Chaoyang School District Professional Development Course May 19-30 2015

Teaching Math & Science With Technology in the 21st Century

朝陽區 朝阳区

UBC Faculty of Education
THE UNIVERSITY OF BRITISH COLUMBIA
EDCP DEPARTMENT OF curriculum & pedagogy

Dr. Marina Milner-Bolotin

Day 2 - May, 2015

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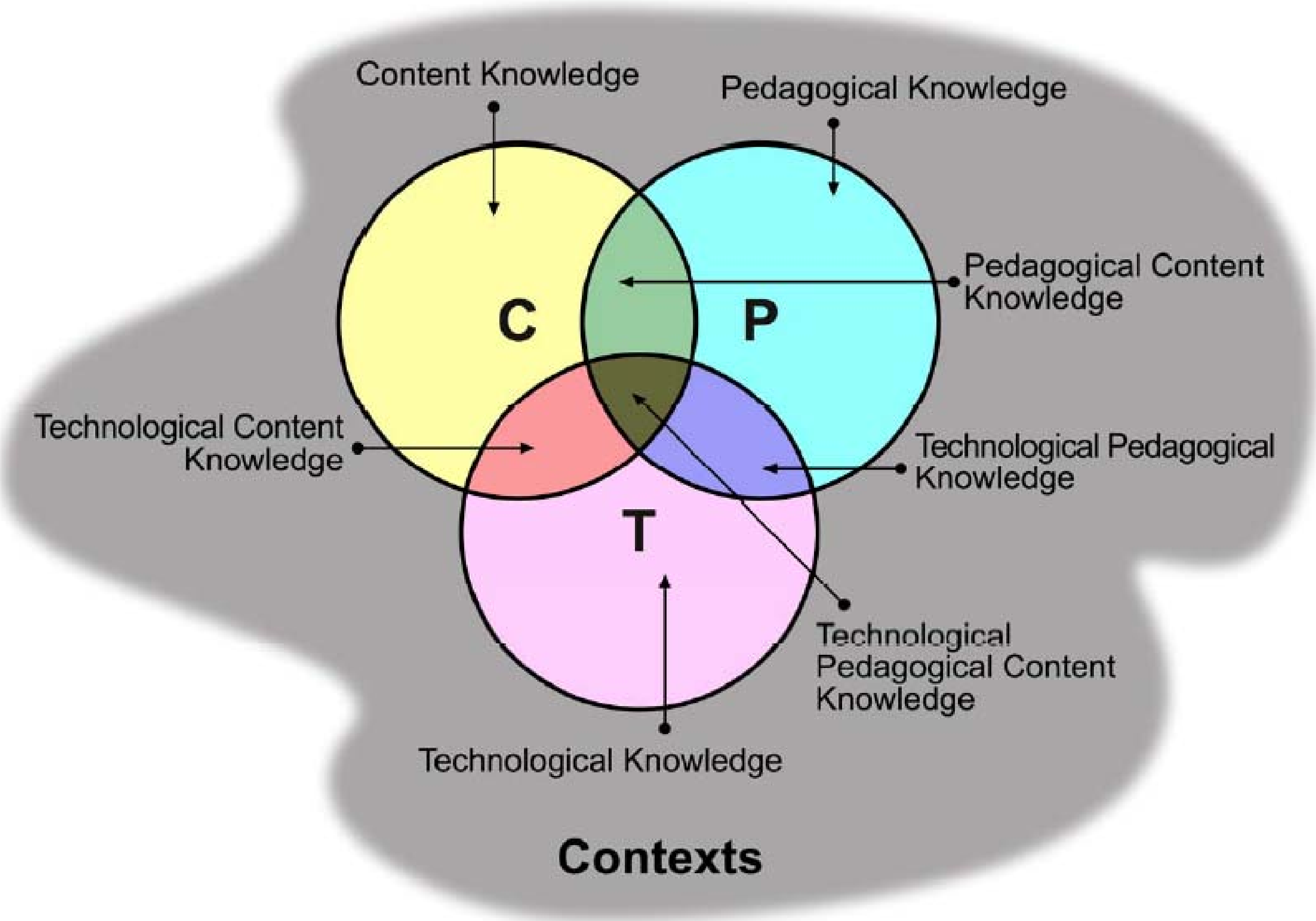
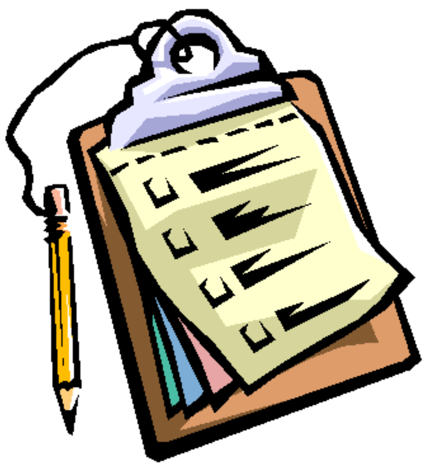


I Course Tentative Schedule

Day	Technology	
1	Student engagement: Clickers, multimedia	✔
2	Peer Instruction and PeerWise: inquiry via questioning; Exploring GeoGebra	✔
3	Data collection and analysis; Desmos	
4	Computer simulations, games, and online learning environments	
5	Summary and projects' presentations	

Agenda for the Day

I. Active engagement: Peer Instruction Pedagogy
II. Group activity: Designing conceptual math and science multiple-choice questions
III. PeerWise Pedagogy introduction
IV. PeerWise activity (group work)
V. Group activity: Exploring GeoGebra
VI. Summary of the day



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I Active Engagement

Group activity

1. What activities are your students engaged in your math and science classes?
2. Why do you choose these activities?
3. What learning do they promote?

I Peer Instruction

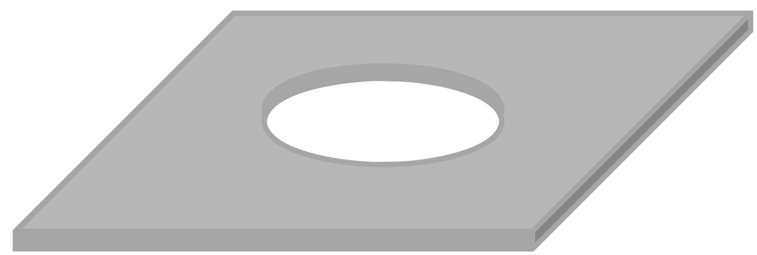
Have you heard of (used) Peer Instruction (clickers) outside of this course?

1. Yes
2. No

Metal Expansion Puzzle

You have a uniform metal plate with a circular hole inside it. You heat it up by 200^{o}C. **As a result of heating, the hole will:**

