Three Examples of Promoting Technology-Enhanced Collaboration in STEM Teacher Education:

From theory to research-informed Practice

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Ottawa
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St. John's
Great Lakes
Nova Scotia
800 mi
Fredericton
Charlottetown
Montreal
800 km
Halifax
Toronto
Pacific Ocean
United States of America
Atlantic Ocean

Does technology presence guarantee improved student learning?

Are We on the Same Page?

Educational technology **should not be used just because it is there**. It should be used because …

1. It helps students engage with STEM fields
2. It helps address challenges we couldn't address before
3. It saves time, money, and other resources
4. It prepares students to become 21st century citizens
5. All of the above

Educational Technologies (ET) in STEM Teacher Education

- **Why** should we use ET?
- **How** can we use ET?
- **What new opportunities** does ET open?
- **Why** would STEM teachers adopt new ETs?
- **How** do we support them in this process?
- **How will ETs** encourage new pedagogies?

Philosophical Premises

- We can’t predict what is coming, but we can prepare teachers for it.
- Teachers should experience the pedagogical benefits of new technologies.
- Teacher education should be informed by both practice and research
- **DELIBERATE PEDAGOGICAL THINKING with TECHNOLOGY** should begin in teacher education.

PROMOTING RESEARCH-BASED PHYSICS TEACHER EDUCATION IN CANADA: BUILDING BRIDGES BETWEEN THEORY AND PRACTICE

BY MARINA MILNER-BOLOTIN

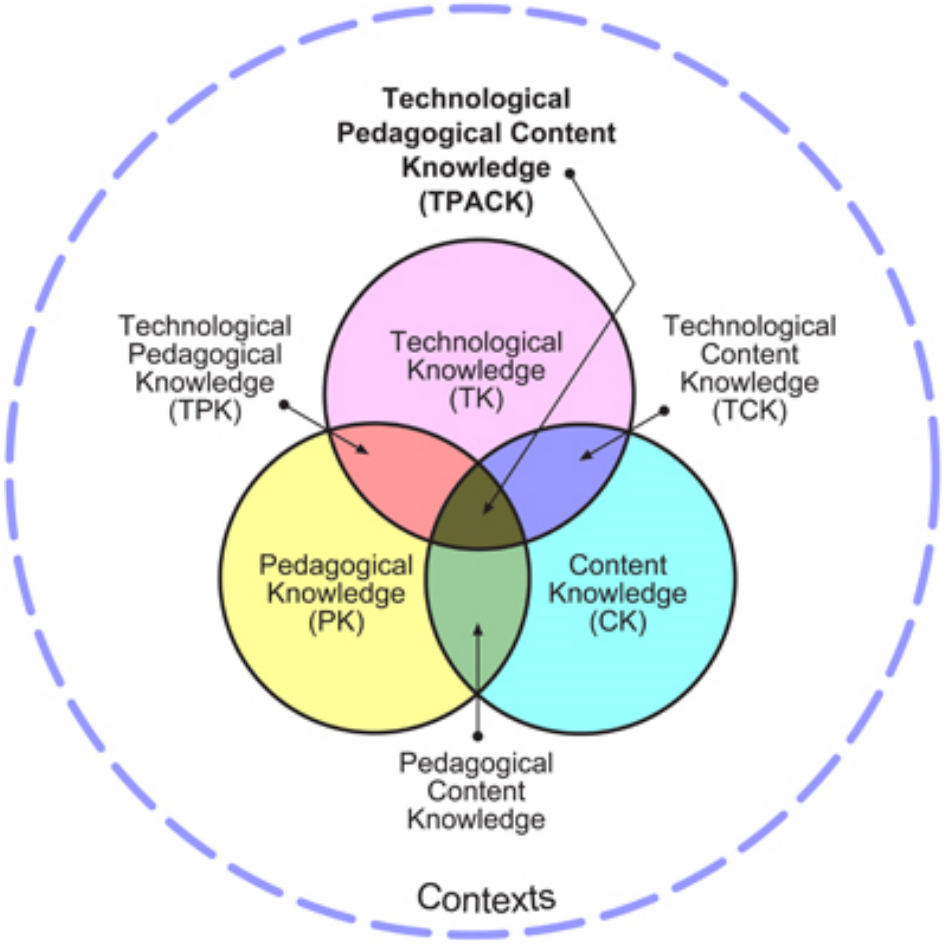
More than 25 years ago, Lee S. Shulman, then president of the American Educational Research Association [1], challenged us to re-think how we prepare teachers through focussing on *Pedagogical Content Knowledge* (PCK) - the knowledge of content and content-specific pedagogies. Shulman pointed out that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

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 the Laureate, Prof. Carl Wieman

[M. Milner-Bolotin, "Promoting research-based physics teacher education in Canada: Building bridges between theory and practice", *Physics in Canada*, **70**, 99-101 (2014).]

