An Examination of Research-Based Innovations in Physics Teacher Education at UBC

Dr. Marina Milner-Bolotin

Budapest, Hungary, September 25th, 2017

Thank you for the invitation!

ICOMP 14th INTERNATIONAL CONFERENCE ON MULTIPHOTON PROCESSES
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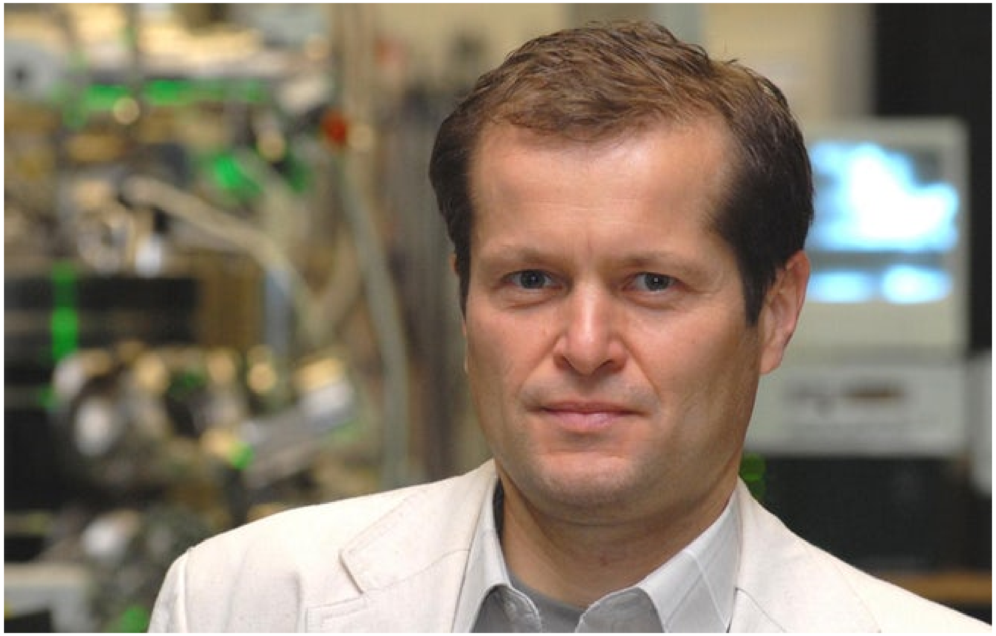


Ferenc Krausz
generated and measured the first attosecondlight pulse and used it for capturing electrons’ motion inside atoms, marking the birth of attophysics.[1]

Graduate or Eotvos Lorand University

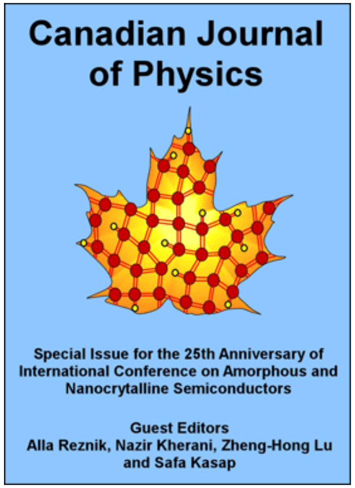
Atto = 10^{-18} s

Dr. Marina Milner-Bolotin

- **Associate Professor** in Science Education at the Department of Curriculum and Pedagogy, Faculty of Education, University of British Columbia, Vancouver, Canada
- **Teacher:** Taught secondary and post-secondary physics and math in Canada, US, and Israel
- **Researcher:** Physics education researcher, Associate Editor of the Canadian Journal of Physics
- **Info:** marina.milner-bolotin@ubc.ca
  http://blogs.ubc.ca/mmilner/

Part 1: Physics Education Research in Canada

Physics Education Research Publications



Canadian Journal of Physics (Physics Education Section)
Physics in Canada
Canadian Journal of Science, Mathematics and Technology Education

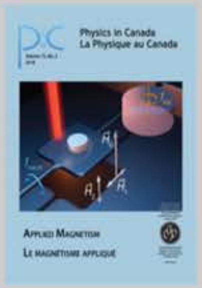
PiC Archives (1955 - 2017)

Vol 73, No. 2a, 2017

Vol 72, No. 4, 2016


Vol 72, No. 3, 2016

Vol 72, No. 2a, 2016



Vol 72, No. 2, 2016

Vol 72, No. 1, 2016

Physics Education Research (PER) Groups

Departments of Physics and Astronomy – Undergraduate and Graduate Focus

Faculties of Education – K-12 and Teacher Education

PER Centers in Canada: UBC, Simon Fraser University, University of Calgary, University of Alberta, University of Toronto (OISE), Queens University, Concordia University in Montreal…

Part 2: Physics Teacher Education @ UBC

UBC Physics Teacher Education

- **Canada:** K-7 elementary; 8 -12 - secondary
- **British Columbia:**
  - Bachelor of Education: B.Sc. + 1 year Teacher Ed.

    60 credits of courses – 10% didactics courses
  - Small classes – 10 – 25 people
  - Teacher-Candidates from all over the world
  - 12 week school practicum
  - Variable teaching and educational experience
  - Most of the them want to teach in Canada

Physics Teacher Education

Promoting Research-Based Physics Teacher Education in Canada: Building Bridges between Theory and Practice

by Marina Milner-Bolotin

More than 25 years ago, Lee S. Shulman, then president of the American Educational Research Association [1], challenged us to re-think how we prepare teachers through focussing on *Pedagogical Content Knowledge* (PCK) - the knowledge of content and content-specific pedagogies. Shulman pointed out that in their attempt to incorporate generic educational research, many Teacher Education Programs suffered from the "missing paradigm" problem. They neglected the nature of the subject-matter that teacher-candidates were preparing to teach.

Teacher Education Programs have since tightened their entrance requirements. For example, to enter the Physics Teacher Education Program at the University of British Columbia (UBC), applicants must have a B.Sc. with a GPA of 65% or higher. At first glance, this should address the "missing" physics content knowledge problem and justify the reduced emphasis on the physics methods courses (courses dedicated to developing teacher-candi-
... PCK). At UBC, out of the 60 credits of the

content-specific professional development, teacher education programs should emphasize the development of teacher-candidates' PCK.