1. Increase
2. Decrease
3. Remain the same

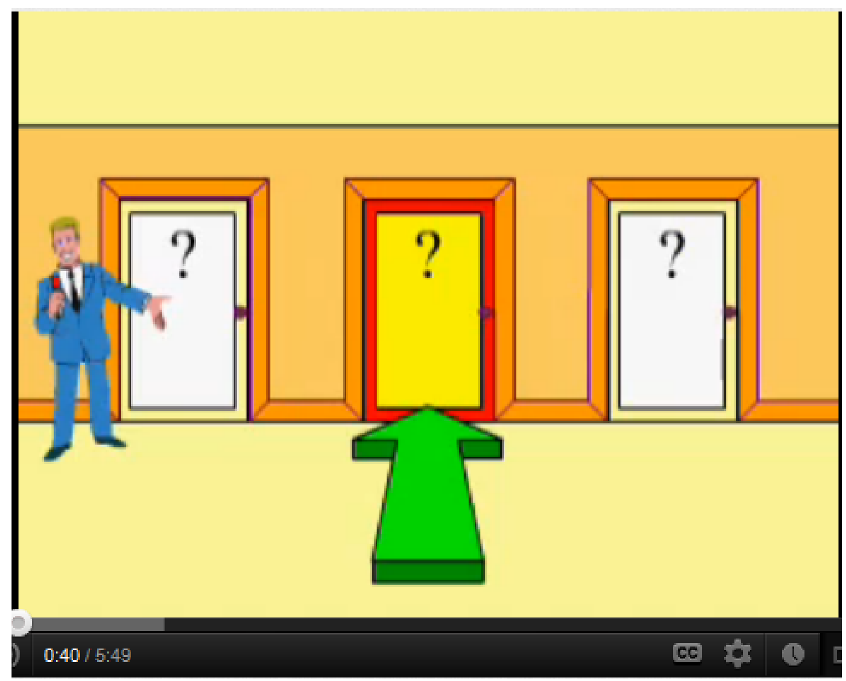


The Monty Hall Problem: Let Us Make a Deal

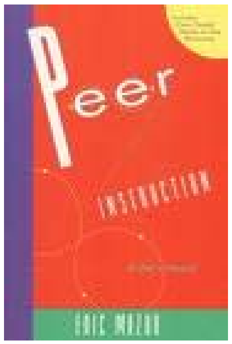
A. Stick with the original choice

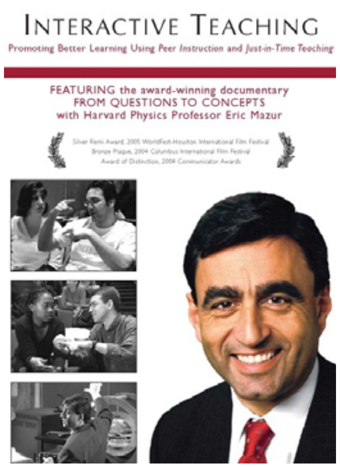
B. Swap doors

C. It doesn't matter



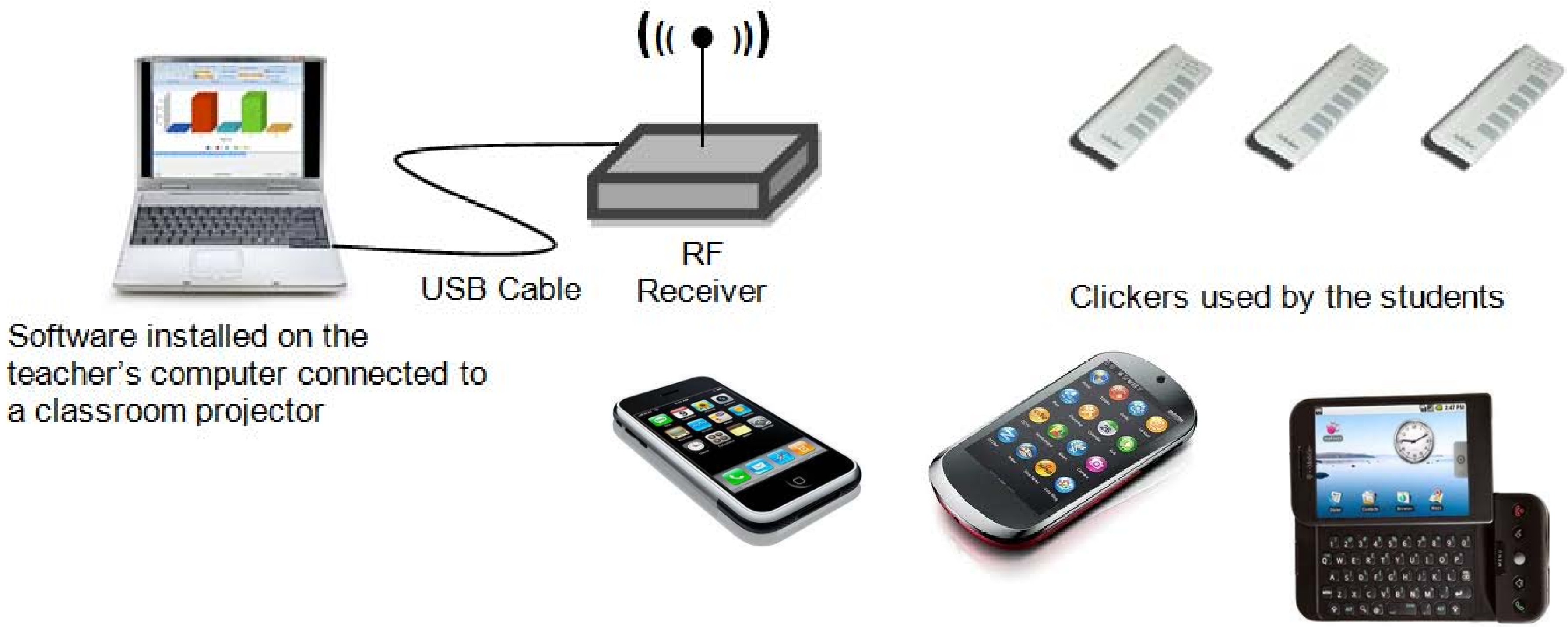
I Peer Instruction





I Peer Instruction

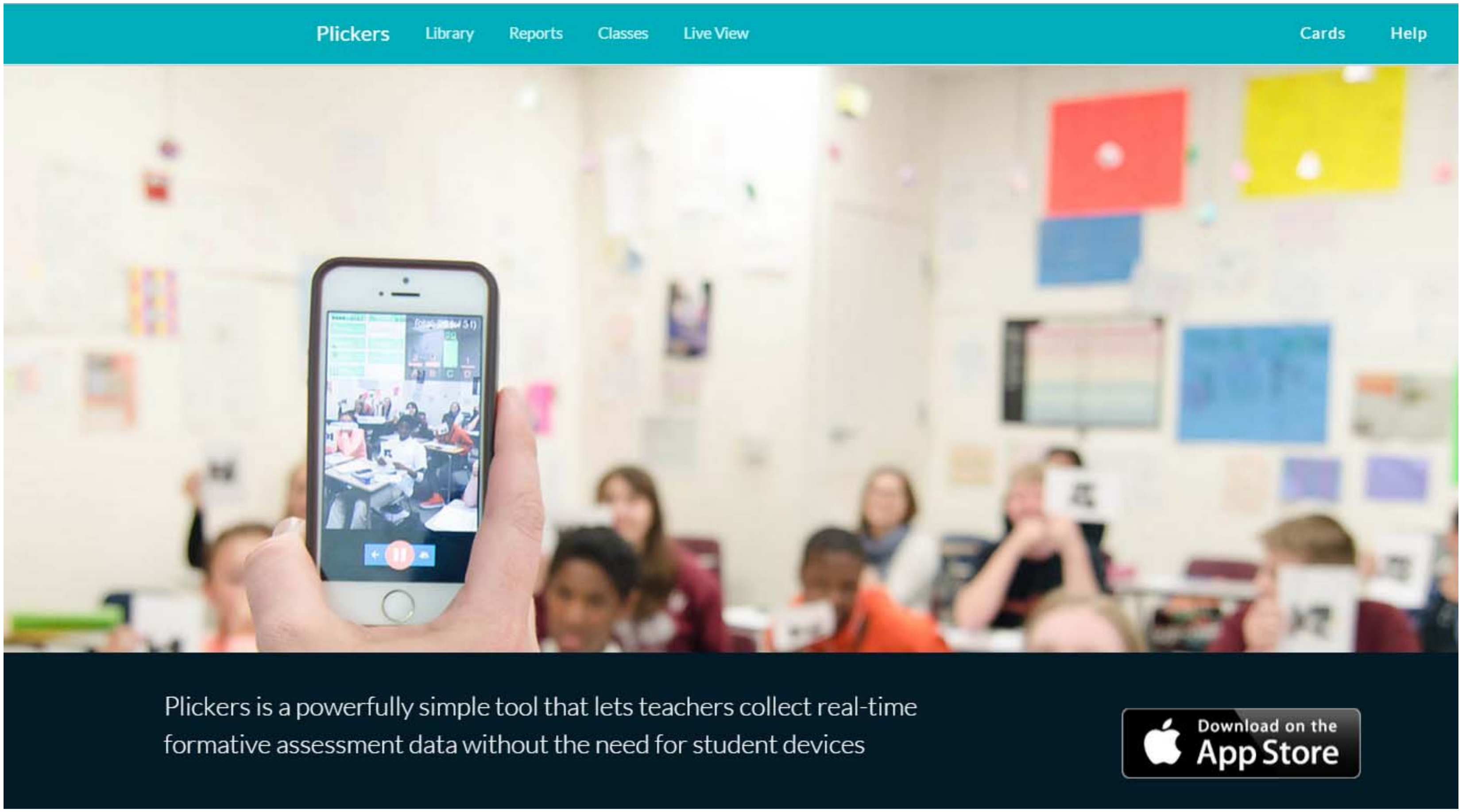
I Technology for Peer Instruction



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

I

Technology for Peer Instruction - Plickers



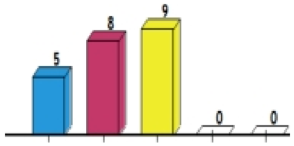
https://www.plickers.com/

I Clicker-enhanced Pedagogy

Stage 1
- Pose a multiple-choice science question

Stage 2
- Students are given time to think and enter their individual responses using clickers (vote)

Stage 3
- The responses are aggregated and displayed and a peer discussion follows