Theoretical Framework



Teachers should experience learning STEM with technology as learners and as future teachers.

[Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education,* **9** (1), 60-70.]

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

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Heather Fisher
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Alexandra MacDonald
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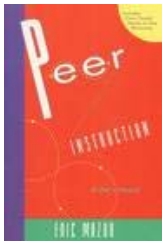
Abstract One of the most commonly explored technologies in Science, Technology, Engineering, and Mathematics (STEM) education is Classroom Response Systems (clickers). Clickers help instructors generate in-class discussion by soliciting student responses to multiple-choice conceptual questions and sharing the distribution of these responses with the class. The potential benefits of clicker-enhanced pedagogy include: increased student engagement, reduced anxiety, continuous formative assessment, and enhanced conceptual understanding. Most studies, however, [illegible] the effects of clicker-enhanced instruction in large undergraduate STE[illegible] pedagogy on learning in small secondary or post-second[illegible] [illegible]ntext of this study is a secondary phys[illegible]

[M. Milner-Bolotin, H. Fisher, & A. MacDonald, "Modeling active engagement pedagogy through classroom response systems in a physics teacher education course", LUMAT: *Research and Practice in Math, Science and Technology Education*, 1, 523-542 (2013).]

Promoting Deliberate Pedagogical Thinking with Technology in STEM Teacher Education



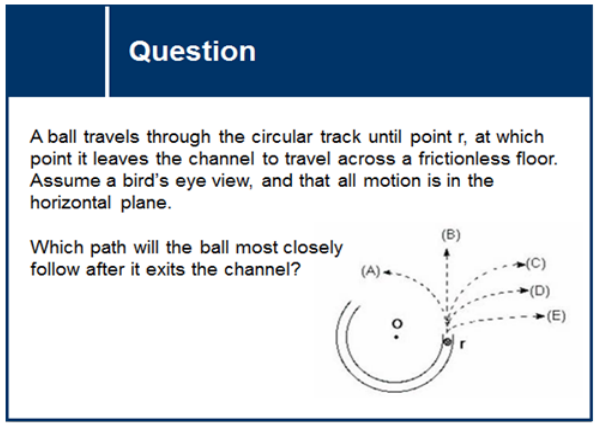
1. Peer collaboration **(Peer Instruction & PeerWise)**

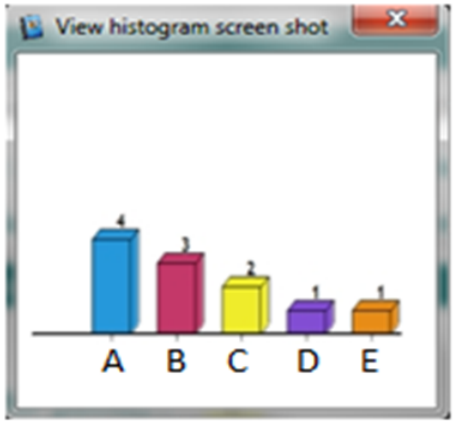
2. Live Data Collection and Analysis **(Logger Pro)**

3. Computer Simulations **(PhET)**

4. Collaborative Learning Annotation Systems **(CLAS)**

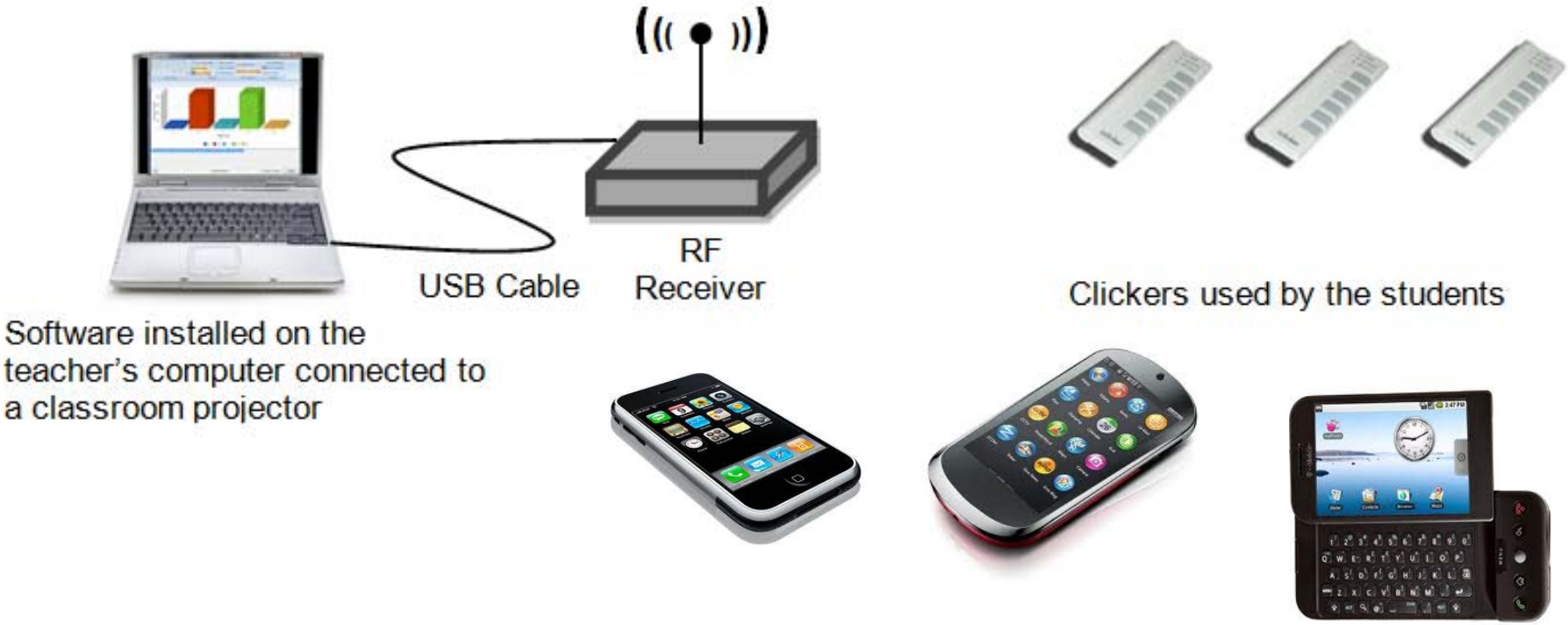
1. Technology-Supported Peer Collaboration