Lastly, there is a significant gap between the findings of Physics Education Research (PER) [4] and current physics teaching practices. In the words of physics Nobel Laureate, Prof. Carl Wieman:

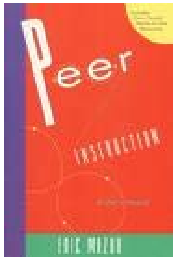
> At the K-12 level, although there are notable exceptions, the typical teacher starts out with a very weak idea of what it means to think like a scientist or engineer. *Very few K-12 teachers, including many who were STEM majors, acquire sufficient domain expertise in their preparation*. Hence, the typical teacher begins with very little capability to properly design the requisite learning tasks. Furthermore ...
> *content mastery, combined wi...*
> *content knowledge...*
> *evaluating ...*
> (Ital...

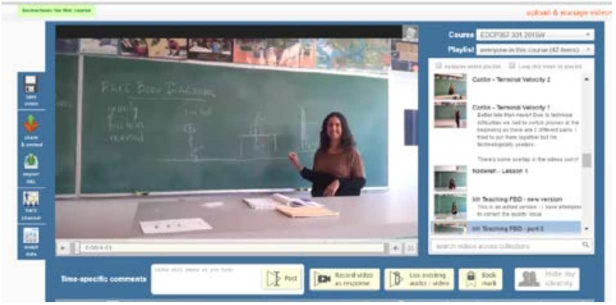
Research-Based Innovations

Innovations that according to research evidence promote physics learning inside and outside of the classroom both in K-12 and university settings.

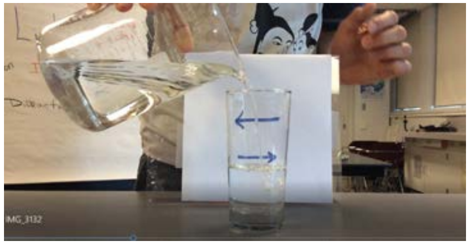
Examples

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…

1a Peer Instruction in Teacher Education

LUMAT 1(5), 2013 [LUMAT: Research and Practice in Math, Science & Technology Education, 2013. **1**(5): p. 525-544.]

Modeling Active Engagement Pedagogy through Classroom Response Systems in a Physics Teacher Education Course

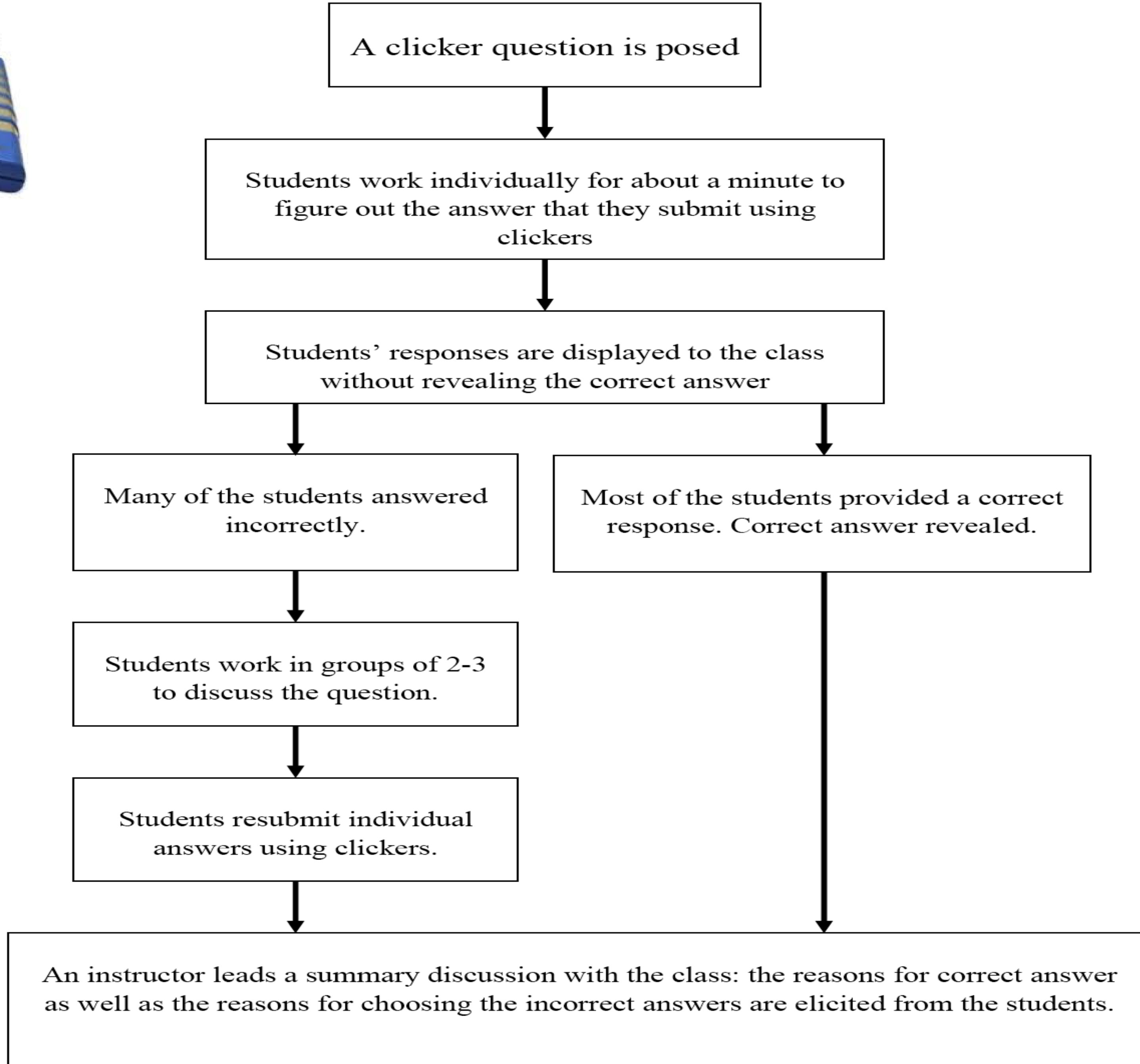
Marina Milner-Bolotin
Department of Curriculum and Pedagogy, Faculty of Education, The University of British Columbia • marina.milner-bolotin@ubc.ca

Heather Fisher
Department of Curriculum and Pedagogy, Faculty of Education, The University of British Columbia

Alexandra MacDonald
Department of Curriculum and Pedagogy, Faculty of Education, The University of British Columbia

Abstract One of the most commonly explored technologies in Science, Tech
and Mathematics (STEM) education is Classroom Respo
instructors generate in-class discussion by solici

Peer Instruction



Example 1: 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) ?

