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

Dr. Marina Milner-Bolotin

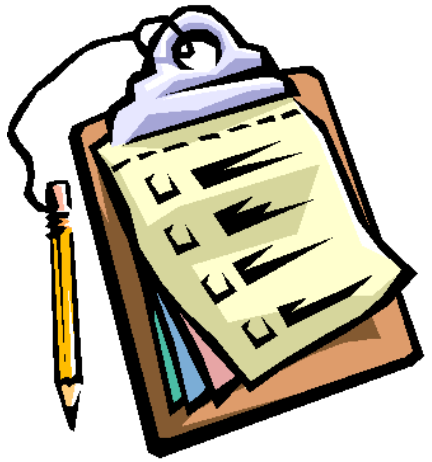
Day 1 - May, 2015

Day 1: May 2015

Does technology presence guarantee improved student learning?

Agenda for the Day

I. Course introduction, goals, big questions
II. Course participants' introductions (discussion)
III. Math & Science (M&S) education in Canada
IV. M&S education in China (discussion)
V. Group activity: How do we learn M&S?
VI. Summary of the day



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I Intro: Course Goals

1. To explore what we know about M&S learning and think together how we can use technology to engage our students in meaningful M&S learning
2. To help you explore M&S educational technologies relevant to your teaching

I Course Tentative Schedule

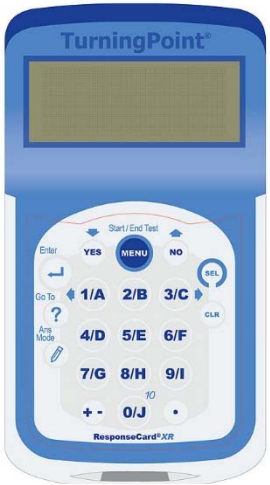
Day	Technology	
1	Student engagement: Clickers, multimedia	✔
2	Peer Instruction and PeerWise: inquiry via questioning; Exploring GeoGebra	
3	Data collection and analysis; Desmos	
4	Computer simulations, games, and online learning environments	
5	Summary and projects' presentations	

Paper is Not Dead…

Paper is not dead - הנייר לא מת
www.youtube.com
Emma.....

Paper is Not Dead…

What is Educational Technology?



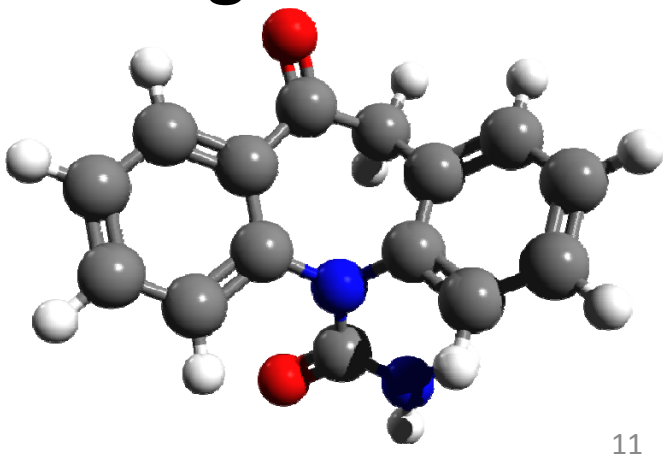
I Course Big Questions

How do we ensure technology in mathematics and science classrooms:

1) Promotes meaningful **learning**?
2) Makes learning **more interesting & engaging**?
3) Opens **new opportunities** for learning?
4) Inspires students to continue learning?

I Course Structure

1) Presentations by Marina and by you
2) Discussions in small groups and in a large group
3) Group and individual work
4) Reading/review of course materials
5) Hands-on activities and lesson design
6) Reflections



I Course Expectations

How to succeed in this course:

1) Participate in class discussions
2) Read and reflect on required materials
3) participate in activities during meetings
4) Work with your group
5) Present the final project at the end

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II Getting to Know Each Other: (15 minute warning)

1. A few words about you:
   - Your teaching interests and experience?
   - Why are you here?
   - What would you like to get out of this course?
2. How do you use technology in your teaching?
3. What does technology mean in your life?

II Dr. Marina Milner-Bolotin

- Assistant Professor in Science Education, UBC, Canada
- Department of Curriculum & Pedagogy
- **e-mail:** marina.milner-bolotin@ubc.ca
- **Web site:** http://blogs.ubc.ca/mmilner/

II UBC (University of British Columbia)

11,965 international students from 139 countries!

UBC Facts:

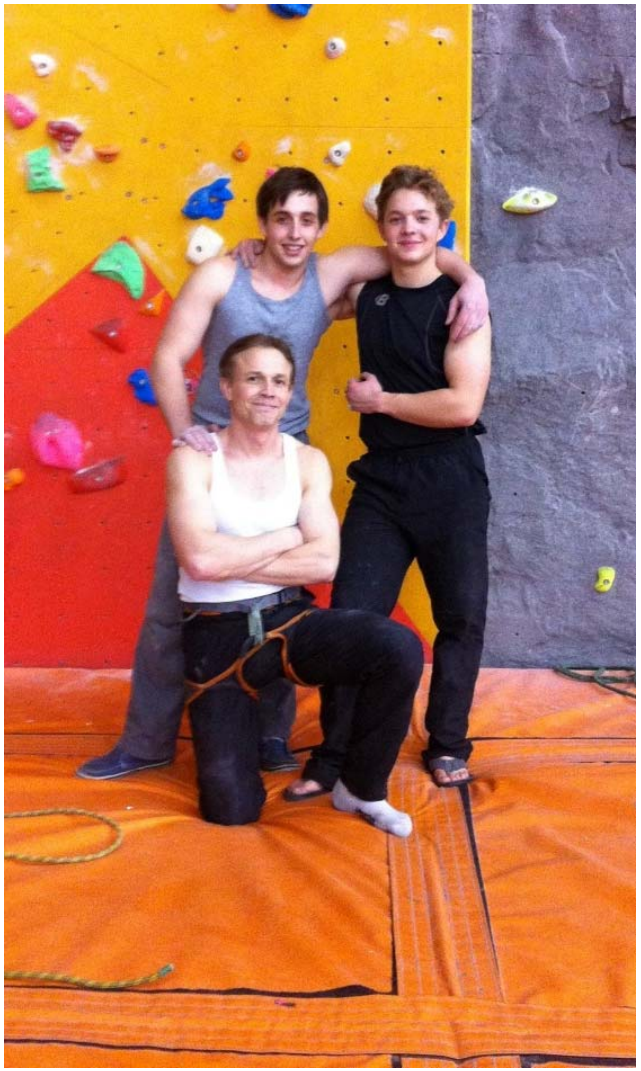
- Public university
- Established: 1908
- 2 campuses: Vancouver & Kelowna
- ~60,000 students
- Academic staff: 5100+
- Acceptance rate: 64%
- International ranking – 30th (U.S. News and World Report 2015)

II My Research Interests

- The use of technology in M&S education
- M&S teacher education
- **Recent publications:**

1. Milner-Bolotin, M. (2015). Technology-enhanced teacher education for 21st century: Challenges and possibilities. In X. Ge, D. Ifenthaler & J. M. Spector (Eds.), *Emerging technologies for STEAM education* (pp. 24).
2. Milner-Bolotin, M. (2015). Increasing girls' participation in physics: Education research implications for practice. *Physics in Canada, 71*(2), 4.
3. Milner-Bolotin, M. (2014). Using PeerWise to promote student collaboration on design of conceptual multiple-choice questions. *Physics in Canada, 70*(3), 149-150.
4. Milner-Bolotin, M., Fisher, H., & MacDonald, A. (2013). 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*(5), 523-542.