Peer Instruction and PeerWise integration

Technology is There – Pedagogy is Often Missing



In near future smart phones, i-pads and other devices will replace clickers, **but the basic pedagogy will remain the same**…

PeerWise – Freely Available

PeerWise

EDCP357 (Winter 1, 2013)

Home | Main menu > Comments written by you

Comments written by you

Comments written by you, about questions you have answered, are shown below.

Select an order:

New replies Most recent first Show agreements only Show disagreements only

Showing new replies only

No comments to view

Return to main menu

What is PeerWise?

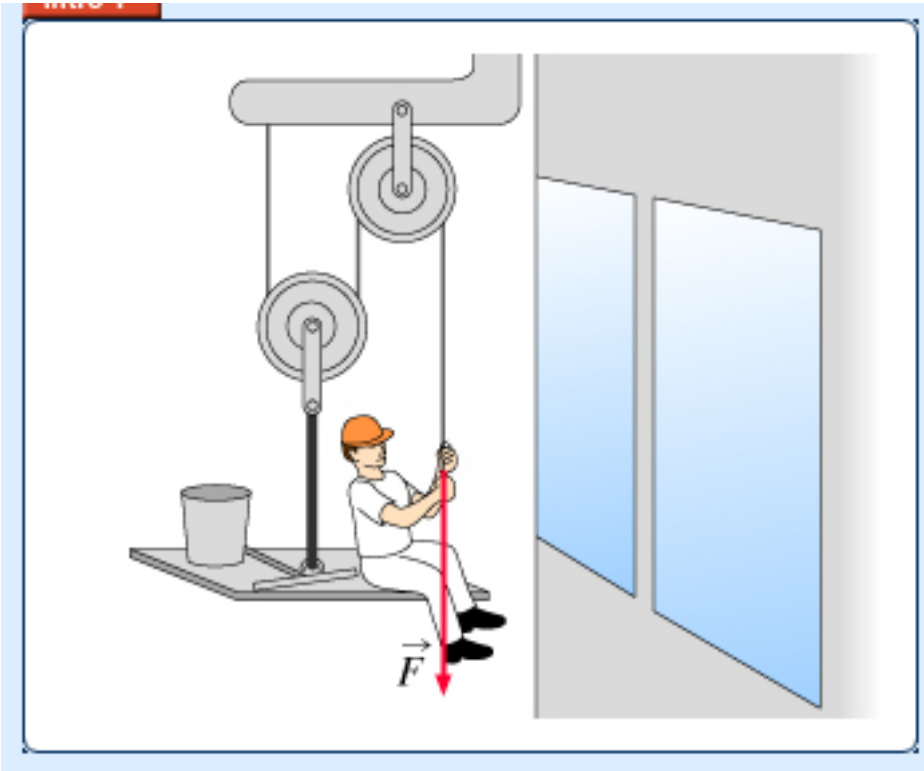
Students use PeerWise to create and to explain their understanding of course related assessment questions, and to answer and discuss questions created by their peers.