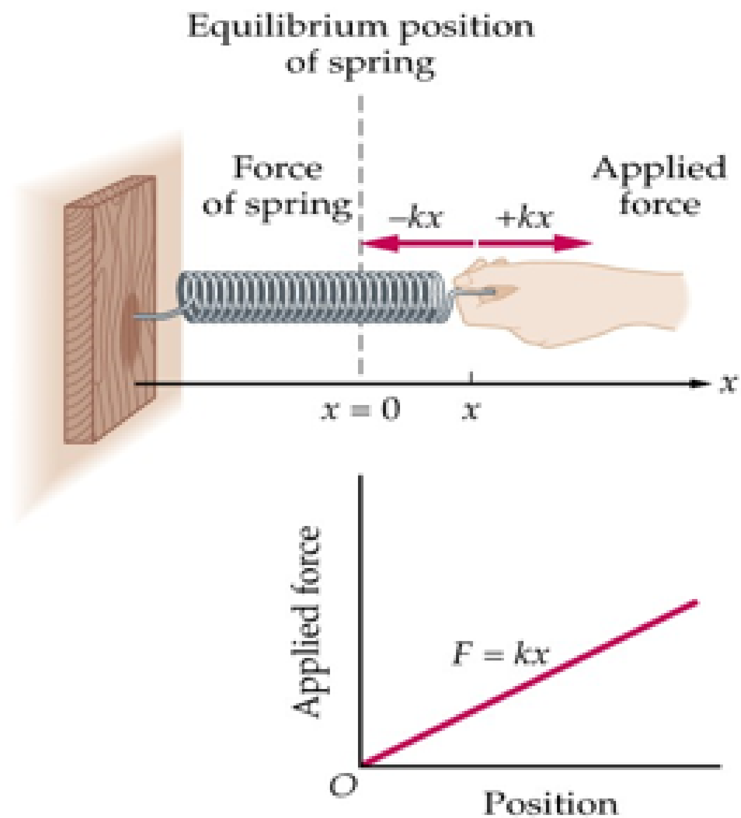
A. 5 J

B. 10 J

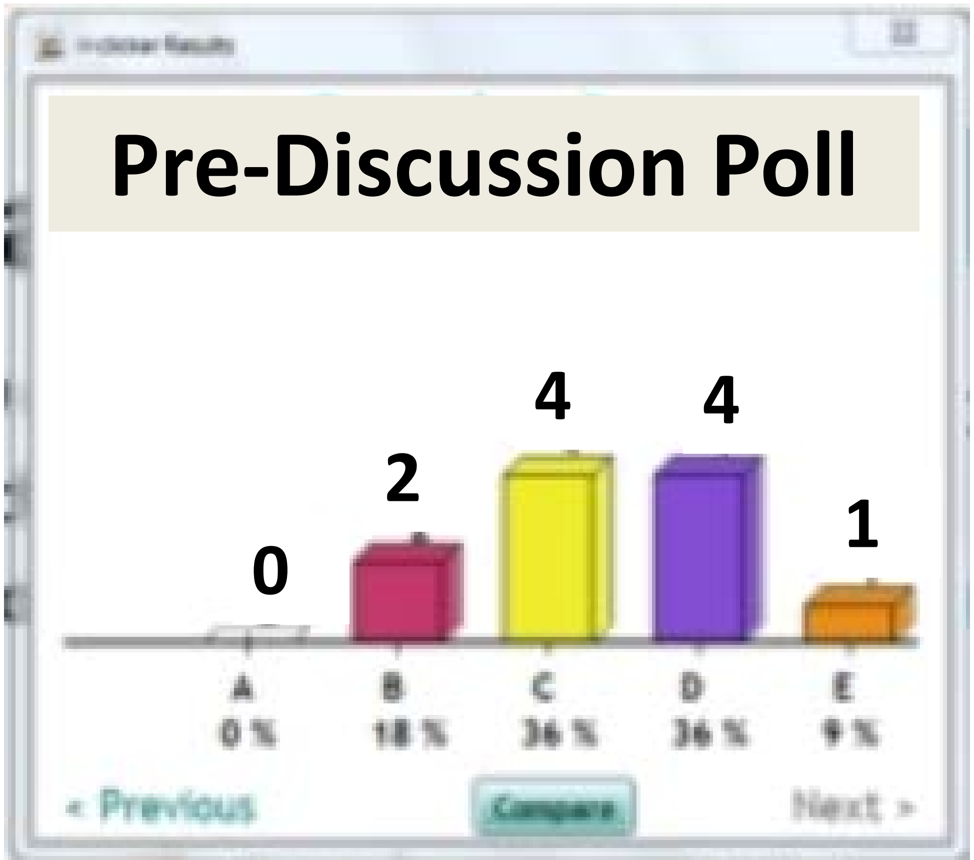
C. 20 J

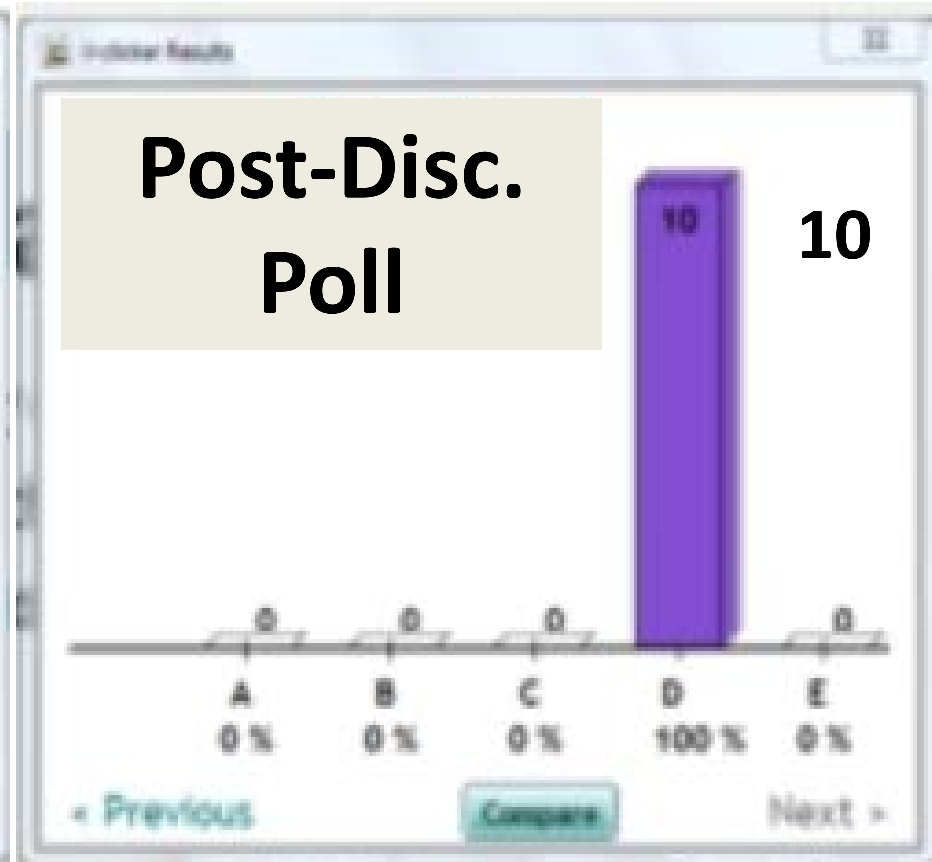
D. 30 J

E. 40 J



Example 1: Results





Respondents: Physics Teacher-Candidates

1b PeerWise

PeerWise

Ask | Share | Learn

JOIN NOW

Get started!

Follow @peerwise

Welcome to PeerWise

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

Go »

Just type the first few characters...

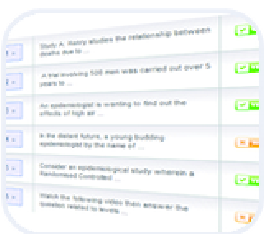
PeerWise supports students in the creation, sharing, evaluation and discussion of assessment questions.

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.

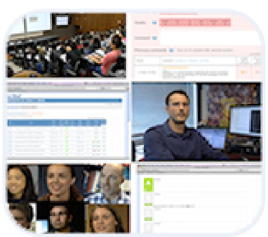
Any subject

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

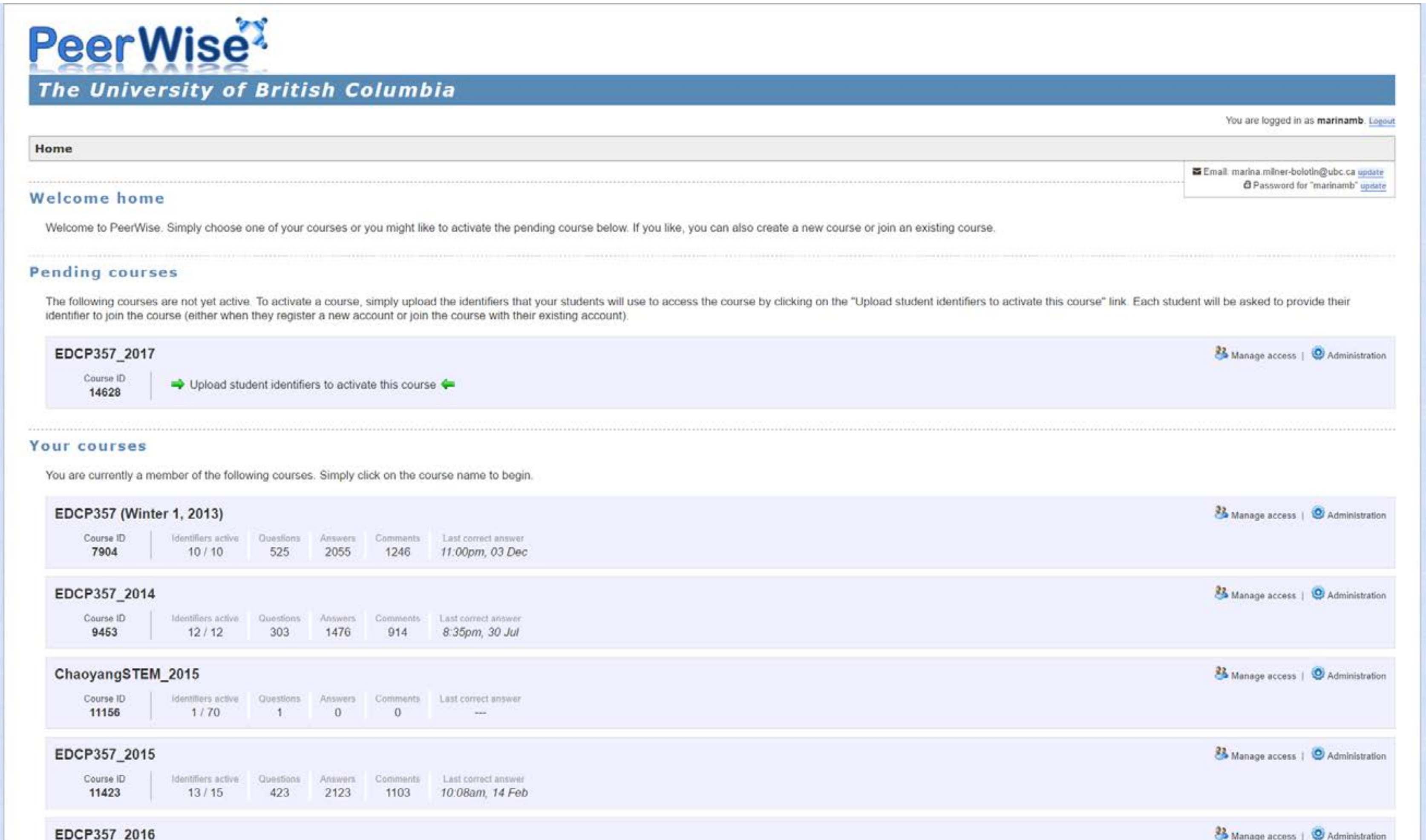
PeerWise is free and very easy to use. Students are presented with a simple, intuitive interface and instructors can easily view student content and monitor participation.



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.

PeerWise: Online Collaboration on Multiple-Choice Questions



Designing, Answering, Commenting, Reflecting & Improving

PeerWise

EDCP357_2014

You are logg

Home | Main menu > Unanswered questions > Rate question

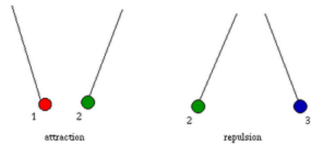
... DO NOT AGREE WITH AUTHOR

... Your answer does not agree with the answer suggested by the author, but more responses are needed

Question:

This question has been answered by 3 people and has an average rating of 4.00 (based on 1 rating)

Each of the three balls shown have been given either a positive charge, a negative charge or no charge. By looking at the diagram below we can conclude that...