Stage 4
- Students have a chance to vote again

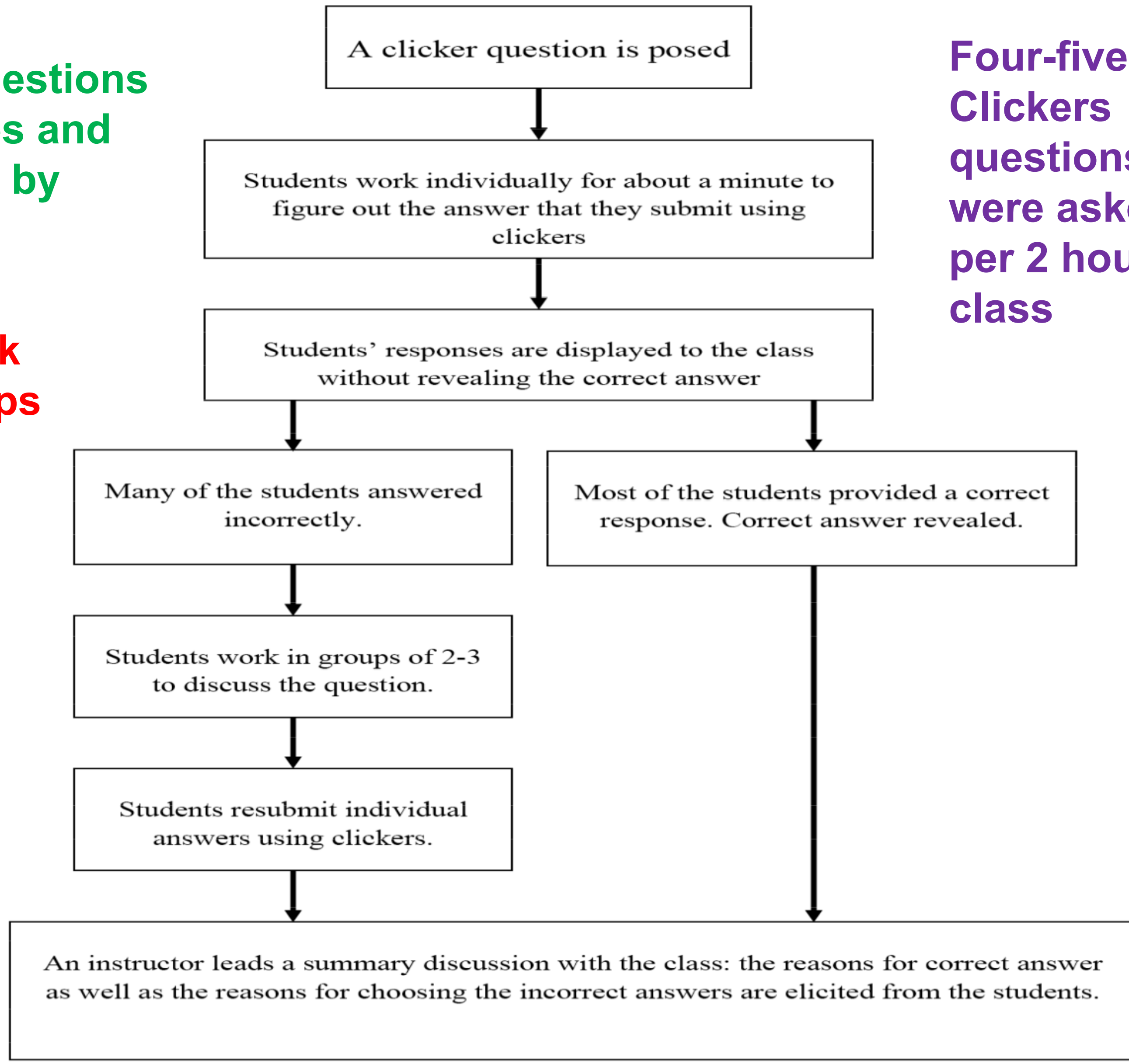
Stage 5
- Whole class discussion about correct, as well as incorrect responses (reasons for each)

Modified Peer Instruction

We design conceptual questions for our courses and use questions by others

Students work in small groups (of 2-3) to figure out conceptual questions

The answers to these questions are tested using simulations, demos, etc.



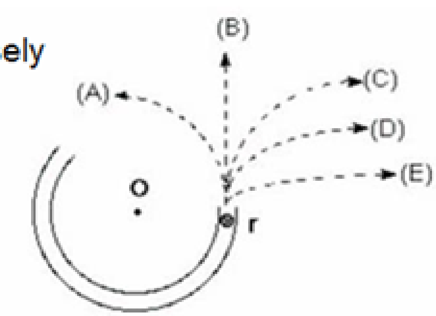
Four-five Clickers questions were asked per 2 hour class

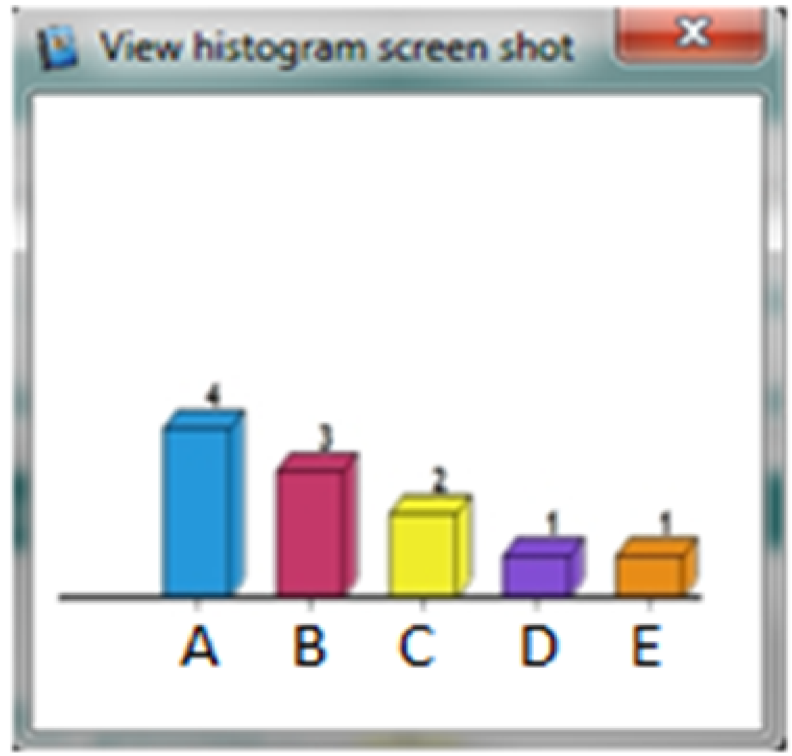
I Challenging Assumptions

Question

A ball travels through the circular track until point r, at which point it leaves the channel to travel across a frictionless floor. Assume a bird's eye view, and that all motion is in the horizontal plane.

Which path will the ball most closely follow after it exits the channel?





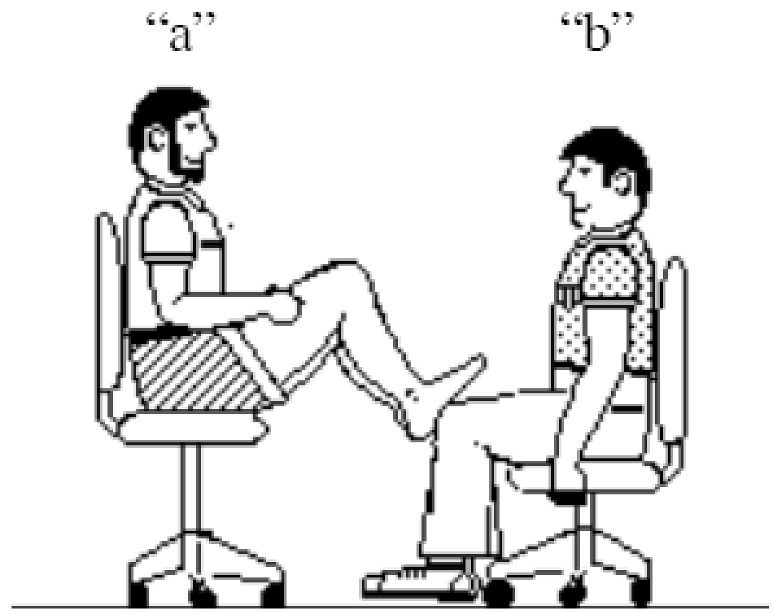
Answers given by pre-service physics teachers

Force Concept Inventory Example

28. In the figure at right, student "a" has a mass of 95 kg and student "b" has a mass of 77 kg. They sit in identical office chairs facing each other.

    Student "a" places his bare feet on the knees of student "b", as shown. Student "a" then suddenly pushes outward with his feet, causing both chairs to move.

    During the push and while the students are still touching one another:



(A) neither student exerts a force on the other.

(B) student "a" exerts a force on student "b", but "b" does not exert any force on "a".

(C) each student exerts a force on the other, but "b" exerts the larger force.

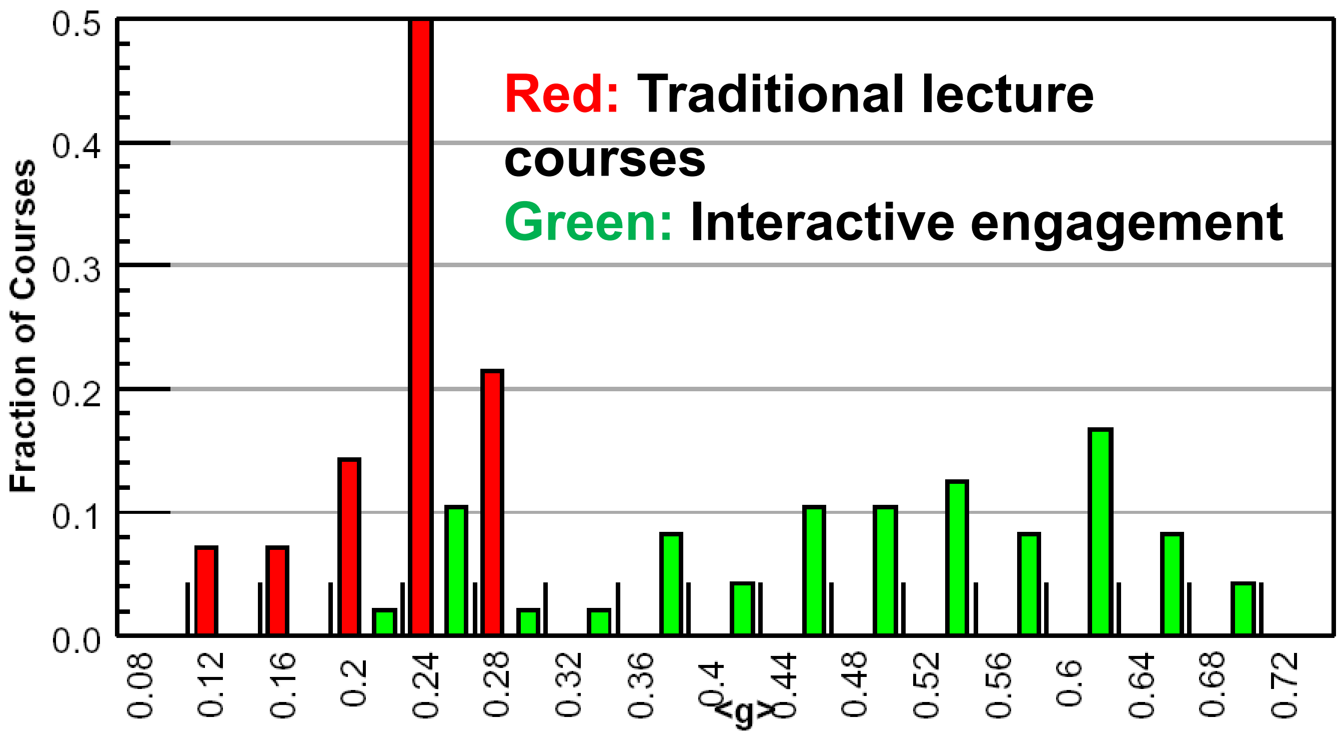
(D) each student exerts a force on the other, but "a" exerts the larger force.