http://peerwise.cs.auckland.ac.nz/

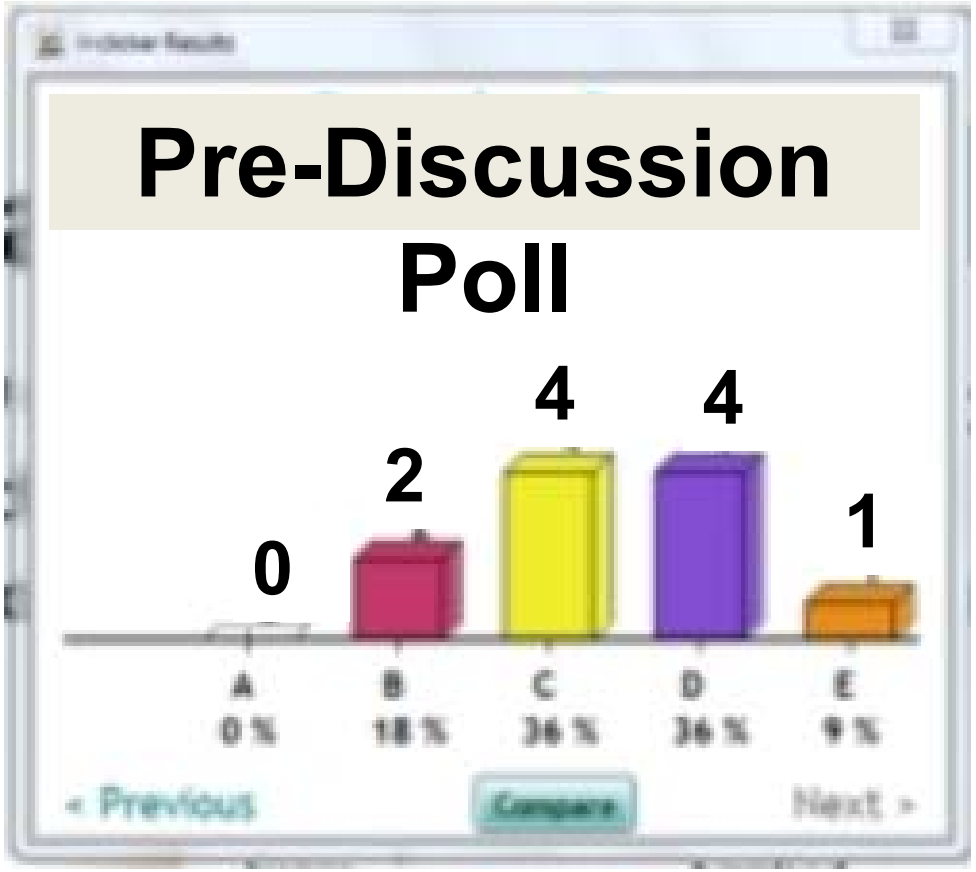
Physics Teacher Education Example

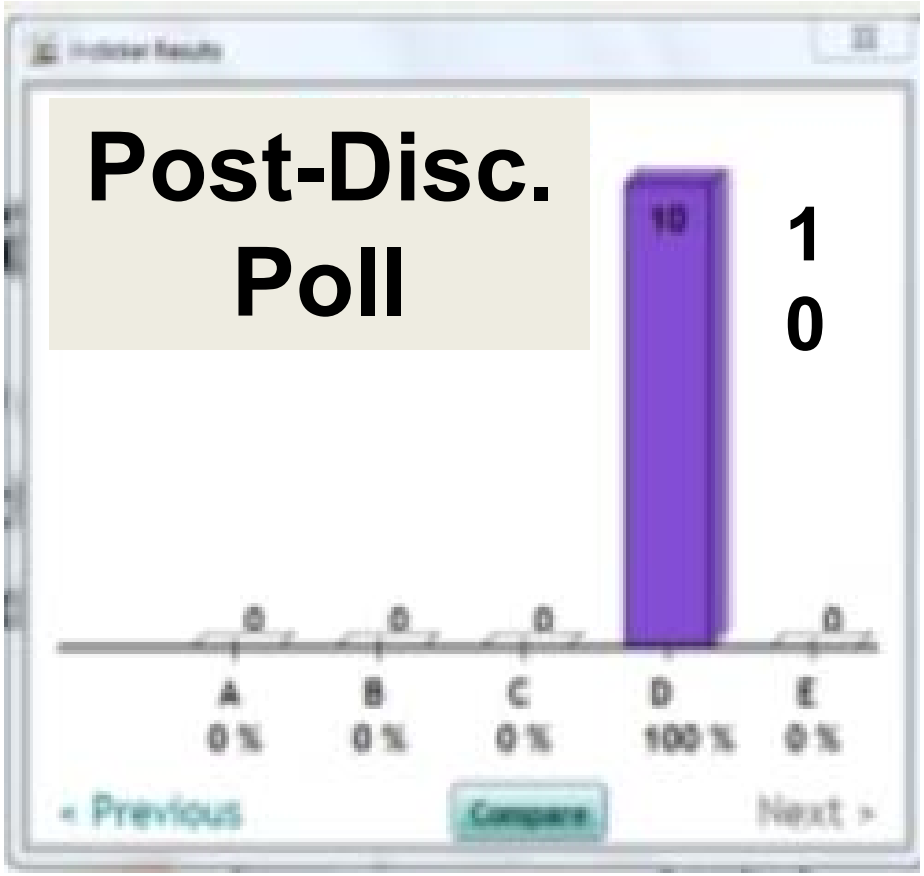
Find the magnitude of the force a person has to pull the rope with in order to pull himself upwards with a **constant speed.** He and the platform “weigh” 60 kg.