Alternatives

You selected A when answering this questic
The contributor suggests E is the correct opti

OPTION	ALTERNATIVE	FIRST ANSWERS	CONFIR ANSWE
A	...balls 1 and 3 carry charges of opposite sign.	3 (100.00%)	0
B	...balls 1 and 3 carry charges of the same sign.	0 (0.00%)	0
C	...balls 2 and 3 carry negative charges and ball 1 carries a positive charge.	0 (0.00%)	0
D	...balls 2 and 3 carry negative charges and ball 1 carries no charge.	0 (0.00%)	0
E	None of the above.	0 (0.00%)	0

After looking at the information on this page, *do you believe your answer is correct?*

Yes - my answer is correct confirm answer ✓

No - let me change my answer change answer ↔

Or, you may answer this question again later

Effect of Peer Instruction on Teacher-Candidates’ Content Knowledge

Modeling Active Engagement Pedagogy through Classroom Response Systems in a Physics Teacher Education Course

Marina Milner-Bolotin
Department of Curriculum and Pedagogy, Faculty of Education, The University of British Columbia •
marina.milner-bolotin@ubc.ca

Heather Fisher
Department of Curriculum and Pedagogy,

Alexandra MacDonald
Department of Curriculum and Pedagogy,

Peer-reviewed research article. Submitted

EDUCATION CORNER

SPACE ÉDUC

USING PEERWISE TO PROMOTE STUDENT COLLABORATION ON DESIGN OF CONCEPTUAL MULTIPLE-CHOICE PHYSICS QUESTIONS

BY MARINA MILNER-BOLOTIN*
DEPARTMENT OF CURRICULUM AND PEDAGOGY
UNIVERSITY OF BRITISH COLUMBIA

Every physics instructor who ever used clicker-enhanced pedagogy knows that coming up with pedagogically effective conceptual questions is challenging. These questions are often provided by the undergraduate textbook authors [1], but are not yet as common in K-12 physics textbooks. For the past three years

contributed to PeerWise database has the fields displayed in Table 1.

In addition, PeerWise

Effect of PeerWise on Teacher-Candidates' Content Knowledge

PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH **12,** 020128 (2016)

Investigating the effect of question-driven pedagogy on the development of physics teacher candidates' pedagogical content knowledge

Marina Milner-Bolotin, Davor Egersdorfer, and Murugan Vinayagam

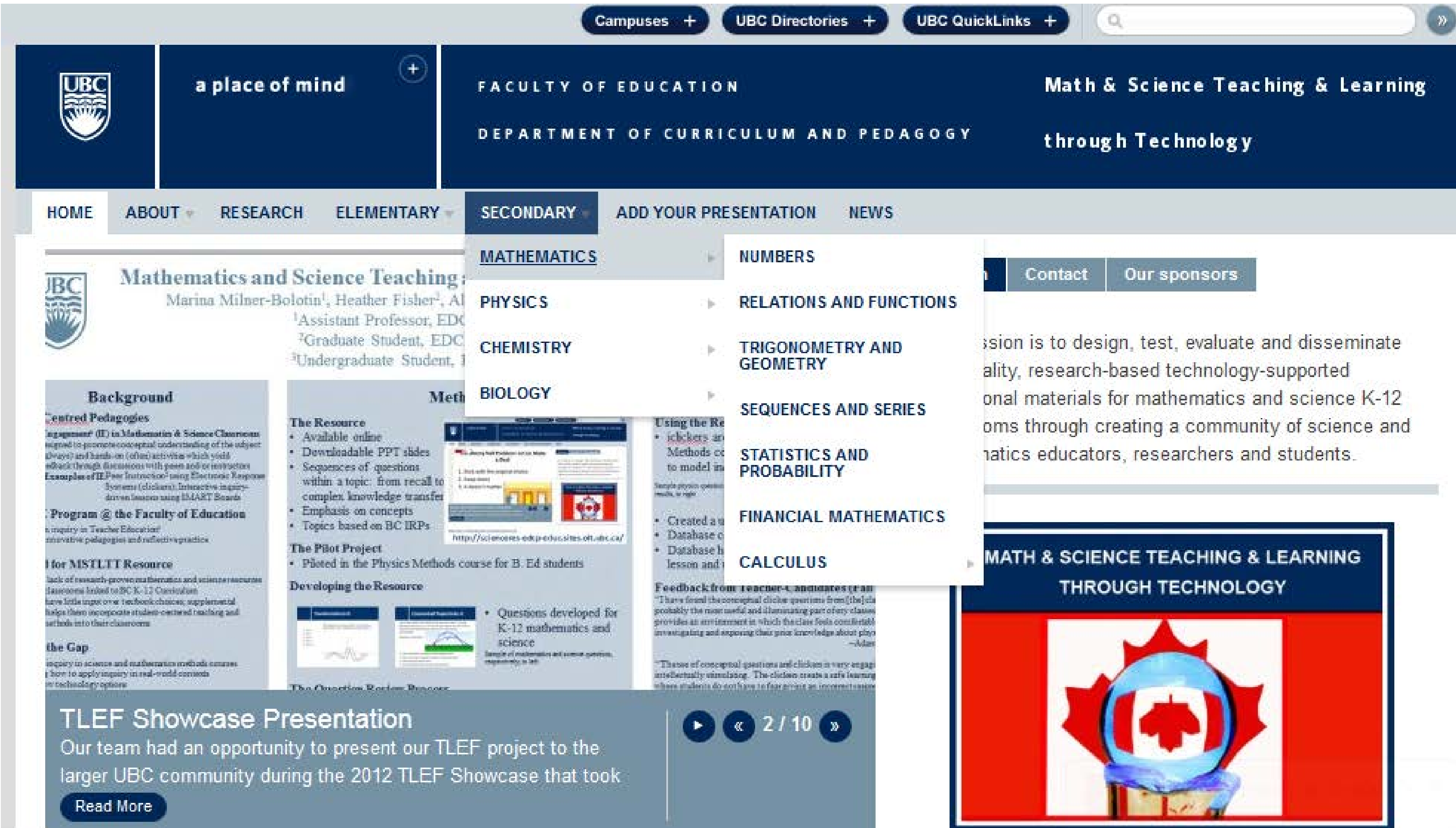
Department of Curriculum and Pedagogy, Faculty of Education, The University of British Columbia, 2329 West Mall, Vancouver, British Columbia V6T 1Z4, Canada

(Received 29 April 2016; published 7 September 2016)