II My Life at a Glance



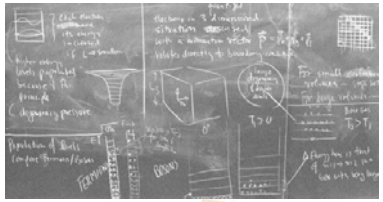
1. Borne in the Soviet Union
2. Lived in Israel, USA and Canada
3. M.Sc. in theoretical physics; Ph.D. in science and mathematics education
4. Two sons: UBC students in science
5. Husband: UBC physics professor
6. Experience (since 1991):
   a) K-12 - school teacher
   b) University instructor (physics)
   c) Teacher educator (math & science)
7. Outreach and gifted students' educator

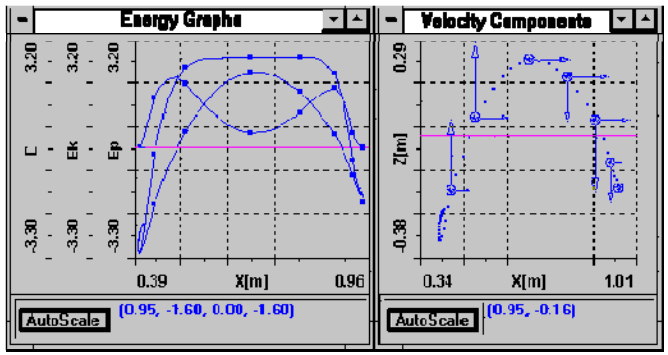
II UBC Outreach Experience

Work with teachers, teacher-candidates and students:

- UBC teacher educator
- Past president of BC Association of Physics Teachers
- Co-Organizer of UBC Physics Olympics
- Founder: UBC Family Math and Science Day

II My Math & Science Education Trajectory





V-scope

II My Questions

1. How has science & math (S&M) learning changed?
2. What do we know about S&M learning?
3. How do we facilitate S&M learning?
4. What does technology enable us to do?
5. How do we support science educators?

II Getting to Know Each Other

What subjects do you teach?

1. Mathematics only
2. Science only
3. Mathematics and science
4. Other: non-math and science
5. I do not teach

II Getting to Know Each Other

What is your favourite subject to teach?

1. Mathematics
2. Biology
3. Chemistry
4. Physics and astronomy
5. Other science

II Getting to Know Each Other

What ages of students do you teach?

1. Primary school
2. Elementary school
3. Middle school
4. Secondary school

II Getting to Know Each Other: Group Activity (45 min)

1. A few words about you:

   - Your teaching interests and experience?
   - Why are you here?
   - What would you like to get out of this course?

2. How do you use technology in your teaching?

3. How do we define technology?

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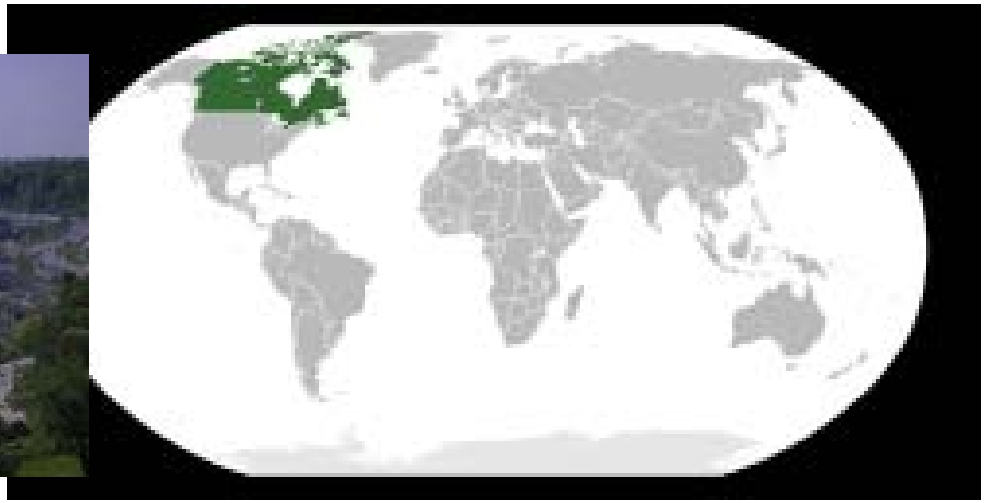
VI. Learning presentation (with clickers)
VII. Summary of the day

III M&S Education in Canada



20.6% of the total population of Canada are immigrants! Toronto transit offers information in > 70 languages. English is often 2nd language.

~75% of Canada's population live within 150 km of the US border.

Science Education in Canada

Science Exposure

K-12

- Elem
- Second

University

- B. Science
- Other fields

Teacher Education in Canada

Bachelor Subject + B.Ed.

Elem

B.A.

B.Ed.

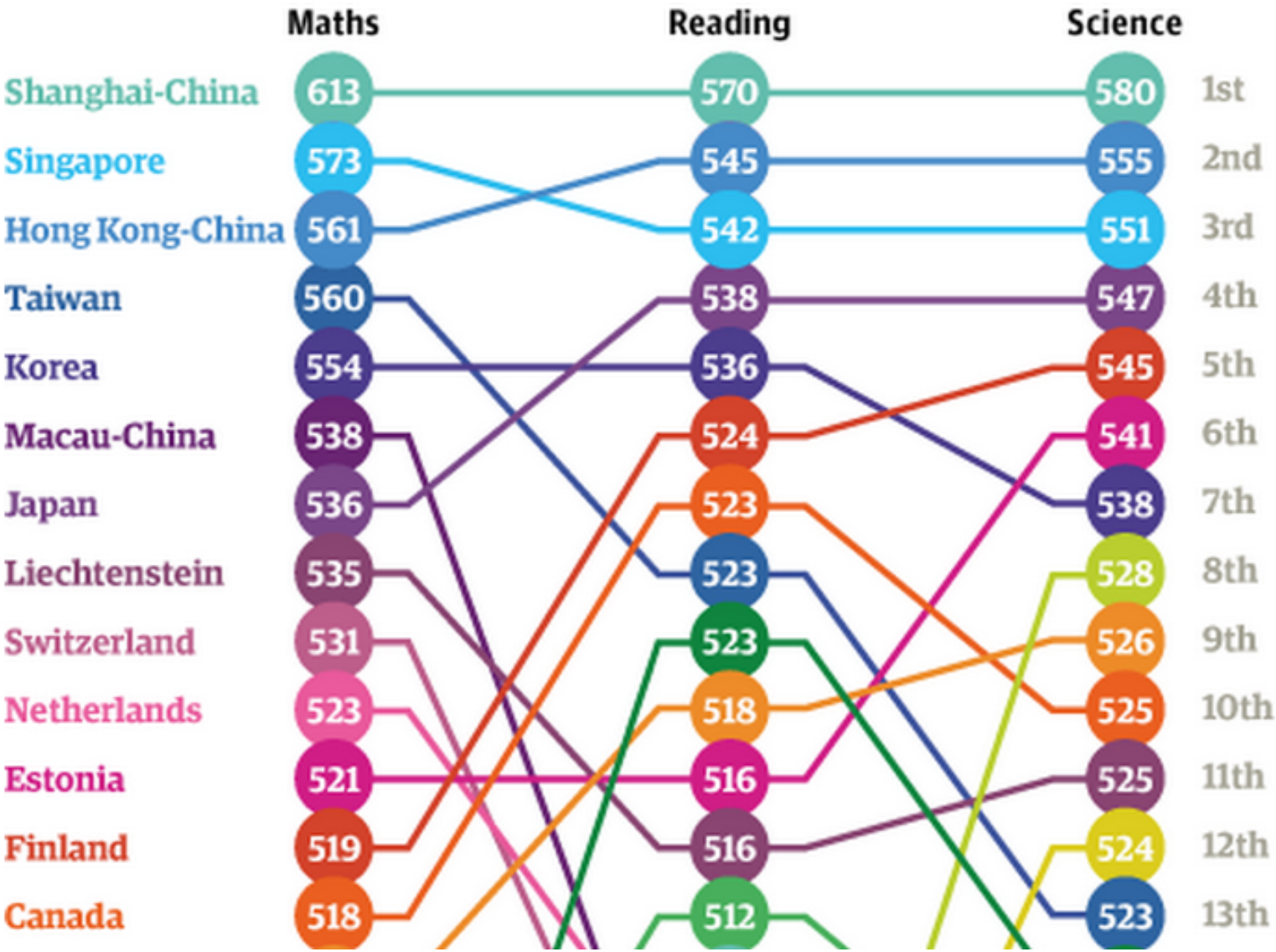
Secondary

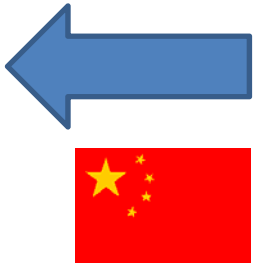
B.Sc.