A. 600 N
B. 450 N
C. 300 N
D. 200 N
E. 150 N



Peer Instruction in Action





Respondents: Physics Teacher-Candidates

2004, The Physics Teacher, 42(8), 47-48.

Tips for Using a Peer Response System in a Large Introductory Physics Class

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Teaching a large introductory physics course can be a challenge for a young physics instructor. To do so, an instructor poses the lecture by asking multiple-choice questions. The students discu about the effective use of the PRS in an in

Clickers beyond the First Year Science Classroom

Marina Milner-Bolotin

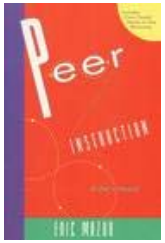
Tetyana Antimirova

Anna Petrov

2010, Journal of College Science Teaching, 40(2), 18-22.

Abstract:

This case study's primary objective is to describe the implementation of the electronic-response-system (clickers) in a small (N=25) second



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

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(Received 29 April 2016; published 7 September 2016)

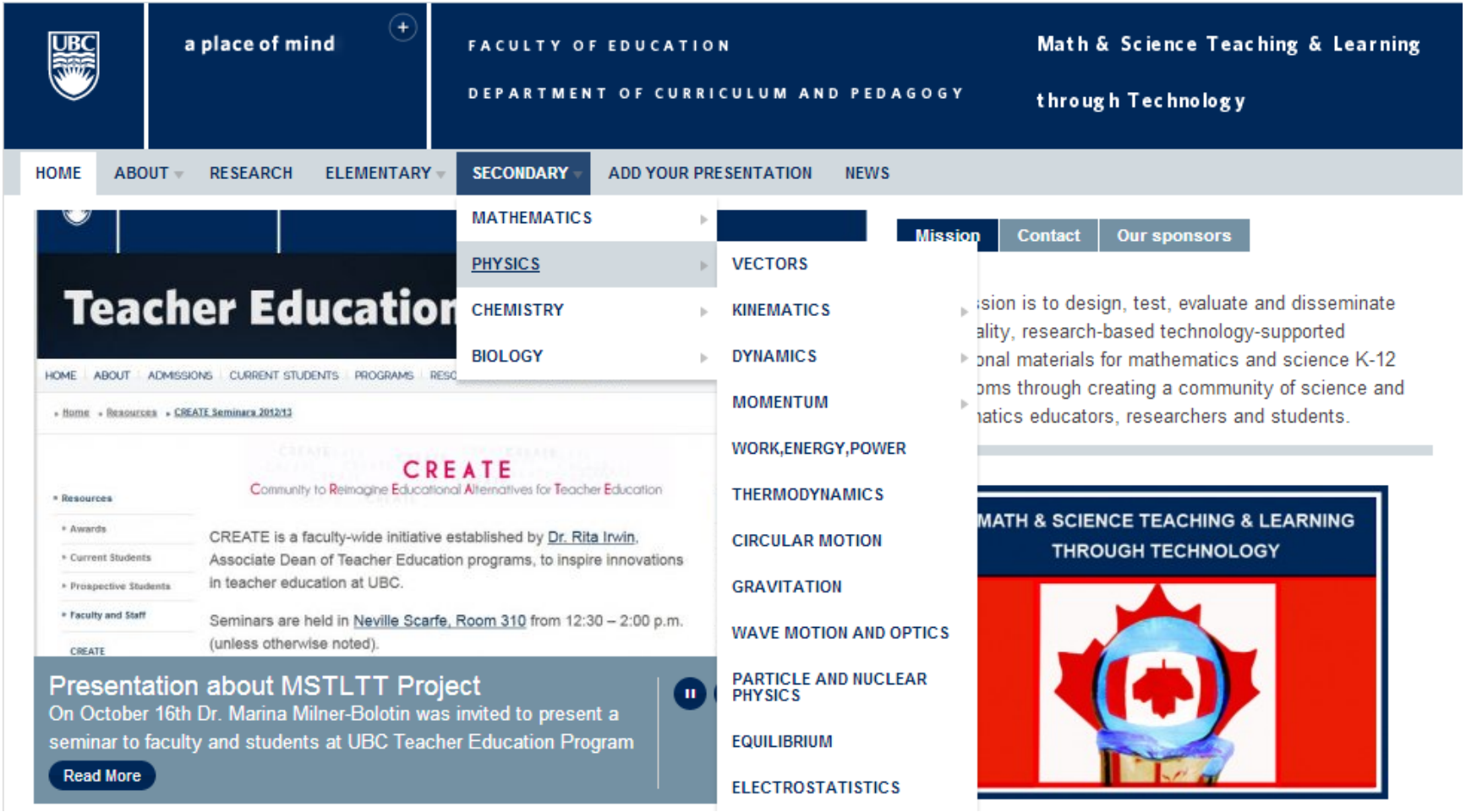
This paper describes the second year of a multi-year study on the implementation of Peer Instruction and PeerWise-inspired pedagogies in a physics methods course in a teacher education program at a large research university in Western Canada. In the first year of this study, Peer Instruction was implemented 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 measured by the rubric developed for the study.