(E) each student exerts the same amount of force on the other.

FCI Gain Factor

FCI Gain: fraction of unknown physics concepts learned

$$\text{Course gain:} < g >= \frac{\text{Post (\%)-Pre(\%)}}{100\% - \text{Pre(\%)}}$$



R. Hake, "…A six-thousand-student survey…" AJP **66**, 64-74 ('98).

I How much do students learn?

A. 10-20%
B. 20-40%
C. 40-60%
D. 60-80%
E. 80-95%

What % of what the students could have learned in our courses is actually learned?

$$\text{Course gain:} < g >= \frac{\text{Post (\%)-Pre(\%)}}{100\% - \text{Pre}(\%)}$$

I Clickers & Active Learning

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

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

Marina Milner-Bolotin, Physics and Astronomy Department, Rutgers, The State University of New Jersey
Piscataway, NJ 08854-8019; milnerm@physics.rutgers.edu

Teac
phy
lenge for a

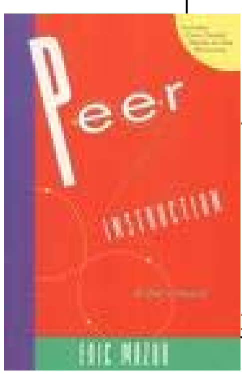
Clickers beyond the First Year Science Classroom

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 electron

response-system (clickers) in a small (N=25) secon

I Peer Instruction Pedagogy

LUMAT 1(5), 2013

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

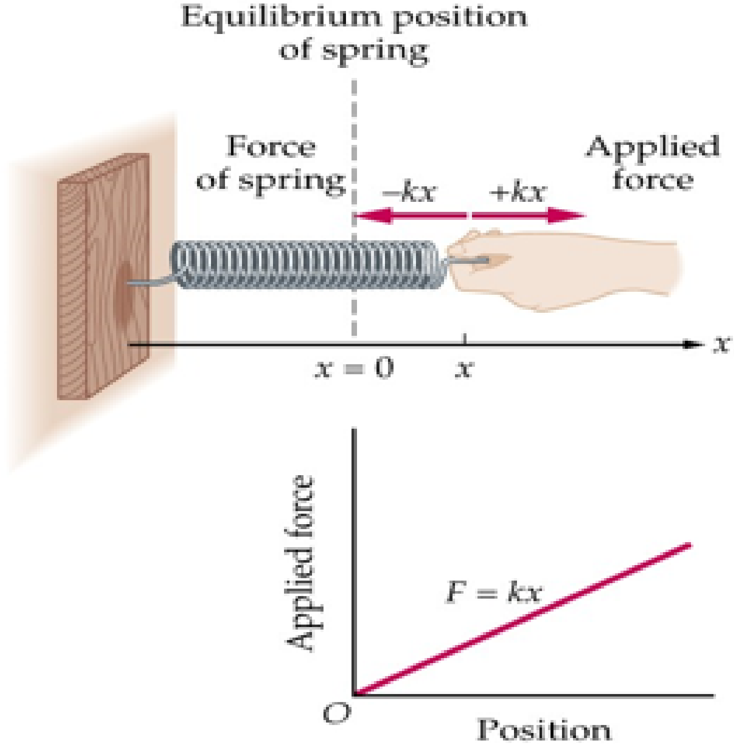
Abstract One of the most commonly explored technologies in Science, Tech
and Mathematics (STEM) education is Classroom Respo
instructors generate in-class discussion by solicit

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

I	Peer Instruction Example

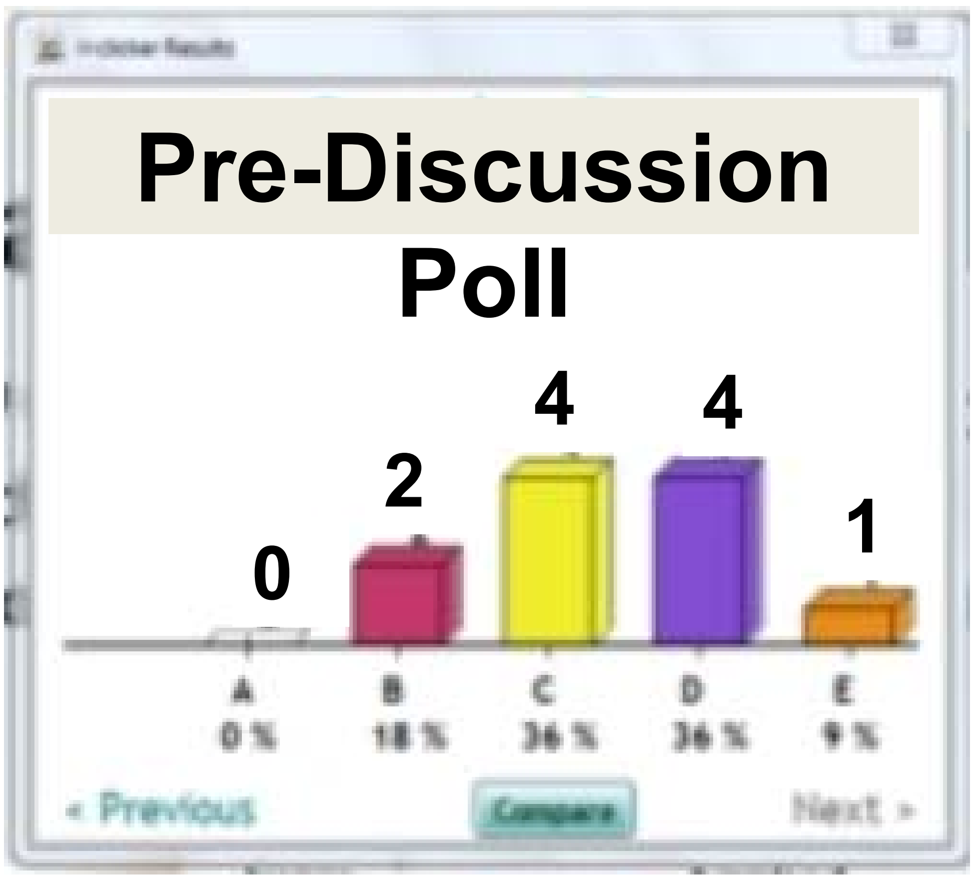
The work needed to stretch a spring **10 cm** from equilibrium (from $x_1 = 0$ m to $x_2 = 0.1$ m) is **10 J**. How much work needs to be done to stretch the spring additional **10 cm** (from $x_2 = 0.1$ m to $x_3 = 0.2$ m) ?