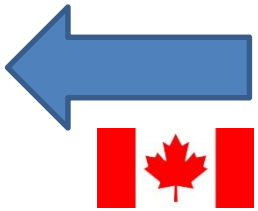
B.Ed.


raphicMaps.com
Arctic Ocean
Banks Island
Prince of Wales Island
Somerset Island
Bylot Island
Beaufort Sea
Victoria Island
Nunavut
Baffin Bay
MacKenzie R.
Arctic Circle
Baffin Island
Greenland
Foxe Basin
Great Bear Lake
Yukon Territory
Northwest Territories
Southampton Island
Davis Strait
Iqaluit
Godthab
Yukon River
Nunavut
Hudson Strait
Mt. Logan
Whitehorse
Yellowknife
Great Slave Lake
Canada
worldatlas.com
Labrador Sea
Lake Athabasca
Manitoba
Newfoundland & Labrador
Alaska (U.S.)
British Columbia
Churchill River
Hudson Bay
Lake Winnipeg
Quebec
Queen Charlotte Islands
Fraser River
James Bay
Saskatchewan
Regina
New Brunswick
Vancouver Island
Ontario
St. Lawrence River
Lake Manitoba
Great Lakes
PEI
Nova Scotia
Fredericton
Charlottetown
Montreal
Halifax
Toronto
800 mi
800 km
Pacific Ocean
United States of America
Atlantic Ocean

PISA 2012 Results







[OECD, PISA 2012 Results]

III Teacher Education in Canada

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 [illegible] Laureate, Prof. Carl Wieman

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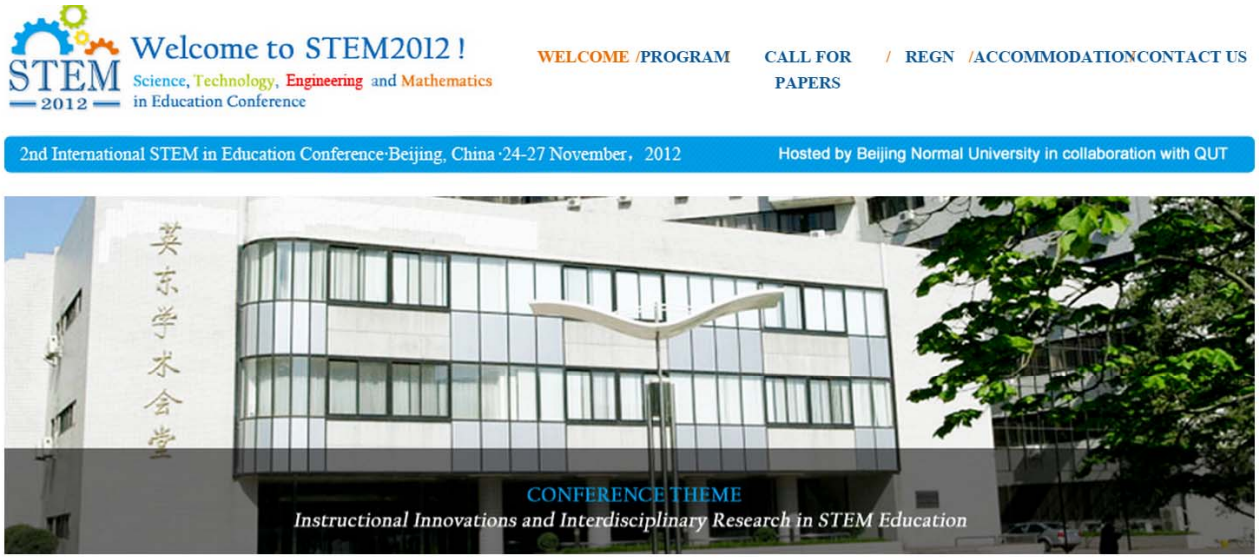
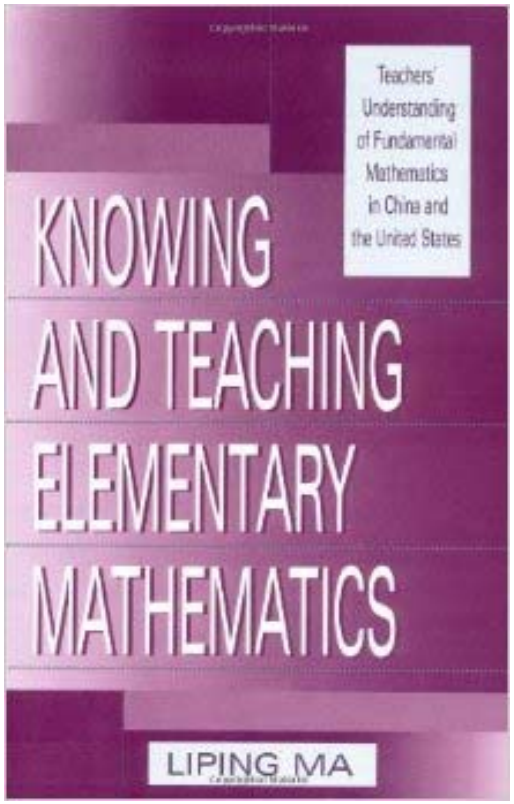
IV Teaching Science and Math in China





http://stem2012.bnu.edu.cn/

IV Teaching Science and Math in China

- What are your greatest challenges in math and science teaching?
- What would you like about math and science teaching in China?
- What would you like to improve?
- How do you improve your teaching?

Break: Mental Exercise

Milk and Tea Puzzle

You have 2 identical glasses of milk & tea. 3 tea-spoons of milk from a glass of milk are poured into a glass of tea, and the liquid is thoroughly mixed. Then three teaspoons of this mixture are poured back into the glass of milk.

Which is greater now: the % of milk in the tea or the % of tea in the milk? Why?

1. More milk in tea
2. More tea in milk
3. About the same

Baseball and Math

One year a soccer team played 180 games. They never lost more than 3 games in a row and never won more than 5 games in a row. The number of games the team must have won must have been:

1. At least 36 games
2. At least 45 games
3. At least 135 games
4. At least 111 games
5. At least 150 games

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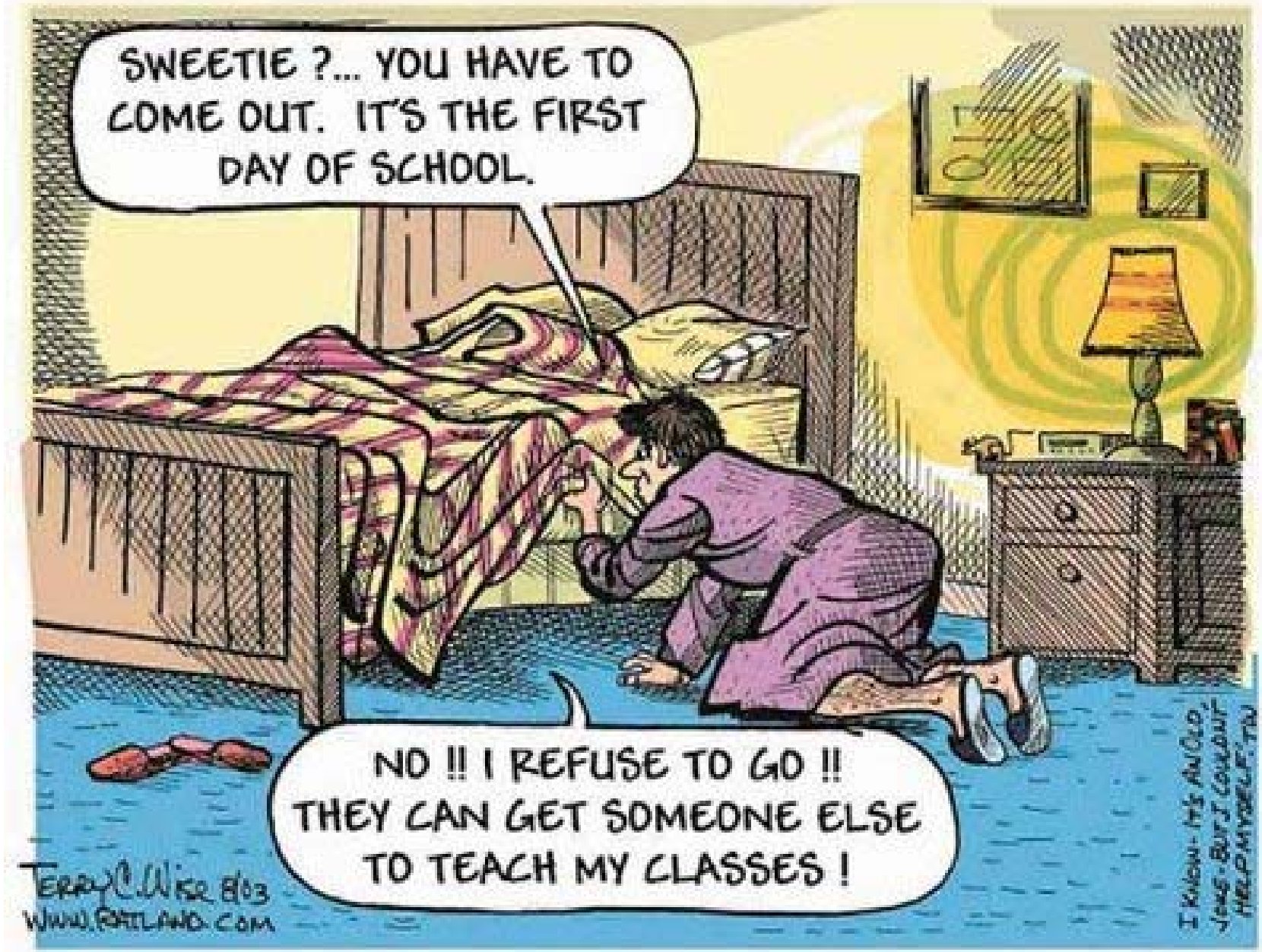
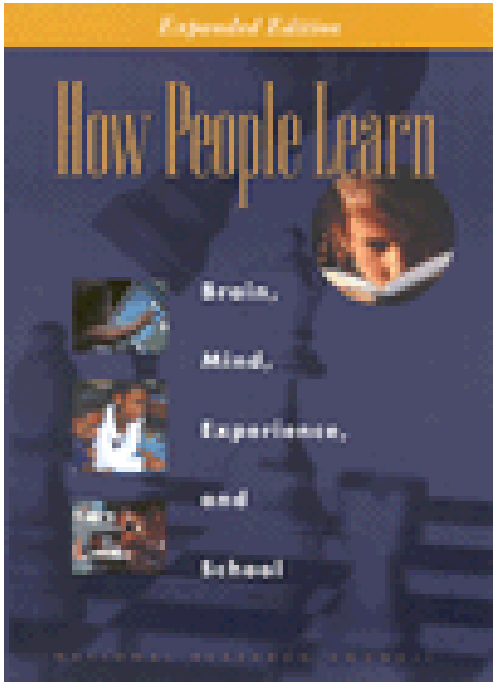
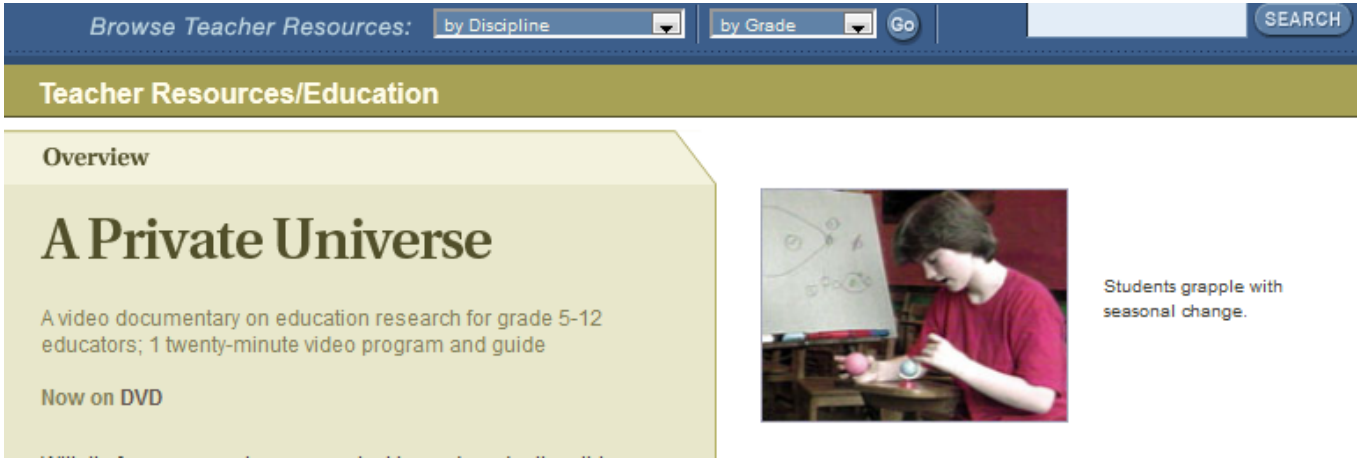

SWEETIE ?... YOU HAVE TO COME OUT. IT'S THE FIRST DAY OF SCHOOL.
NO !! I REFUSE TO GO !! THEY CAN GET SOMEONE ELSE TO TEACH MY CLASSES !
TERRY C. WISE 8/03
WWW.FORTLAND.COM





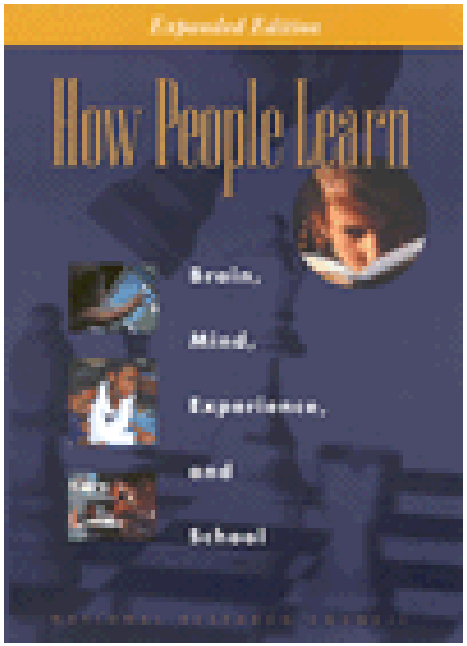
DISCUSSION

How People Learn Mathematics and Science: Building a case for technology integration

What do we know about human learning and how may (should) it shape the design of technology-enhanced SMET learning environments?

How Familiar Are You With "How People Learn" book?

1. I have read most of it
2. I have read a few chapters
3. I have skimmed over it quickly
4. I haven't read it yet
5. I do not think I will be able to read it



Challenges of Mathematics and Science Learning

Essence of effective education – transforming how students think about science and mathematics in terms of attitudes and problem solving skills.

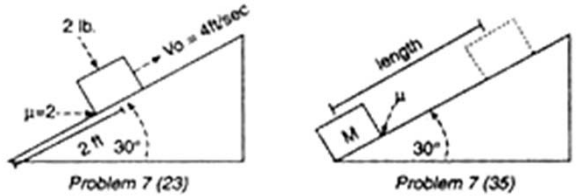
Challenge: Novice –…. – Expert transformation

$$N \quad => \quad E$$

$N => E$

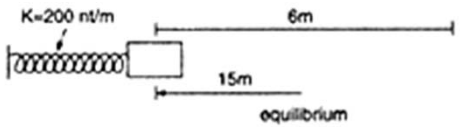
Thinking Like Scientists (?)

Novices' explanation for their grouping of two problems

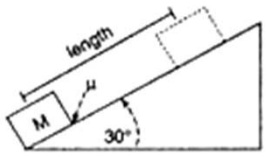


Problem 7 (23) Problem 7 (35)

Experts' explanation for their grouping of two problems



Problem 6 (21)



Problem 7 (35)

Grouping Explanations: Novices

N1: These deal with blocks on an incline...

N5: Incline plane problems, coefficient of friction.

N6: Blocks on inclined planes with angles.

Grouping Explanations Experts:

E2: Conservation of energy.

E3: Work-energy theorem.

E4: These can be done from energy considerations.

How People Learn: Brain, Mind, Experience, and School (1999), Commission on Behavioral and Social Sciences and Education

$N => E$

Knowledge Organization

Experts organize their knowledge by building a web of **interrelated concepts.** The relationships between the concepts are based on **physical laws**.

Novices have their knowledge organized using **superficial features**.