DOI: 10.1103/PhysRevPhysEducRes.12.020128

I. INTRODUCTION: ADDRESSING THE CHALLENGES OF PHYSICS TEACHER EDUCATION

often question driven, it is not surprising that a key element of PCK is teacher's ability to ask questions that elicit student conceptual difficulties and promote meaningful

Research-Based Resource for Teachers



http://scienceres-edcp-educ.sites.olt.ubc.ca/

2. 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 Kotlicki and

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

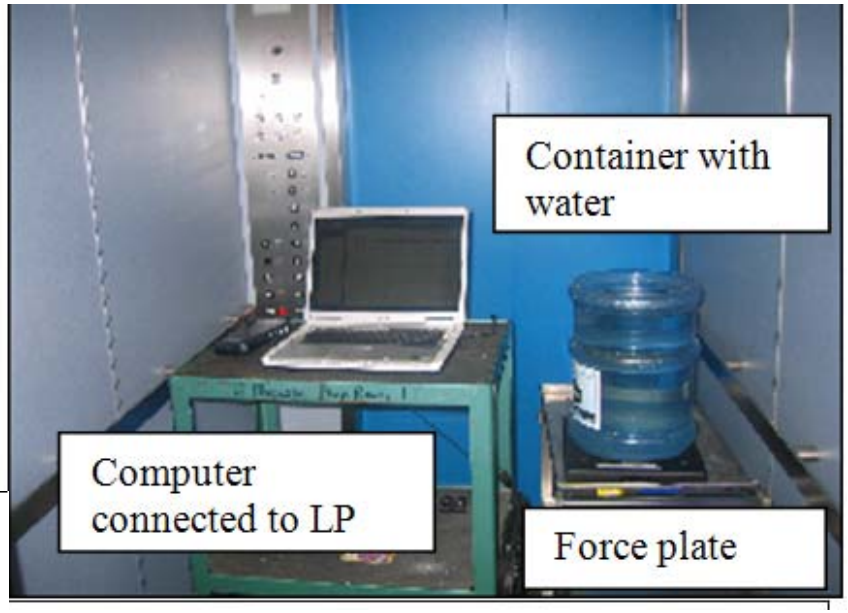
Physics Exam Problems Reconsidered: ***Using Logger Pro to Evaluate Student Understanding of Physics***

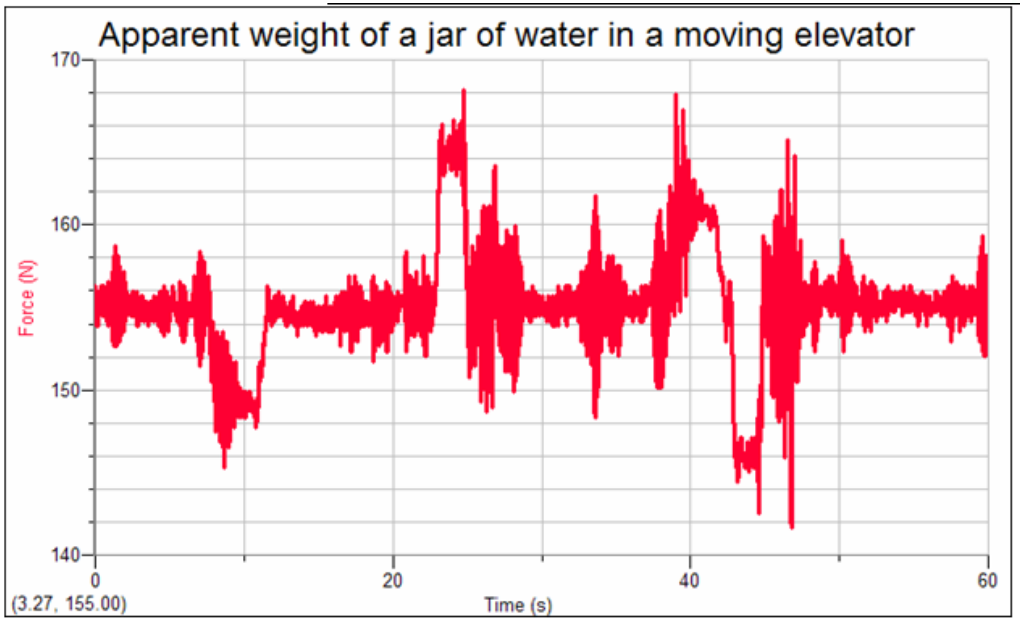
Marina Milner-Bolotin, Ryerson University, Toronto, ON

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

Real Life HW & Exam Problems

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

Reconsidering Assessment

Your friend analyzed a video clip of a basketball shot using a Logger *Pro* Video Analysis feature. However she was not certain how to find the acceleration of free fall from his analysis and turned to you for advice. What is the **reasonable experimental value** of the **magnitude** of the acceleration of free fall your friend should report during the next class?

