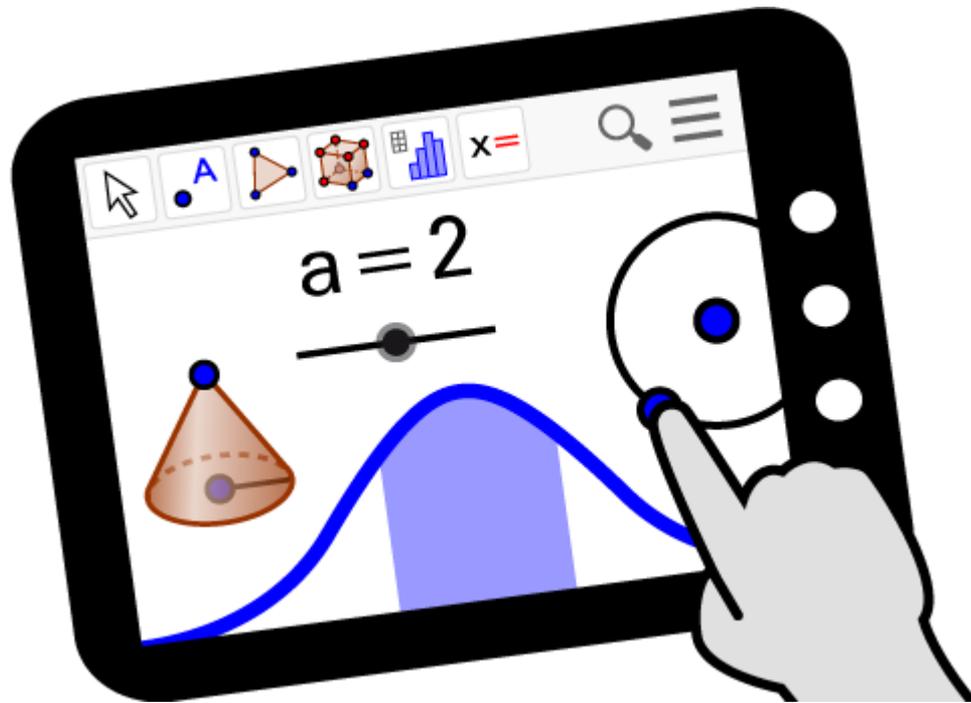
# Computer Simulations



<https://phet.colorado.edu/>

# 5

# Computer Simulations



<https://www.geogebra.org/>

# Conclusions

- We need to learn **HOW** to use technology for learning
- It takes time and lots of practice
- Mistakes are inevitable along the way
- Collaboration and mentorship are the key





# Dr. Marina Milner-Bolotin

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- Blog: <http://blogs.ubc.ca/mmilner/>
- Phone: 1-604-822-4234