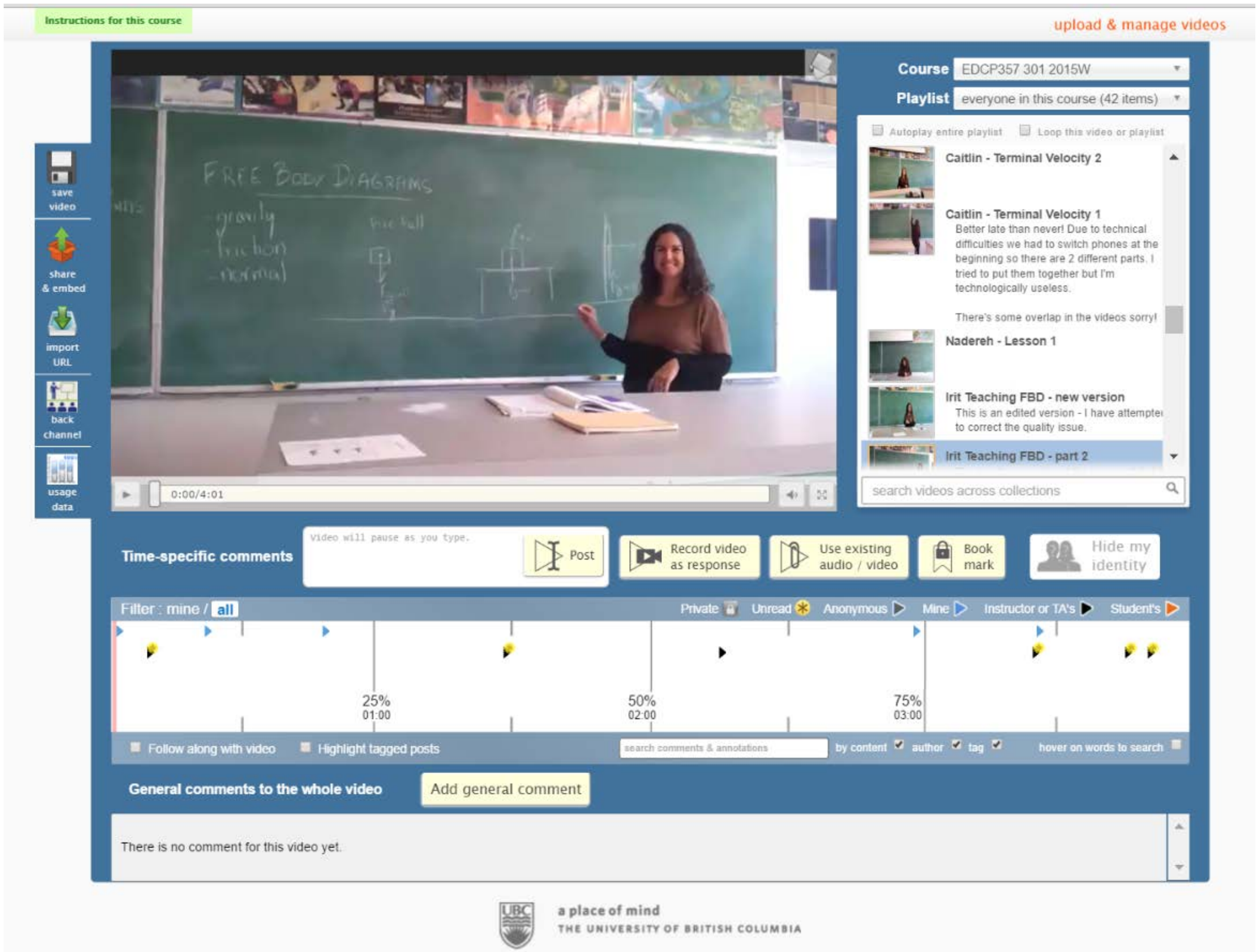
This paper describes the second year of a multi-year study on the implementation of Peer Instruction and PeerWise-inspired pedagogies in a physics methods course in a teacher education program at a large research university in Western Canada. In the first year of this study, Peer Instruction was implemented consistently in the physics methods course and teacher candidates were asked to submit five conceptual multiple-choice questions as a final assignment. In the second year of the study we incorporated PeerWise online tool to facilitate teacher candidates' design of conceptual questions by allowing them to provide and receive feedback from their peers, and consequently improve their questions. We have found that as a result of this collaboration teacher candidates improved their pedagogical content knowledge as measu
rubric developed for the study.