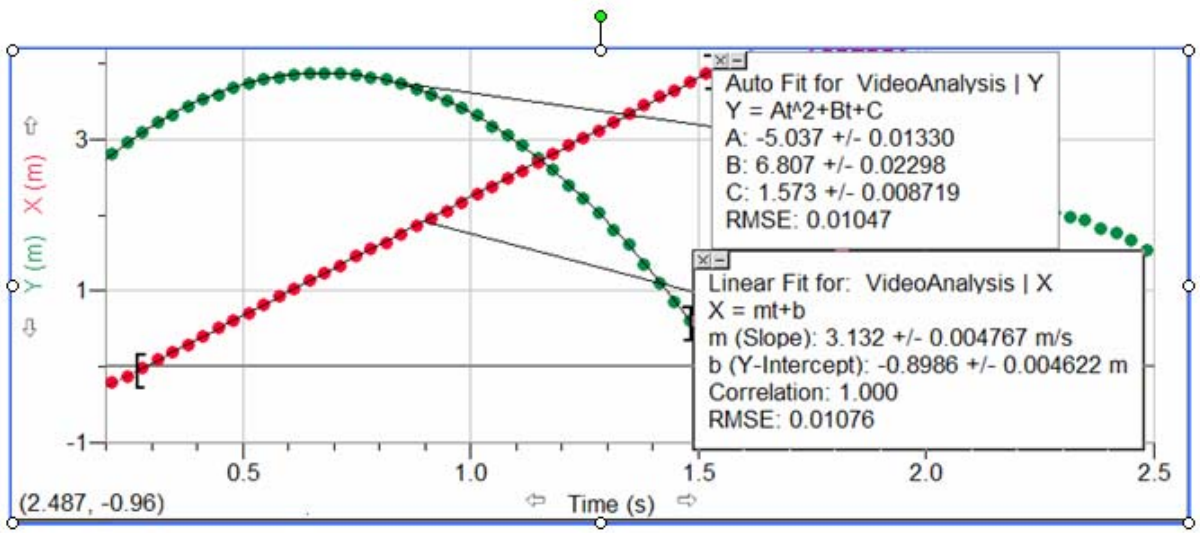
a) 5.037 m/s^2

b) 6.807 m/s^2

c) 9.823 m/s^2

d) 10.074 m/s^2

e) 10.10 m/s^2



3. Computer Simulations

FREE resources

PhET Computer simulations from the University of Colorado, Boulder

You can download the simulations. You can also use them in Chinese!

Developing STEM Intuition

Simulations can help develop intuition about physical phenomena via testing experimentally different scenarios which or cannot be tested in the lab – WHAT IF…? (Think critical thinking). However, for this to take place the teacher must **be creative in designing meaningful assignments**.