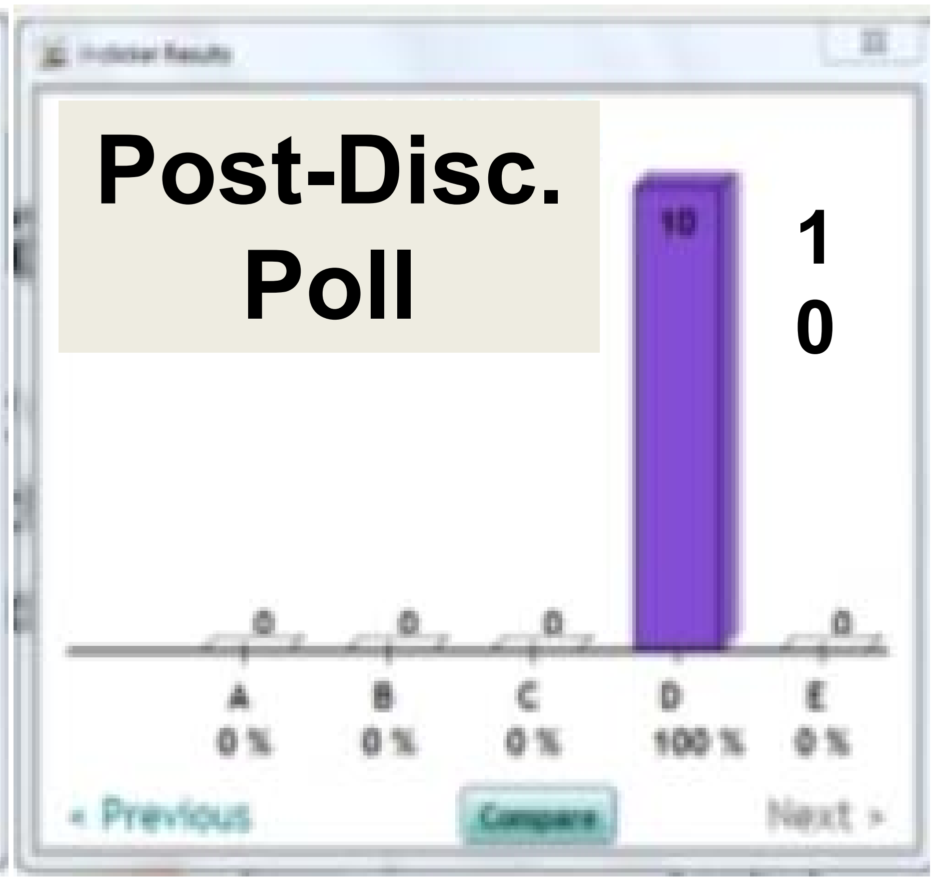
A. 5 J
B. 10 J
C. 20 J
D. 30 J
E. 40 J



I

Peer Instruction in Action

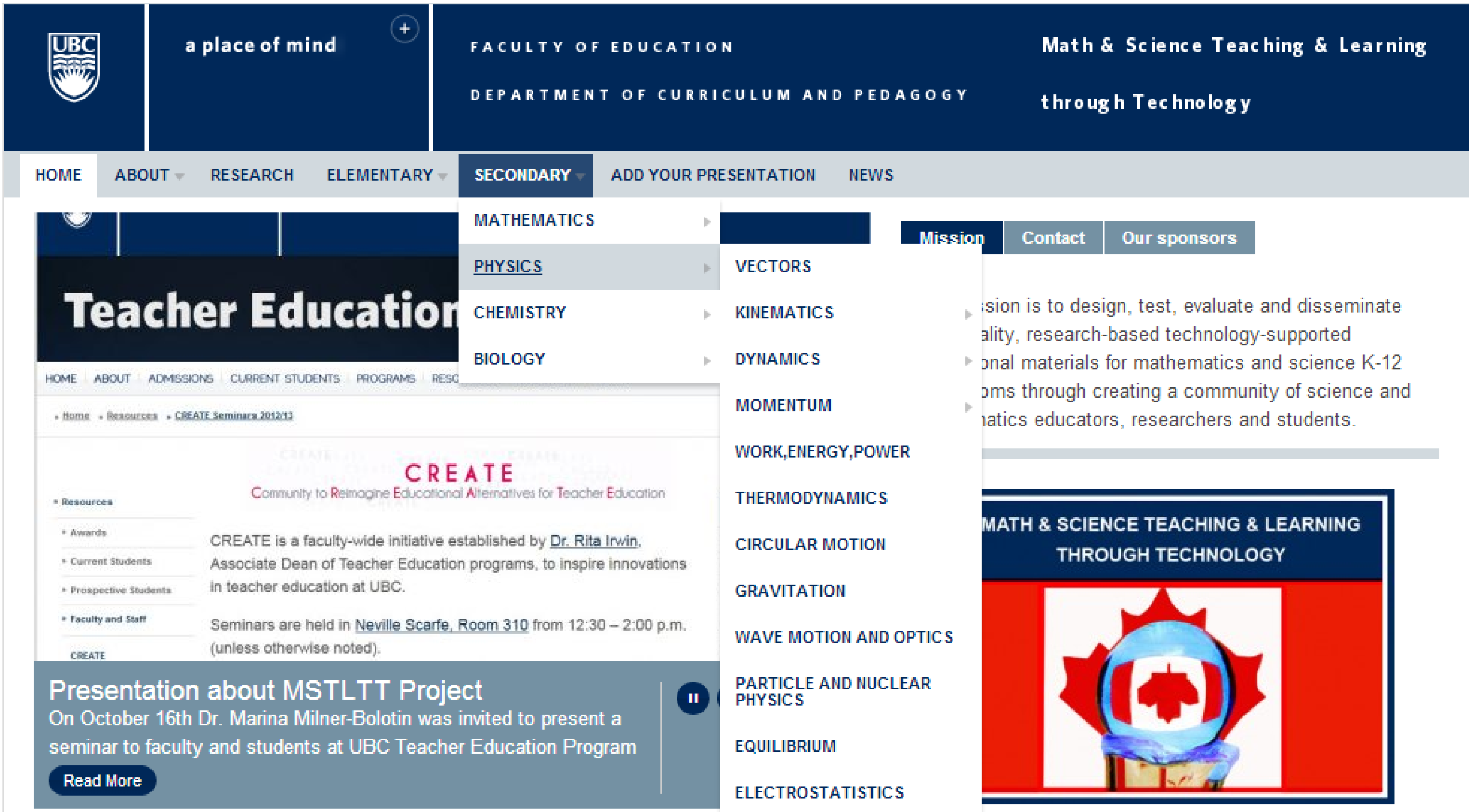




Respondents: Physics Teacher-Candidates

I

Math & Science Teaching & Learning through Technology



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

I Navigating the Resource

a place of mind

FACULTY OF EDUCATION

DEPARTMENT OF CURRICULUM AND PEDAGOGY

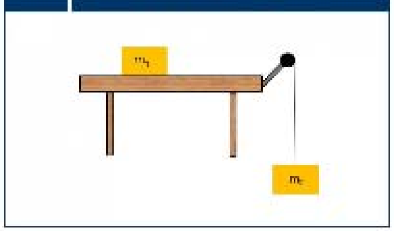
Math & Science Teaching & Learning through Technology

HOME | ABOUT | RESEARCH | ELEMENTARY | SECONDARY | ADD YOUR PRESENTATION | NEWS

» Home » Secondary » Physics » Dynamics » Forces

FORCES

Blocks and a Pulley

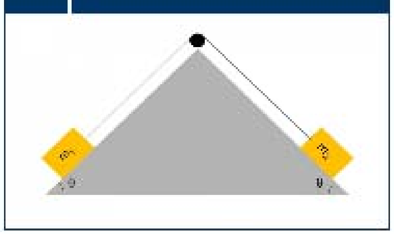


Exploration of free body diagrams, two body acceleration, and Newton's law through the system of two blocks attached through a pulley and one of them resting on a table.

acceleration, forces, friction, Newton's laws, pulleys, string tension

rating (No Ratings Yet)

Blocks on a Pyramid



Exploration of free body diagrams, two body acceleration, and newton's laws through the system of two blocks resting on a pyramid and attached by a pulley.

acceleration, forces, friction, gravitational acceleration, net force, normal force, weight

rating (No Ratings Yet)

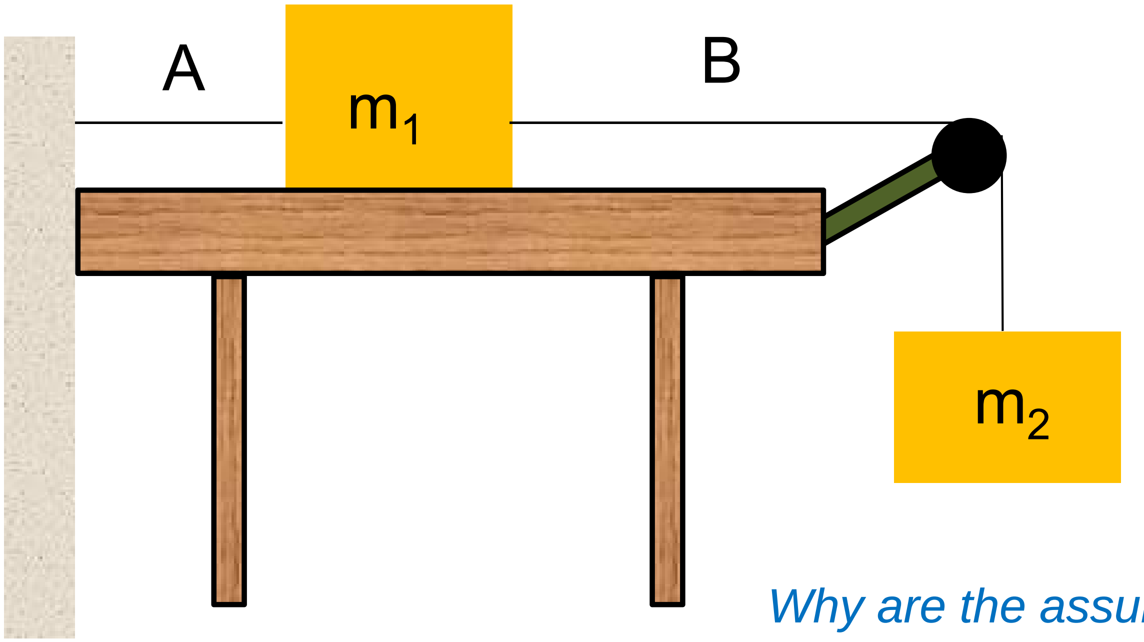
- + Mathematics
- − Physics
  - » Vectors
  - + Kinematics
  - − Dynamics
    - » Forces
    - » Springs
    - » Newton's Laws
  - + Momentum
  - » Work,Energy,Power
  - » Thermodynamics
  - » Circular Motion
  - » Gravitation
  - » Wave motion and Optics
  - » Particle and Nuclear Physics

I Navigating the Resource

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

Blocks and a Pulley

Two blocks are connected via a pulley. The blocks are initially at rest as block m_1 is attached to a wall. If string A breaks, what will the accelerations of the blocks be? (**Assume** friction is very small and strings don't stretch)



A. $a_1 = 0;\ a_2 = 0$

B. $a_1 = g;\ a_2 = g$

C. $a_1 = 0;\ a_2 = g$

D. $a_1 = g;\ a_2 = 0$

E. None of the above

Why are the assumptions above important?