Knowledge organization affects how one can access the knowledge and consequently use it.

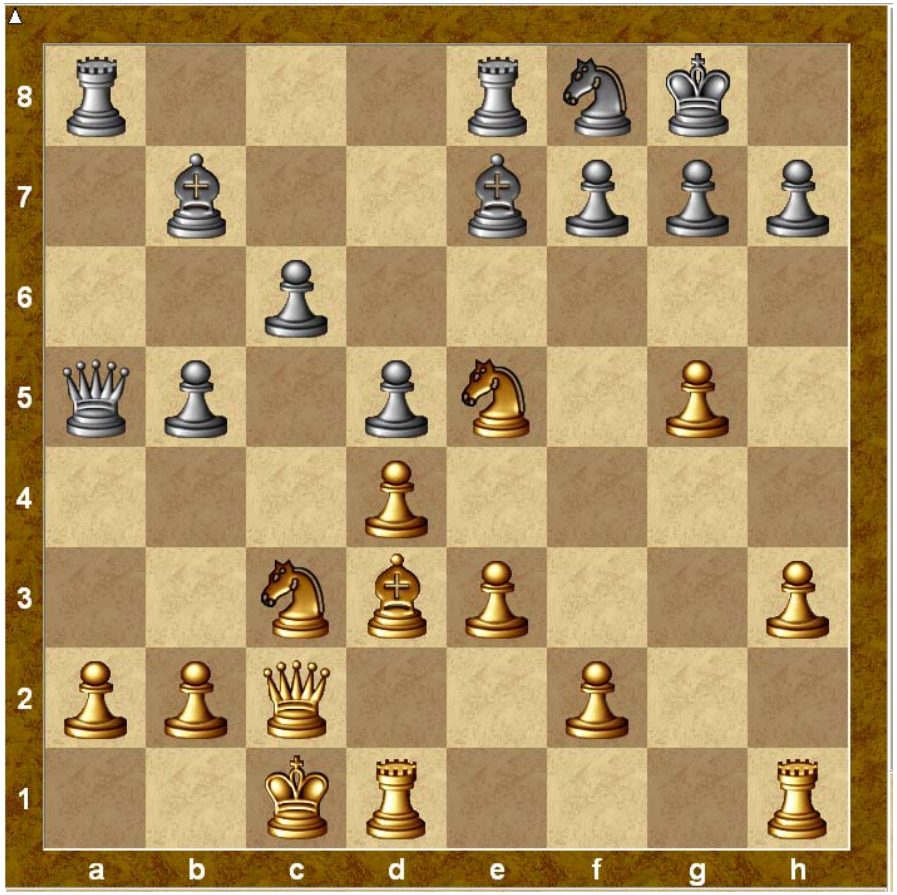
Network representations of incline plane schema of novices and experts. SOURCE: Chi et al. (1982:58). Used with permission of Lawrence Erlbaum Associates.

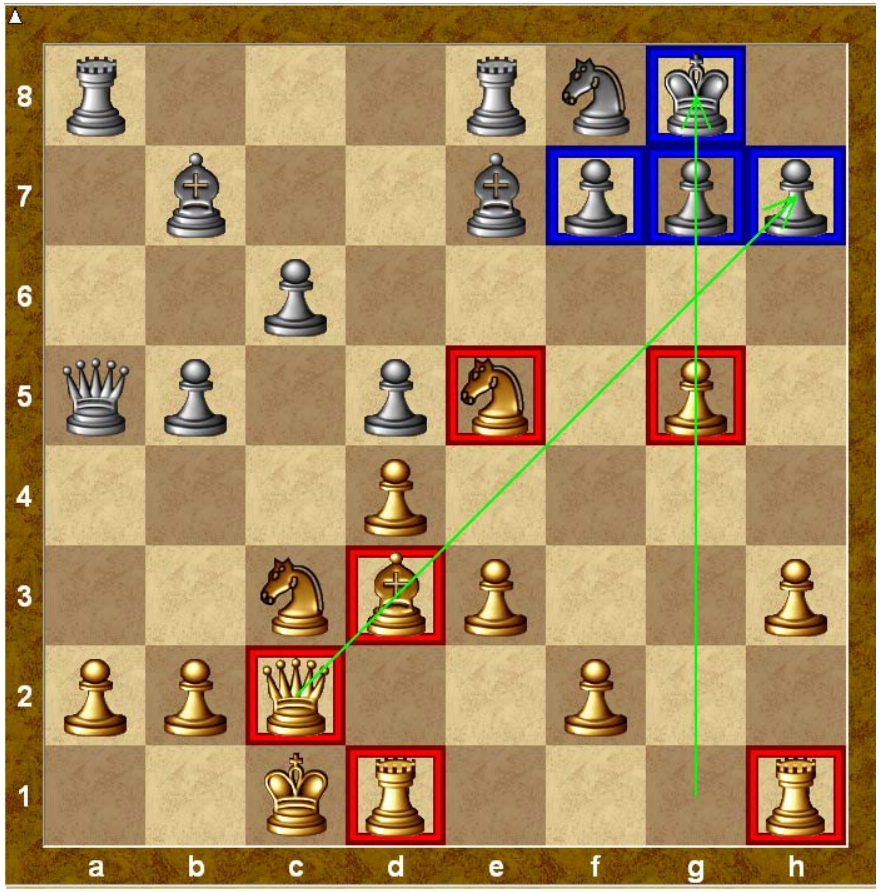
$N => E$

Problem Solving

- **Experts:** make sense of the problem and then use a problem solving strategy and appropriate tools to solve it.
- **Novices:** immediately turn to “the formula” which has the right variables involved without even understanding a problem or if this formula is even applicable.

What do Experts and Novices See?