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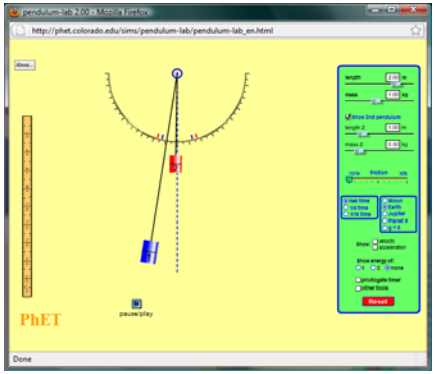
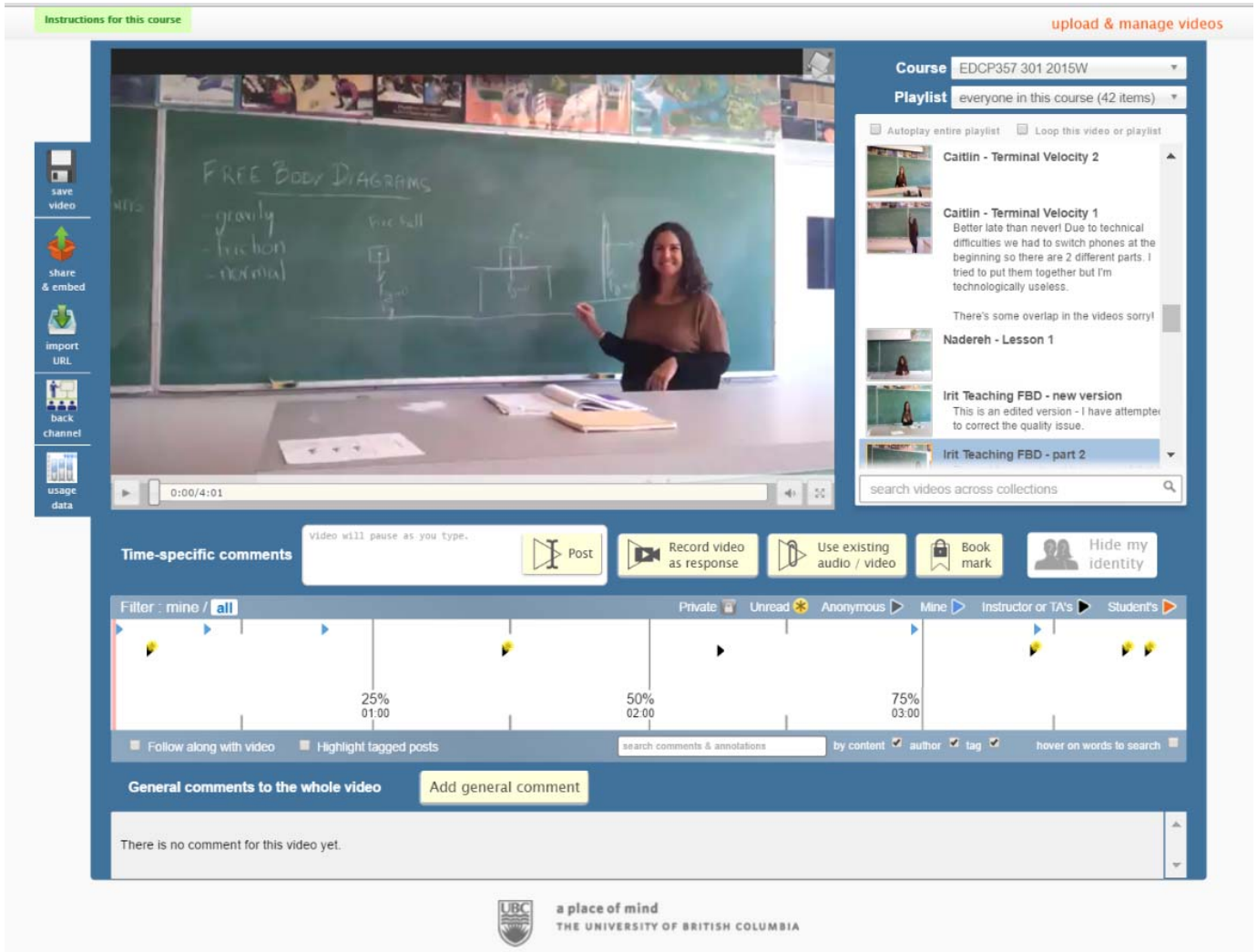


We can place the pendulum on the Moon, Earth, Jupiter or even Planet X…

4. CLAS – Collaboration on Improving Teaching Skills



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

FREE RESOURCES

Why CLAS: Collaborative Learning Annotation System?

CLAS - Collaborative Learning Annotation System

ARTS | About CLAS | Ideas & Strategies | Help & Support | Workshops | Quick Guide | Best Practices | FAQ | SIGN-IN TO CLAS

Home / Marina Milner-Bolotin in Curriculum and Pedagogy uses CLAS for mini-teaching by Teacher-Candidates

Marina Milner-Bolotin in Curriculum and Pedagogy uses CLAS for mini-teaching by Teacher-Candidates

"CLAS allows you to have a discussion which is very purposeful and to the point. I find that it not only saves time, but also makes it much more meaningful.

–Marina Milner-Bolotin, Assistant Professor of Faculty of Education

Routledge
Taylor & Francis Group

Canadian Journal of Science, Mathematics and Technology Education

ISSN: 1492-6156 (Print) 1942-4051 (Online) Journal homepage: http://www.tandfonline.com/loi/ucjs20

Rethinking Technology-Enhanced Physics Teacher Education: From Theory to Practice

Marina Milner-Bolotin

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Technology Education, 16:3, 284-295, DOI: 10.1080/14926156.2015.1

To link to this article: http://dx.doi.org/10.1080/1

[M. Milner-Bolotin, "Rethinking technology-enhanced physics teacher education: From theory to practice", *Canadian Journal of Science, Mathematics and Technology Education,* **16**, 284-295 (2016).]

Conclusions

In order to prepare our students for 21st century challenges, we have to reimagine how we use technology in STEM teacher-education.

Instead of focusing on new gadgets and new innovations we should focus on new technology-enhanced pedagogies.

Let us move from more technology to increased quality of STEM teaching and learning.