I Solution

Answer: E

Justification: None of the above answers is correct. Consider two blocks as one system: one can see that the system has a mass of (m_1+m_2), while the net force pulling the system down is m_1g. Therefore, applying Newton's second law, one can see that the acceleration of the system must be less than g:

$$a = \frac{m_2 g}{(m_1 + m_2)} = \frac{m_2}{(m_1 + m_2)} g < g$$

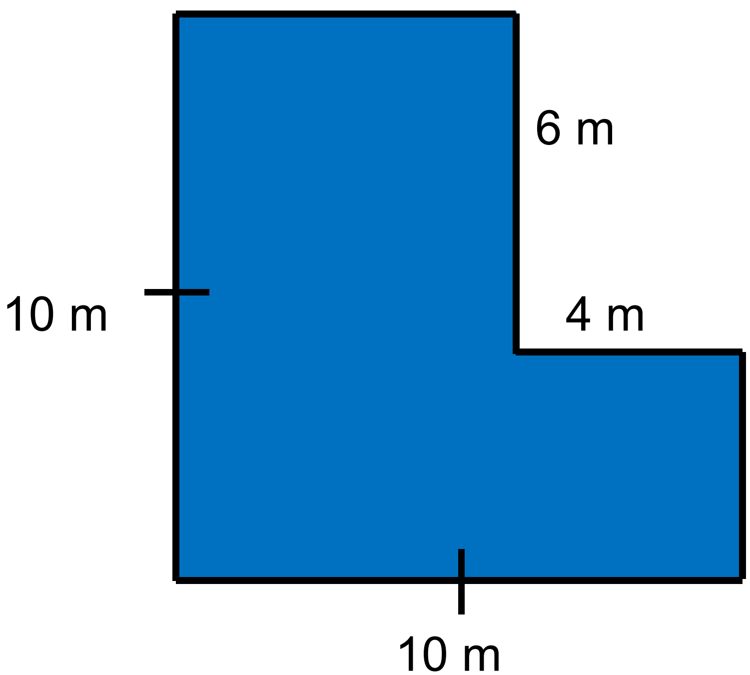
Some people think that the acceleration will be g. They forget that the system consists of two blocks (not just m_1) and the only pulling force is m_1g. Thus the system is NOT in a free fall. Compare this questions to the previous one to see the difference.

I

Break: Mental Exercise

I Area

What is the area of the figure below?



A. 24 m^2

B. 76 m^2

C. 100 m^2

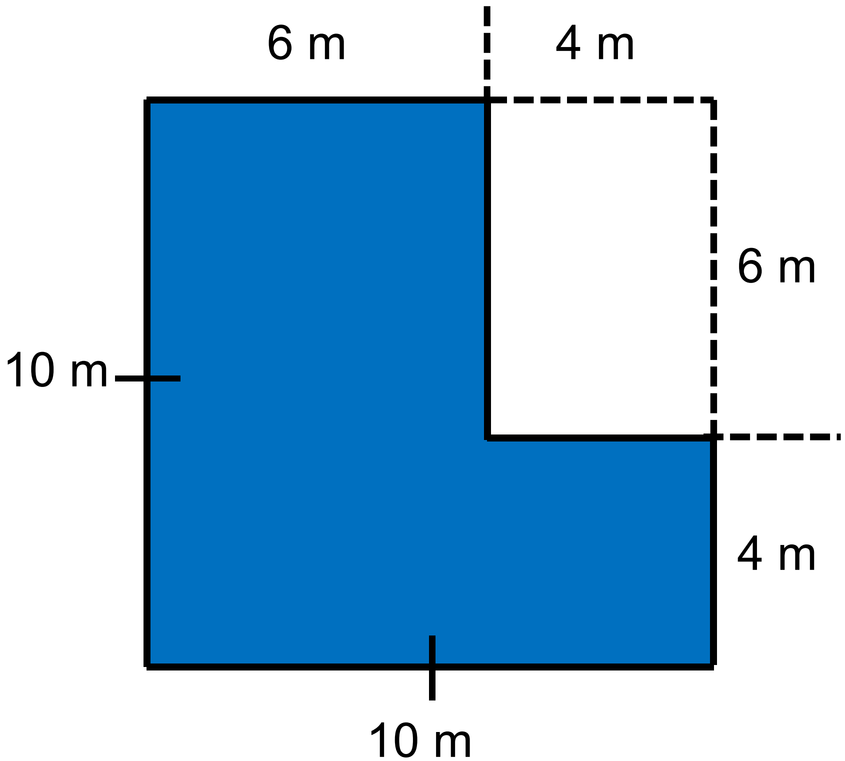
D. 124 m^2

E. Not enough information

I Solution

Answer: B

Justification: The easiest way to find the area is to imagine a 10 m by 10 m square and subtracting a 4 m by 6 m rectangle.



A = 10 m x 10 m – 4 m x 6 m
= 76 m^2

Alternatively, the shape's area can be found by dividing it into 2 rectangles and adding the areas together.

I

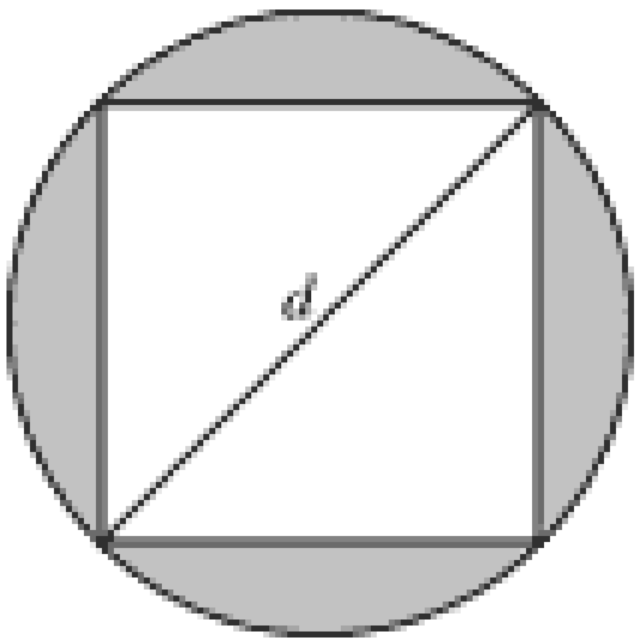
Logical reasoning

If *m* and *p* are positive integers and (*m* + *p*) x *m* is even, which of the following must be true?

(A) If *m* is odd, then *p* is odd.
(B) If *m* is odd, then *p* is even.
(C) If *m* is even, then *p* is even.
(D) If *m* is even, then *p* is odd.
(E) *m* must be even.

I Logical reasoning

In the figure below, a square is inscribed in a circle with diameter *d*. What is the sum of the areas of the shaded regions, in terms of *d* ?



$(a)\ d^2\left(\frac{\pi}{4}-\frac{1}{2}\right)$

$(b)\ d^2\left(\frac{\pi}{4}-\frac{1}{4}\right)$

$(c)\ d^2\left(\frac{\pi}{2}-\frac{1}{4}\right)$

$(d)\ d^2\left(\pi-2\right)$

$(e)\ d^2\left(\pi-1\right)$

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II

Designing Multiple-Choice Questions: Group activity

Group activity

1. While working with a partner, design 3 multiple-choice questions on the relevant topic. Consider distractors carefully.
2. Pair up with another group and answer each other's questions.

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III PeerWise Online System

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

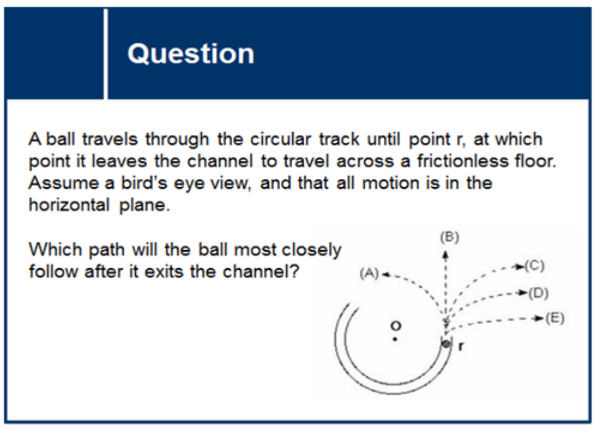
Return to main menu

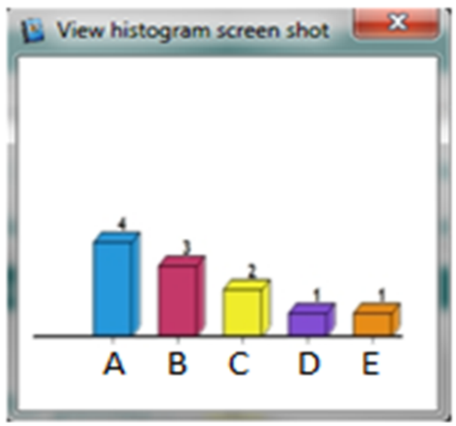
What is PeerWise?