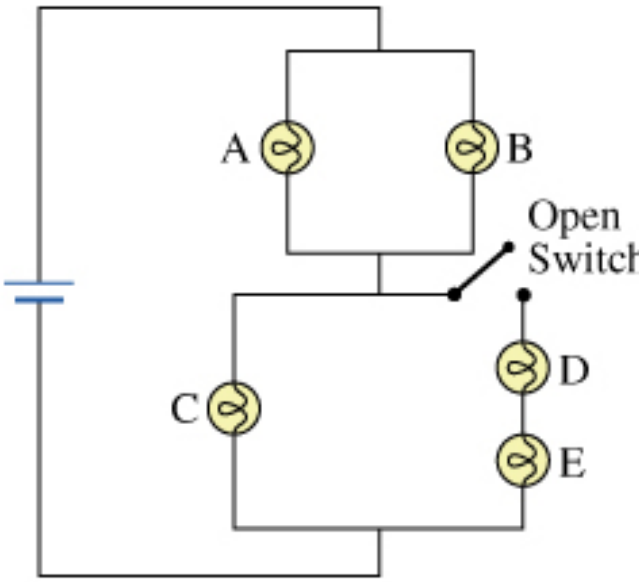


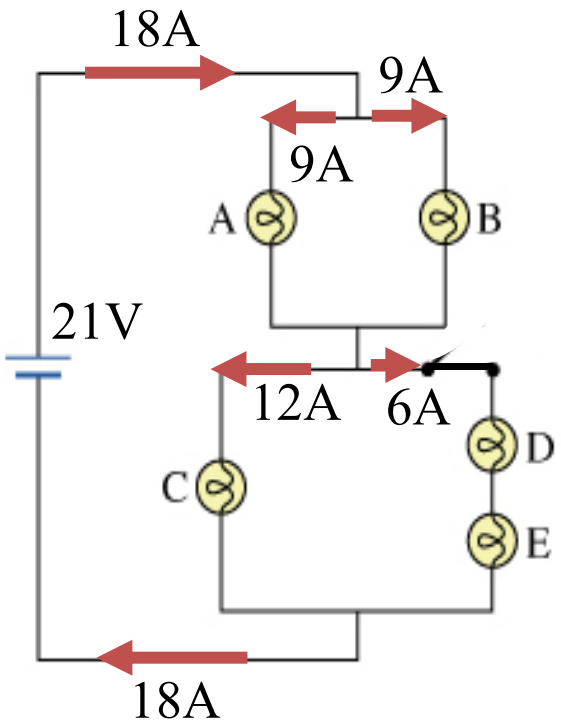


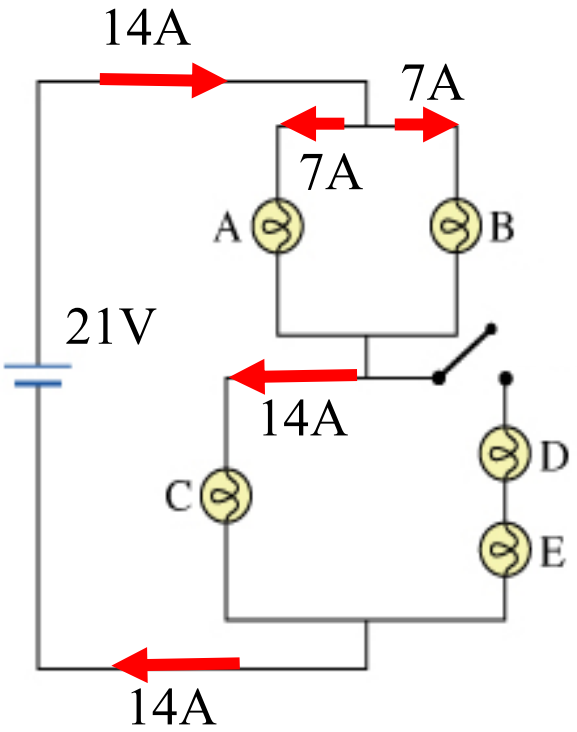
White to move. Topic: Lack of King's defense.

Solution: […] 1. Bxh7+! Nxh7 2. g6! fxg6 3. Qxg6 Nf8 4. Qf7+ Kh8 5. Rhg1 Bf6 6. Rxg7! Bxg7! 7. Rg1 Ne6 8.Rg6! Kh7 9.Rh6! Kxh6 10.Qg6#

What do Experts and Novices See?







Rank the bulbs' brightness. Each bulb has 1 Ohm resistance. Topic: Series and parallel DC circuits, conservation of I.

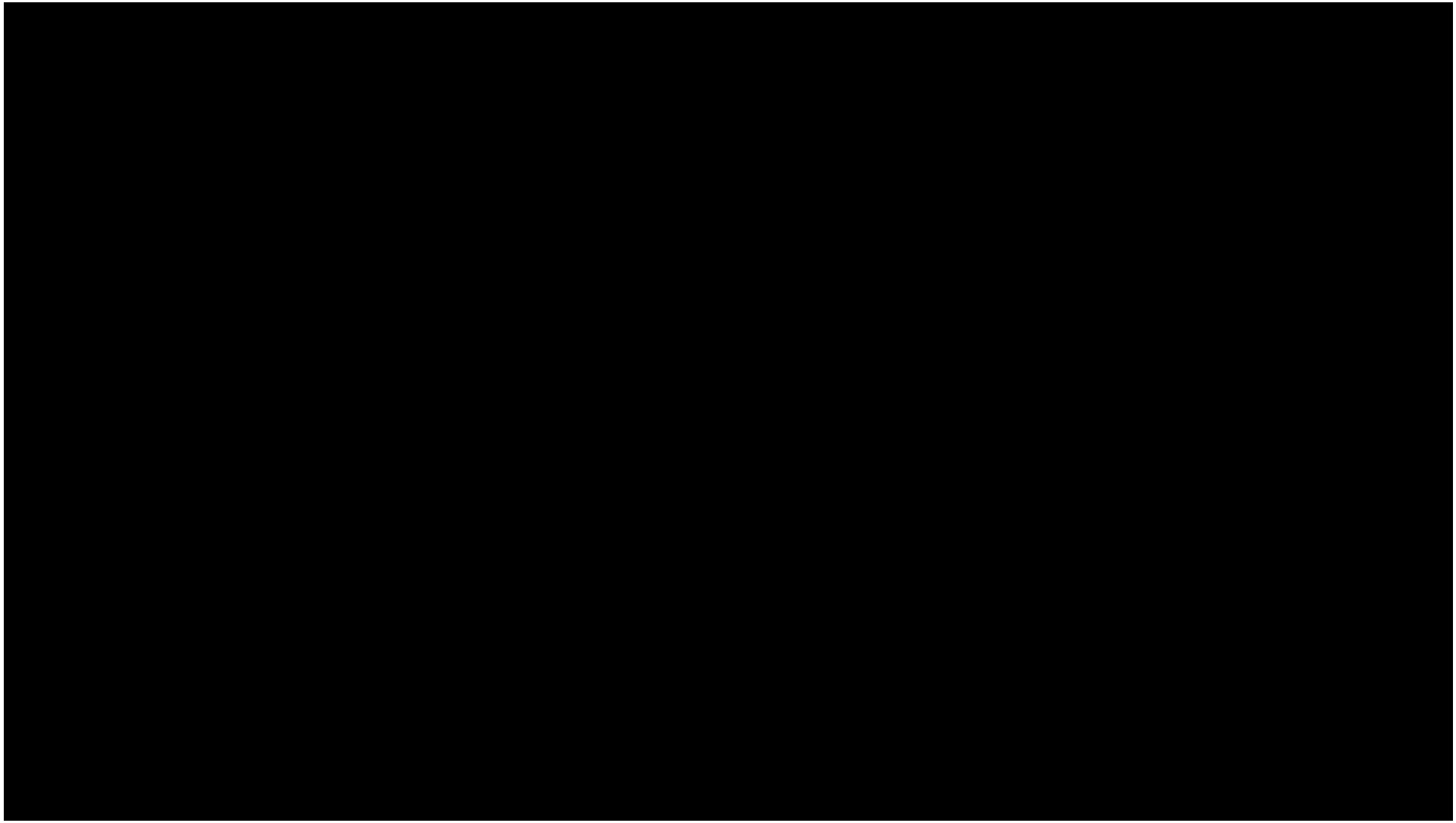
Solution: Switch closed: C>A=B>D=E; Switch open: C>A=B>D=E=0; When the switch is open bulb C gets brighter than when the switch was closed.

UBC ETEC 533 2013 Assignment

An online MET course on teaching and learning mathematics and science with technology