DOI: 10.1103/PhysRevPhysEducRes.12.020128

Math & Science Teaching and Learning through Technology

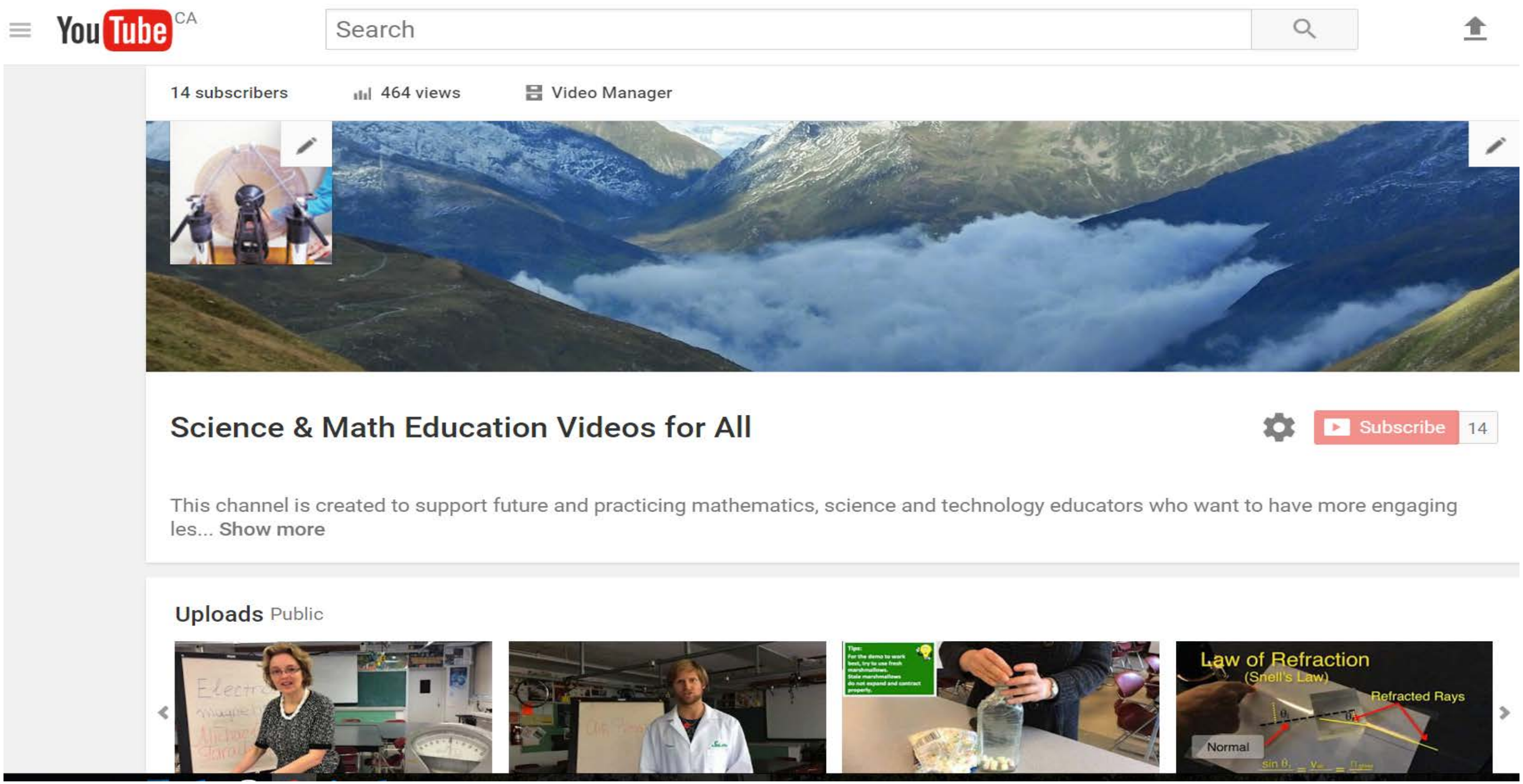


2 CLAS



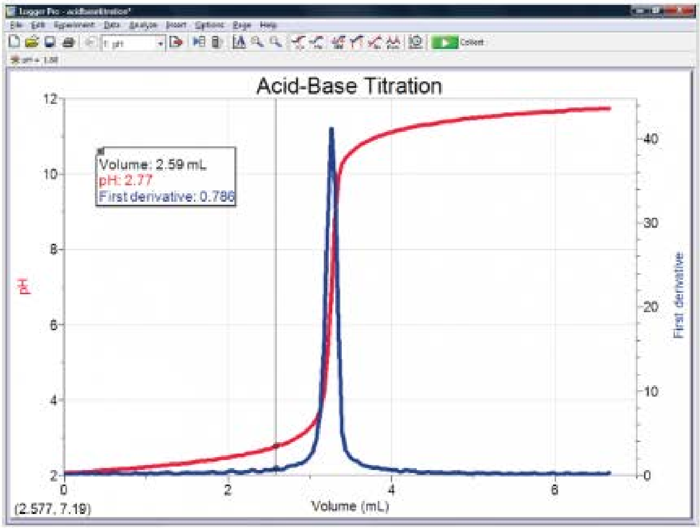
- Upload & manage videos
- Annotate them
- Collaborate
- Share
- Learn from each other
- Improve

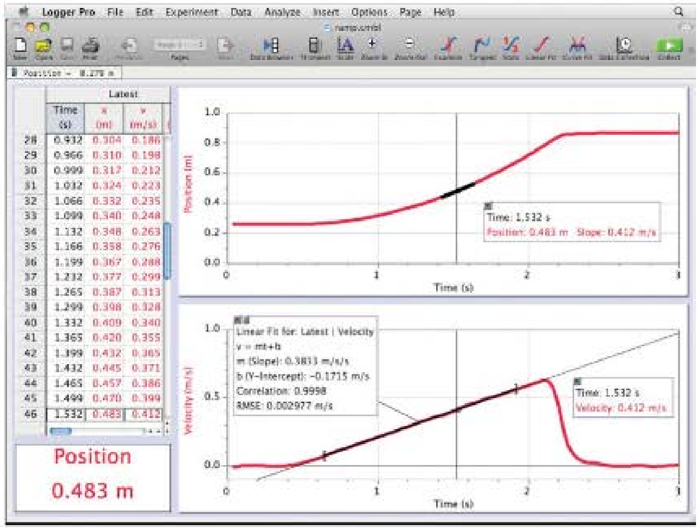
3 Collection of Video STEM Experiments



4 Live Data Collection & Analysis

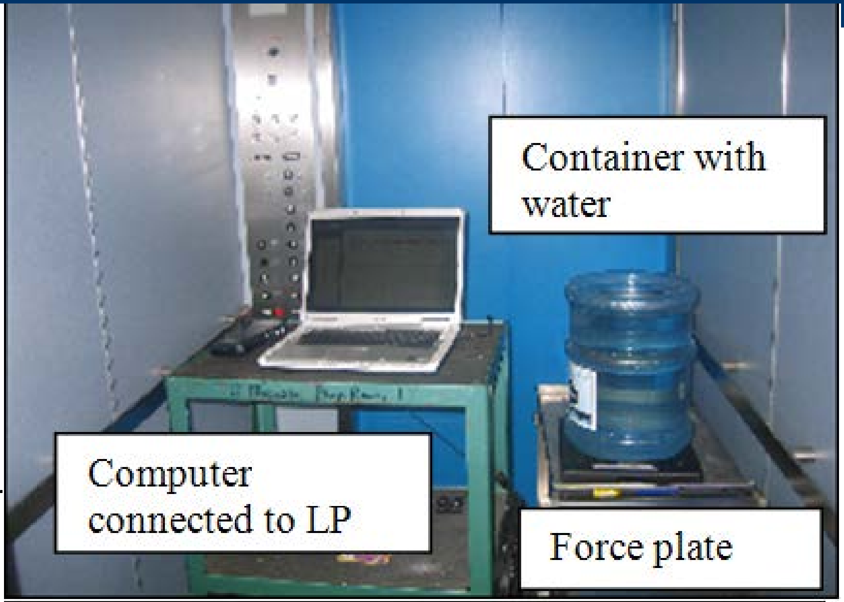
Thinking like a scientist means being able to analyze real life situations using real life data.