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/

III Technology-Enhanced Active Engagement Integration





Peer Instruction and PeerWise integration

III PeerWise Pedagogy

LUMAT 1(5), 2013

[Res. & Pract. in Math, Sci. & Techn. Ed., 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 Ped
marina.milner-bolotin@ubc.ca

Heather Fisher
Department of Curriculum and Ped

Alexandra MacDonald
Department of Curriculum and Ped

Abstract One of the most comm
and Mathematics (STEM) educat
instructors generate in-class discus

EDUCATION CORNER

SPACE ÉD

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 i

contributed to PeerWise d
Table 1.

[Physics in Canada., 2014, 70(3): p. 149-150]

III PeerWise Online System

Home | Main menu > Your questions > Question details

Question stats

This question has been answered by 5 people and has an average rating of 4.20 (based on 5 ratings)

YES The answer you suggested is the most popular answer

Your question

Roger Federer tosses a tennis ball up in the air during his match against Rafael Nadal. When the ball reaches its highest point, its:

Alternatives

You suggested B is the correct option

OPTION	ALTERNATIVE	FIRST ANSWERS	CONFIRMED ANSWERS
A	velocity is zero and acceleration is zero	1 (20.00%)	0 (0.00%)
B	velocity is zero and acceleration is non-zero	4 (80.00%)	3 (100.00%)
C	velocity is non-zero and acceleration is non-zero	0 (0.00%)	0 (0.00%)
D	velocity is non-zero and acceleration is zero	0 (0.00%)	0 (0.00%)
E	The answer depends on the initial speed of the ball.	0 (0.00%)	0 (0.00%)

Explanation

The following explanation has been provided relating to this question:

At its highest point the ball should stop (it has zero instantaneous velocity). However, its acceleration is non-zero. The earth is pulling the ball down equally hard along the way, so its acceleration in its highest point is 9.8 m/s^2, and it is directed downwards.

Improve explanation

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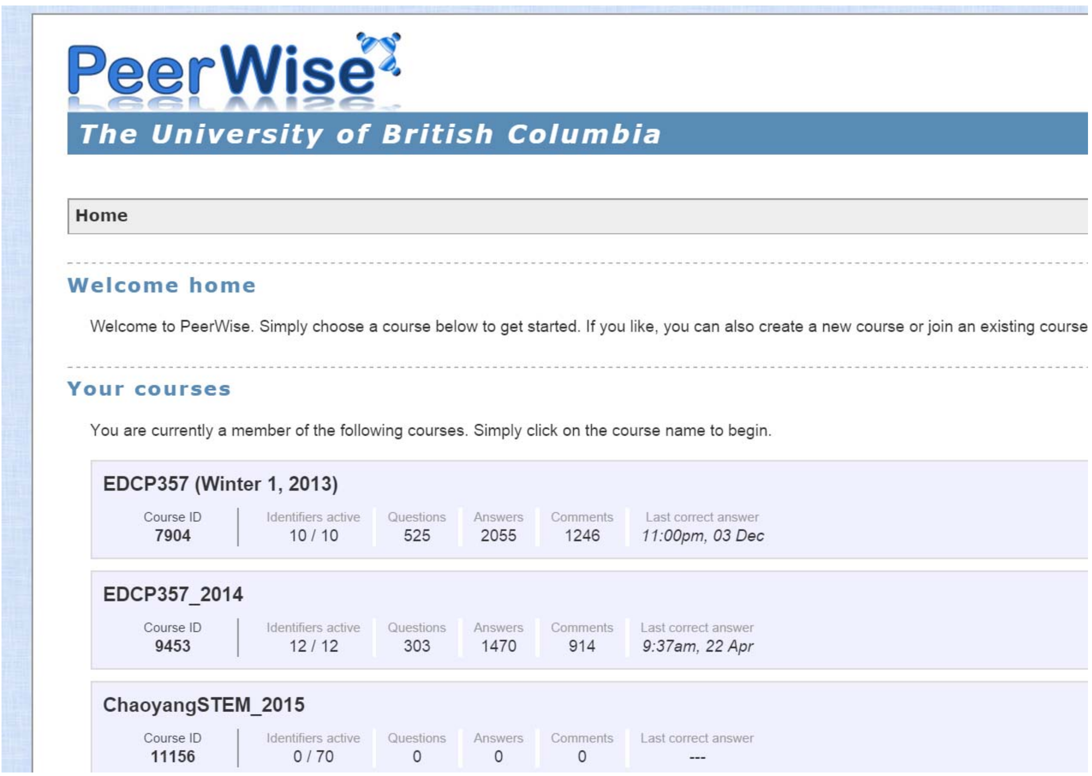
IV PeerWise Activity

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



Student ID:

Student1_ChB
Student2_ChB …
Student70_ChB

Register at PeerWise use the username Student#
Your Identifier is:
Student1
Student 2 …
Your own password is the same as your student ID.

IV PeerWise Activity: Registration

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

Creating new user:

- Institution: **The University of British Columbia**
- User name: **Student1_ChB**
- Password: *************

Course to join:

- Course ID: **11156**
- Identifier: **Student1**

Student ID: Student1_ChB
Your Identifier is: Student1
Your password = Your student ID.

IV Exploring PeerWise (PW)

Group activity

1. Register to PeerWise (PW) and explore the system.
2. Work with a partner, design 3 multiple-choice questions on the relevant topic. Enter them into PW.
3. Answer 3 questions designed by other people. Rate these questions and comment on them.

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V Interactive Mathematical Tools

- Geometer's Sketchpad
- Cinderella
- Cabri
- GeoGebra

V GeoGebra: What is it?

- Dynamic mathematics software
- Used for learning and teaching:

Geometry
Calculus

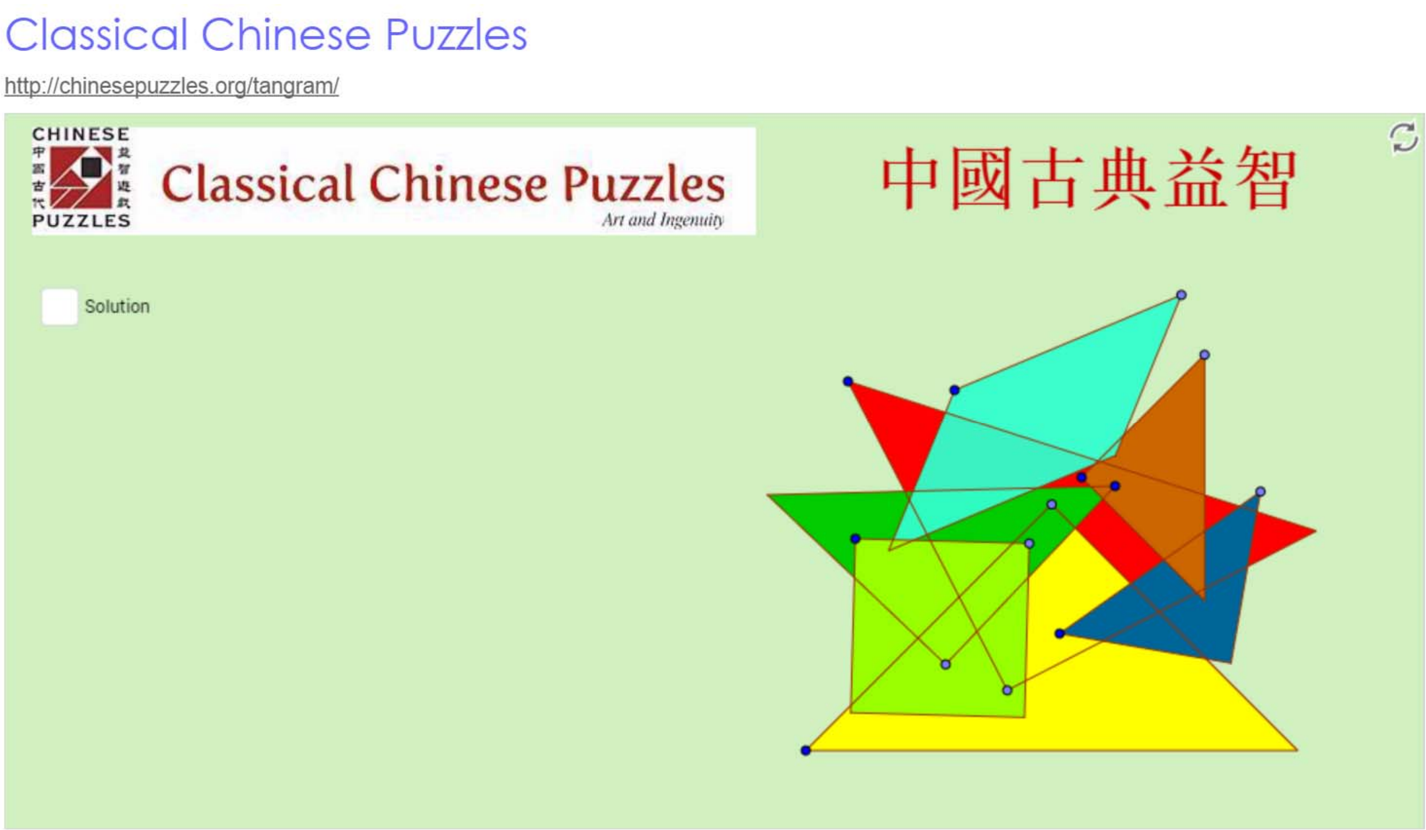
Science • Technology • Engineering • Mathematics