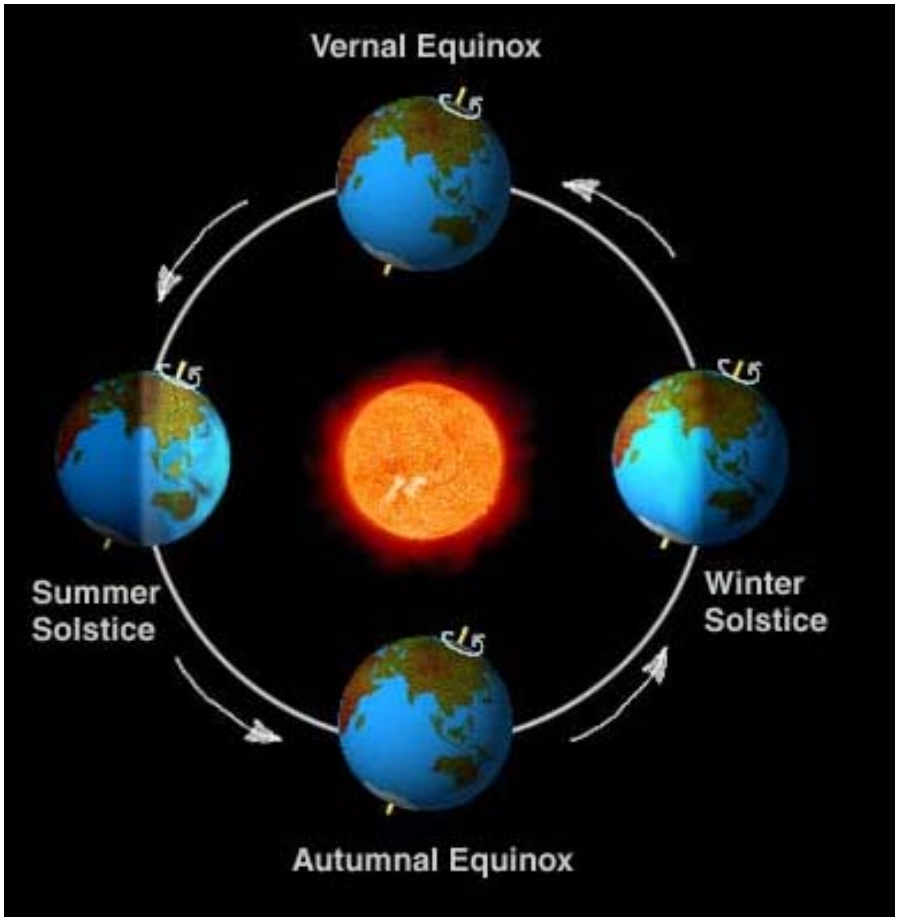
Ryan Layton
Suhayl Patel
Colleen Ruddy

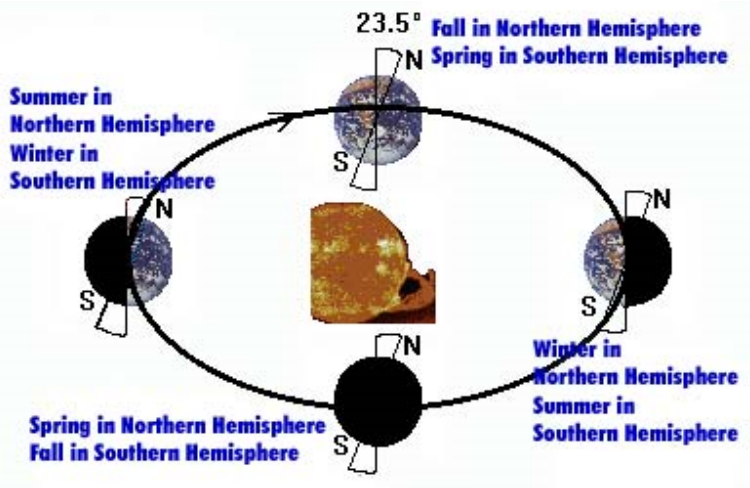
From Novices to Experts



What we teach is what is learnt or is it?

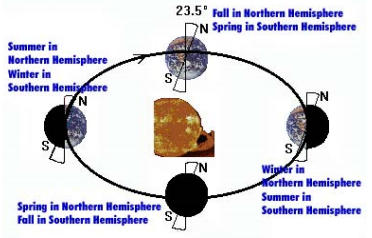
Causes of Seasons: The Importance of Students' Prior Knowledge





Textbook representations are often aimed at scientists, not students…

Causes of Seasons



The seasons are caused by the Earth's tilt. Why?

1. Because the part of the Earth closer to the Sun has summer and the farther away has winter
2. Because the Earth moves along an elliptical orbit and is tilted
3. Because the tilt changes the amount of direct light coming to Earth and it causes seasons
4. Because the tilt and the clouds in the Earth's atmosphere produce indirect light and cause seasons.

Do Harvard Graduates Do Any Better?

Overview

A Private Universe

A video documentary on education research for grade 5-12 educators; 1 twenty-minute video program and guide

With its famous opening scene at a Harvard graduation, this classic of education research brings into sharp focus the dilemma facing all educators: Why don't even the brightest students truly grasp basic science concepts? This award-winning program traces the problem through interviews with Harvard graduates and their professors, as well as with a bright ninth-grader who has some confused ideas about the orbits of the planets. Equally useful for education methods classes, teacher workshops, and presentations to the public, ***A Private Universe*** is an essential resource for science and methodology teachers.

Produced by the Harvard-Smithsonian Center for Astrophysics. 1987.

ISBN: 1-57680-404-6

Students grapple with seasonal change.

VoD *Look for this icon to play FREE video.*

- Overview
- Individual Program Descriptions
- Printable Page
- Broadcast Dates
- Buy Videos and Materials

Related Resources See all

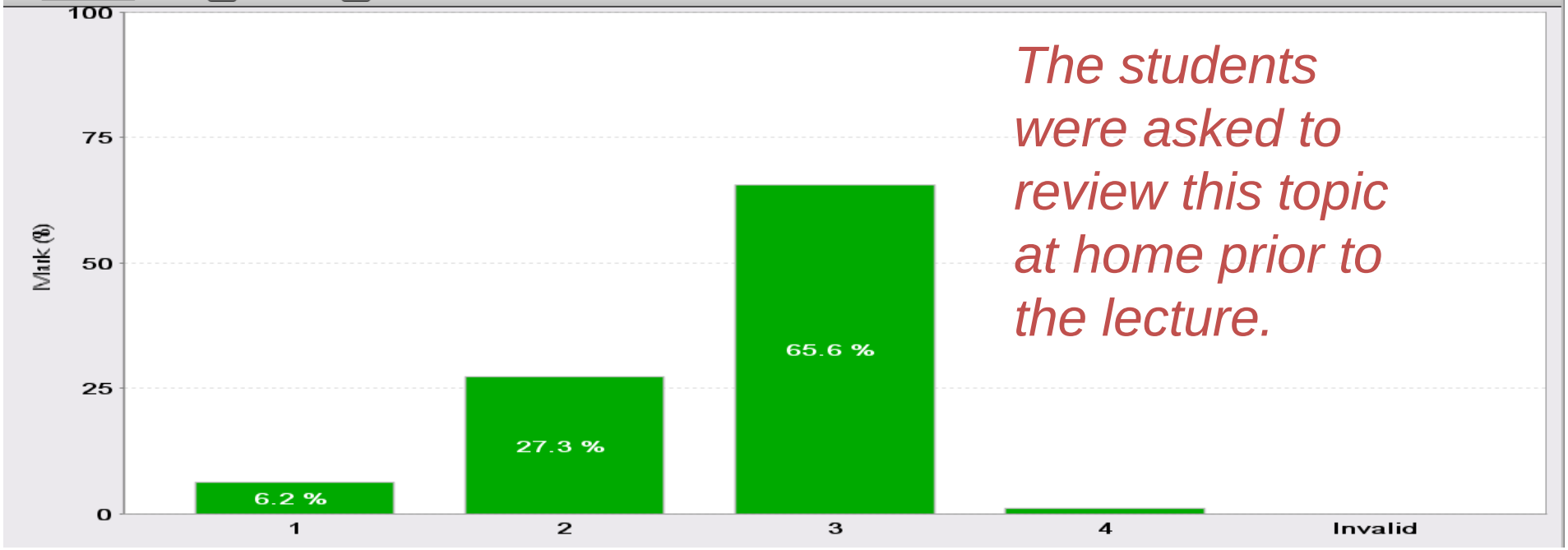
Minds of Our Own
Private Universe Project in Science
Private Universe Project in Mathematics
Surprises in Mind
Essential Science for Teachers: Earth and Space Science

End Review 1/7 220 Mark Session

Q: We all **know** that the seasons are caused by the Earth's tilt. But why is that?