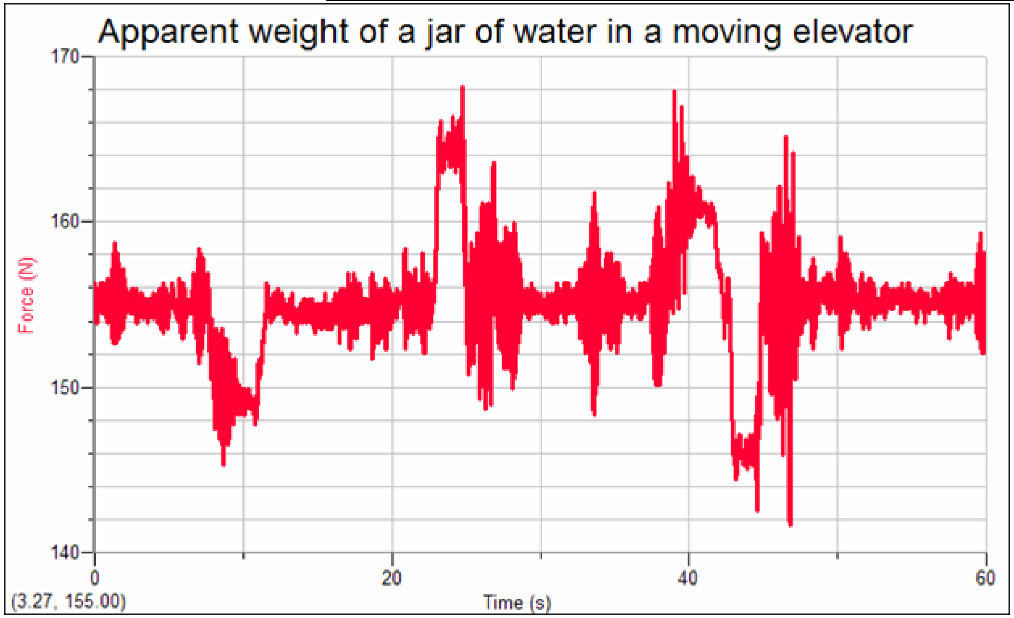




Logger Pro Example

Thinking like a scientist means being able to analyze real life situation using real data.





A water jar was placed on a force plate inside a moving elevator: weight and apparent weight problem

Live Data Collection & Analysis

2007, Journal of College Science Teaching, 36(4), 45-49.

Can Students Learn from Lecture Demonstrations? The Role and Place of Interactive Lecture Experiments in Large Introductory Science Courses

By Marina Milner-Bolotin, Andrzej

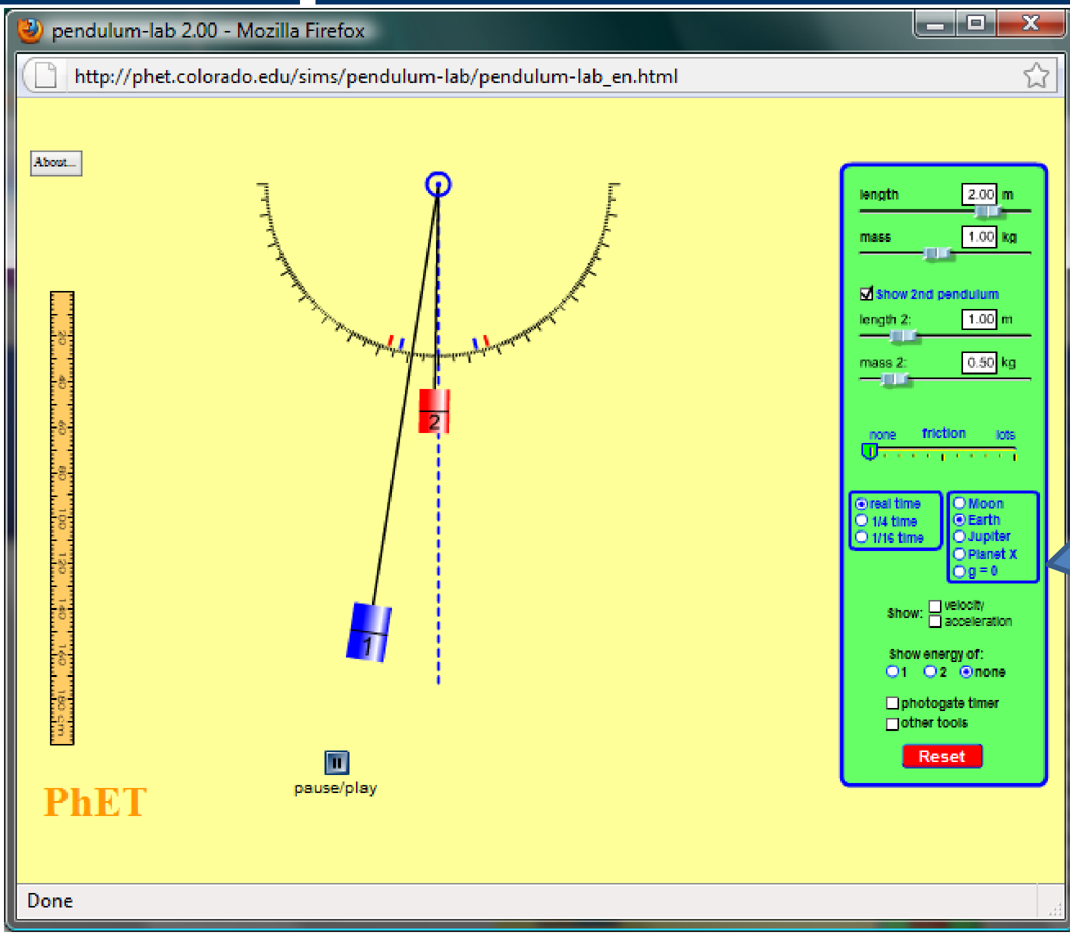
2008, The Physics Teacher, 46(8), 494-500.

Physics Exam Problems Reconsidered: ***Using Logger Pro to Evaluate Student Understanding of Physics***

Marina Milner-Bolotin, Ryerson University, Toronto, ON

Rachel Moll, The University of British Columbia, Vancouver, BC

5 Simulations & Modeling



$$T = 2\pi\sqrt{\frac{l}{g}}$$

We can place the pendulum on Moon, Earth, Jupiter or even Planet X…

Part 3: PER – Examining Innovations

Many pedagogical innovations in physics courses remain unexamined and often unshared. We keep reinventing the wheel and rarely learn from each other. **More research is needed in our countries and internationally.**

PER can help bridge what we know about learning to how we teach physics both in K-12 and at university.

Conclusions

Eötvös Loránd University