Algebra
Statistics

Science

V GeoGebra and Tangrams

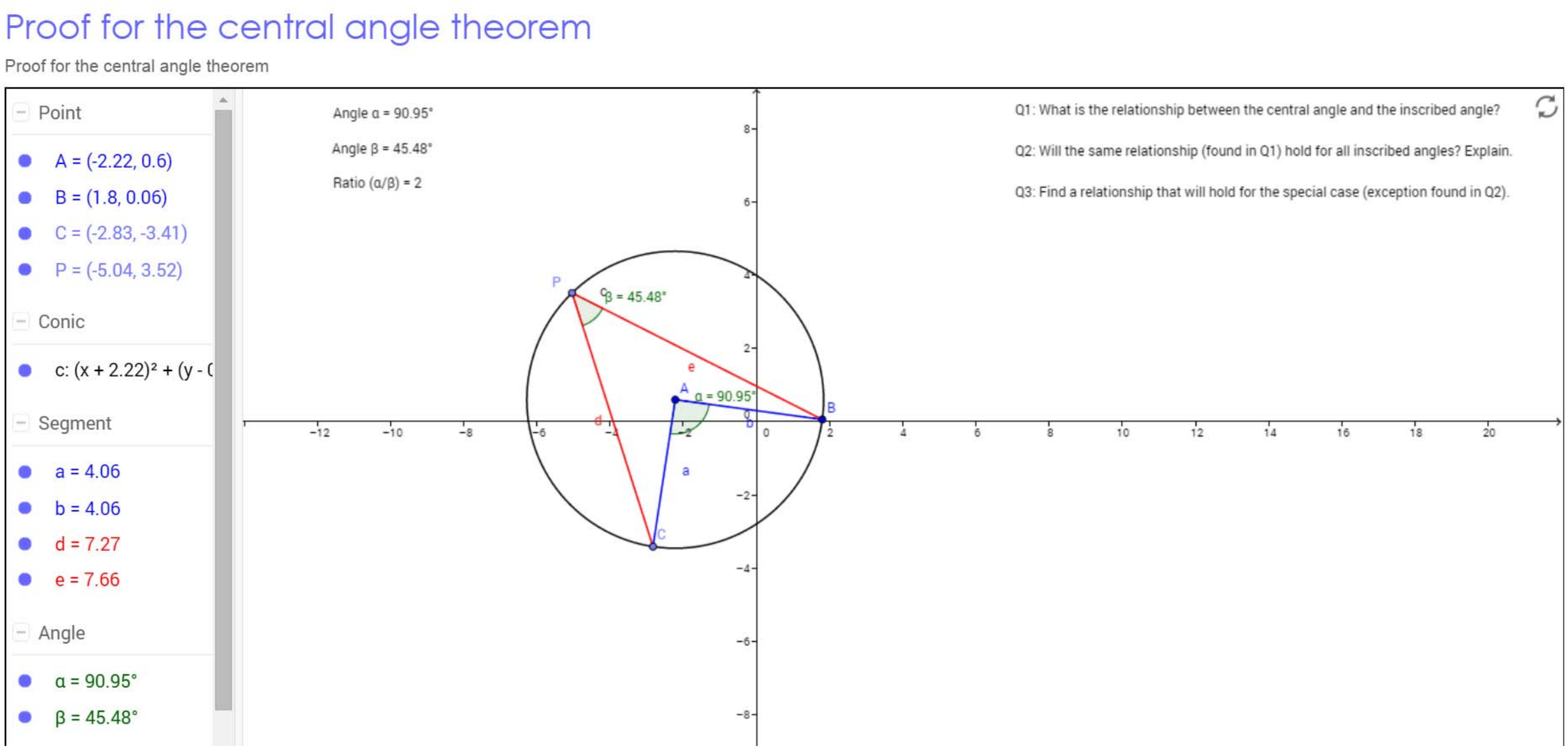
http://www.geogebra.org/student/m157562



http://chinesepuzzles.org/tangram/

GeoGebra Example Central Angle Theorem

http://tube.geogebra.org/student/mCntMT6zE



V GeoGebra: What can it do?

- Geometry: Central Angle Theorem
- Calculus: Integration
- Algebra: Transformation of functions
- Geometric construction: Inscribed circles
- More resources: www.geogebra.org

V GeoGebra: Why to use it?

- Dynamic and interactive
- Accurate construction (Vs. Drawing)
- Visualization of mathematical objects
- Exploration and discovery (what-ifs)

V GeoGebra: Group activity

Group activity

1. Visit www.geogebra.org
2. Browse available materials
3. Work with a partner to design a GeoGebra activity you can use with your students them.

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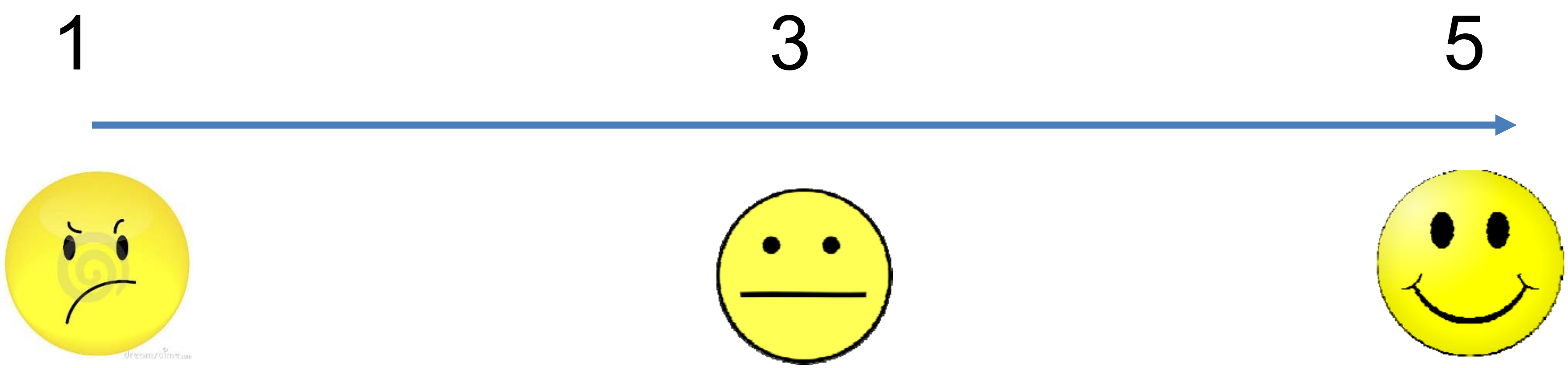
Day 2: Feedback 1

How satisfied are you with the day?

1 3 5

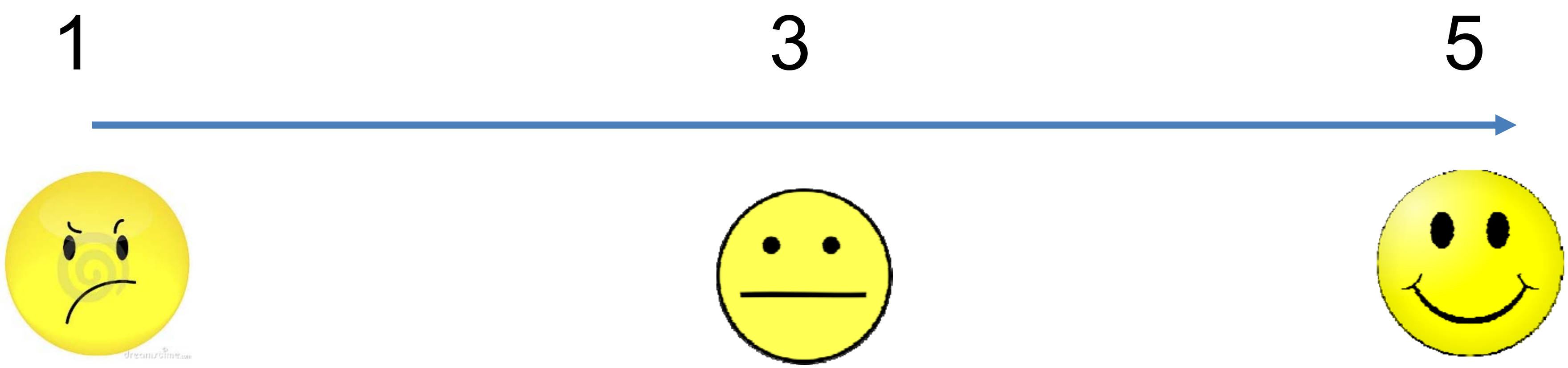
Day 2: Feedback 2

Do you feel you have learned new ideas for math and science teaching?



Day 2: Feedback 3

Are you looking forward to Day 2?



Day 2: Feedback 4

What was the pace of the day?

1 3 5

Day 2: Feedback 5

What was the amount of information for you today?

1 3 5