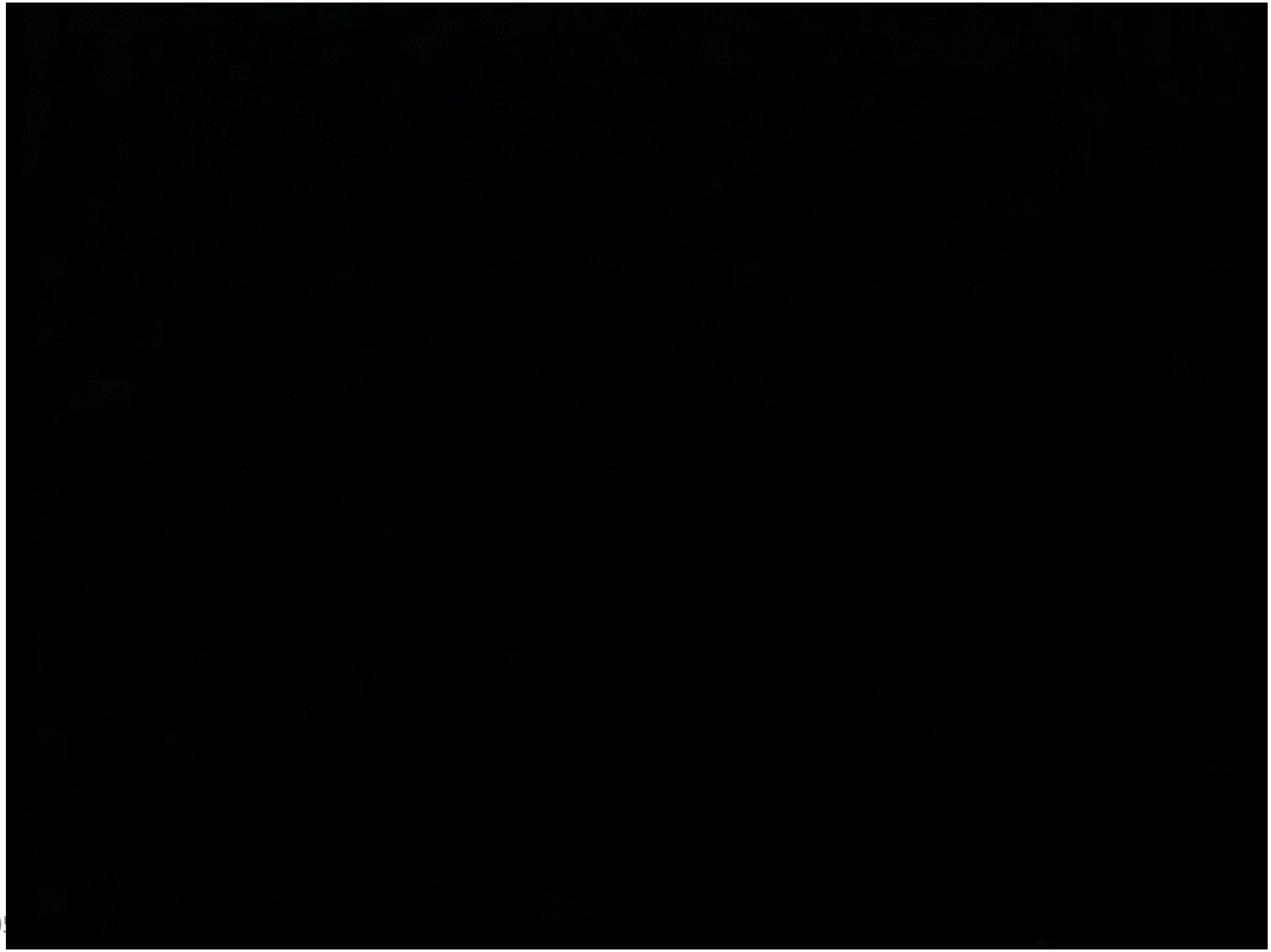
1. Because the part of the Earth closer to the Sun has summer and the farther away has winter (distance from the Sun determines the season).
2. Because the Earth moves along an elliptical orbit and is tilted (distance from the Sun).
3. Because the tilt changes the amount of direct light coming to Earth and it causes seasons.
4. Because the tilt and the clouds in the Earth's atmosphere produce indirect light and cause seasons.

1/7 Change Correct Answer



The students were asked to review this topic at home prior to the lecture.

A Private Universe



What does it all mean for the design of technology-enhanced mathematics and science learning environments?

Agenda for the Day

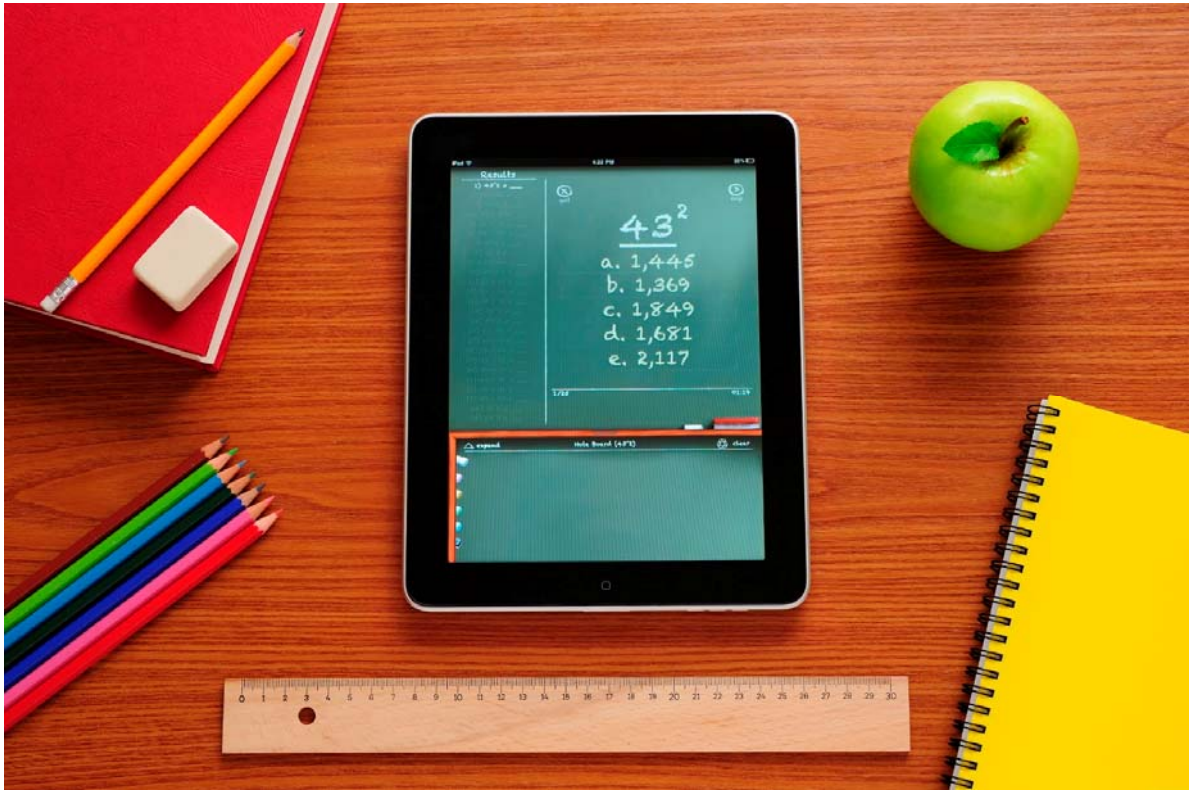
I. Course introduction, goals, big questions
II. Course participants' introductions (discussion)
III. Math & Science (M&S) education in Canada
IV. M&S education in China (discussion)
V. Group activity: How do we learn M&S?
VI. Summary of the day

What difficulties do students face in your classes?

I. **Group activity – 30 min**

How do you think technology can help your students?

I. Brainstorming activity



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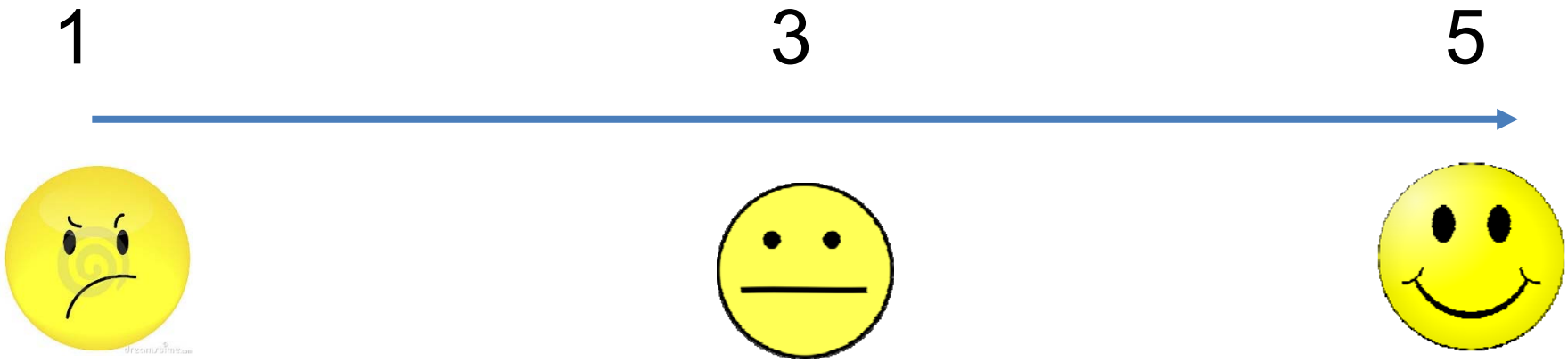
Day 1: Feedback 1

How satisfied are you with the day?



Day 1: Feedback 2

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

1 3 5

Day 1: Feedback 3

Are you looking forward to Day 2?

1 3 5

Day 1: Feedback 4

What was the pace of the day?

1 3 5

Day 1: Feedback 5

What was the amount of information for you today?

1 3 5