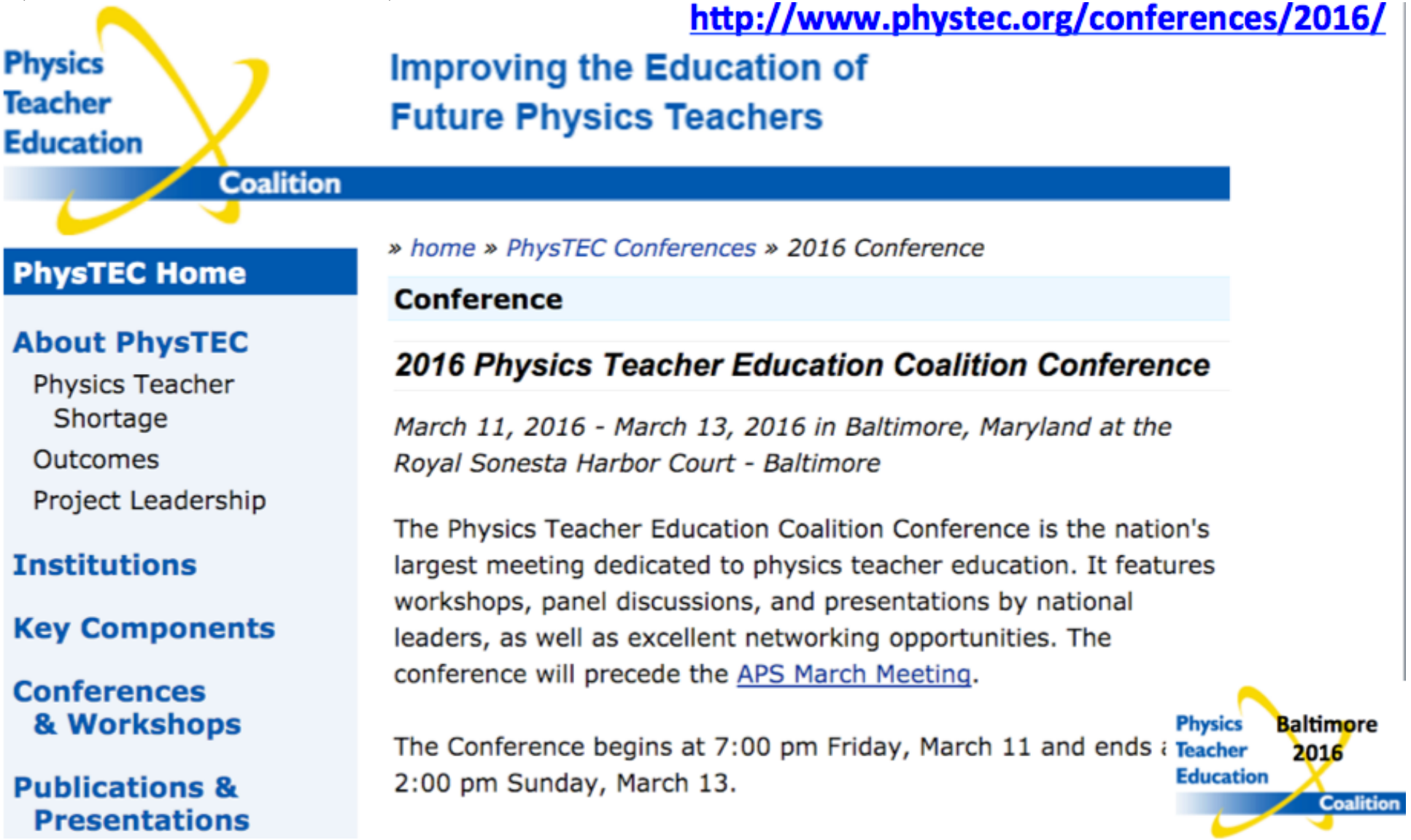
(1) Hello, I am Dr. Valentin Voroshilov,

http://www.phystec.org/conferences/2016/



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(2) I've been in the field of education for many years playing many different roles.
I was born and grew up in Russia. I had a pretty good career in Russia, but when I got a chance to move my family to the US, I took that chance.

Dr. Valentin Voroshilov

www.TeachOlogy.xyz

Professional experience and areas of expertise:

Teaching:

Algebra based physics
Calculus based physics
Physics for science teachers
Physics for students with learning disabilities

Algebra
Geometry
Trigonometry
Methods for teaching physics

Consulting:

Individual teachers
School administrators
District administrators
School and district teams of educators on strategies and tactics for advancing teaching practices and improving learning outcomes.

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(3) **After starting again from the bottom I have regained most of my previous career achievements. I am pretty proud of this, considering I had no formal education in English and no professional network to support my efforts.**

Dr. Valentin Voroshilov www.TeachOlogy.xyz

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Dr. Valentin Voroshilov

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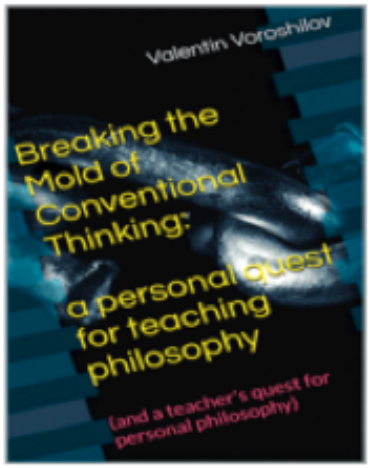
Some of our publications



click here for more

Thinking about becoming a STEM teacher? Think

Professional Designing As One Of The Key Compo

Education reform needs a new paradigm.

A confirmation of good teaching.

How I flipped my class without even knowing it.

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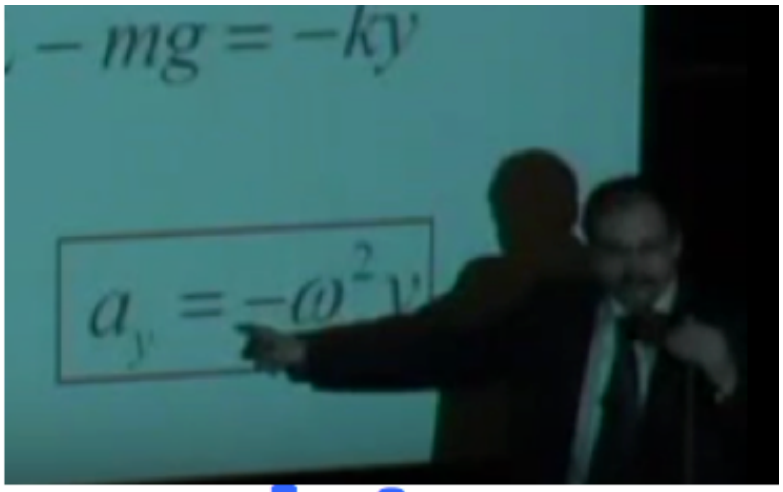
(4) Here I would like to present a framework for developing a universal standard for measuring learning outcomes of students taking physics courses.
I would like to start my presentation from two statements:

A framework for developing a universal standard for measuring learning outcomes of students taking physics courses.

LINKS: video https://youtu.be/sDO0kiodsRw html: www.teachology.xyz/FW.htm

(5) Physics is a science.
Teaching physics is not.
Of course, these statements are based on a certain definition of "science".

Physics is a science.



Teaching physics is *not*.

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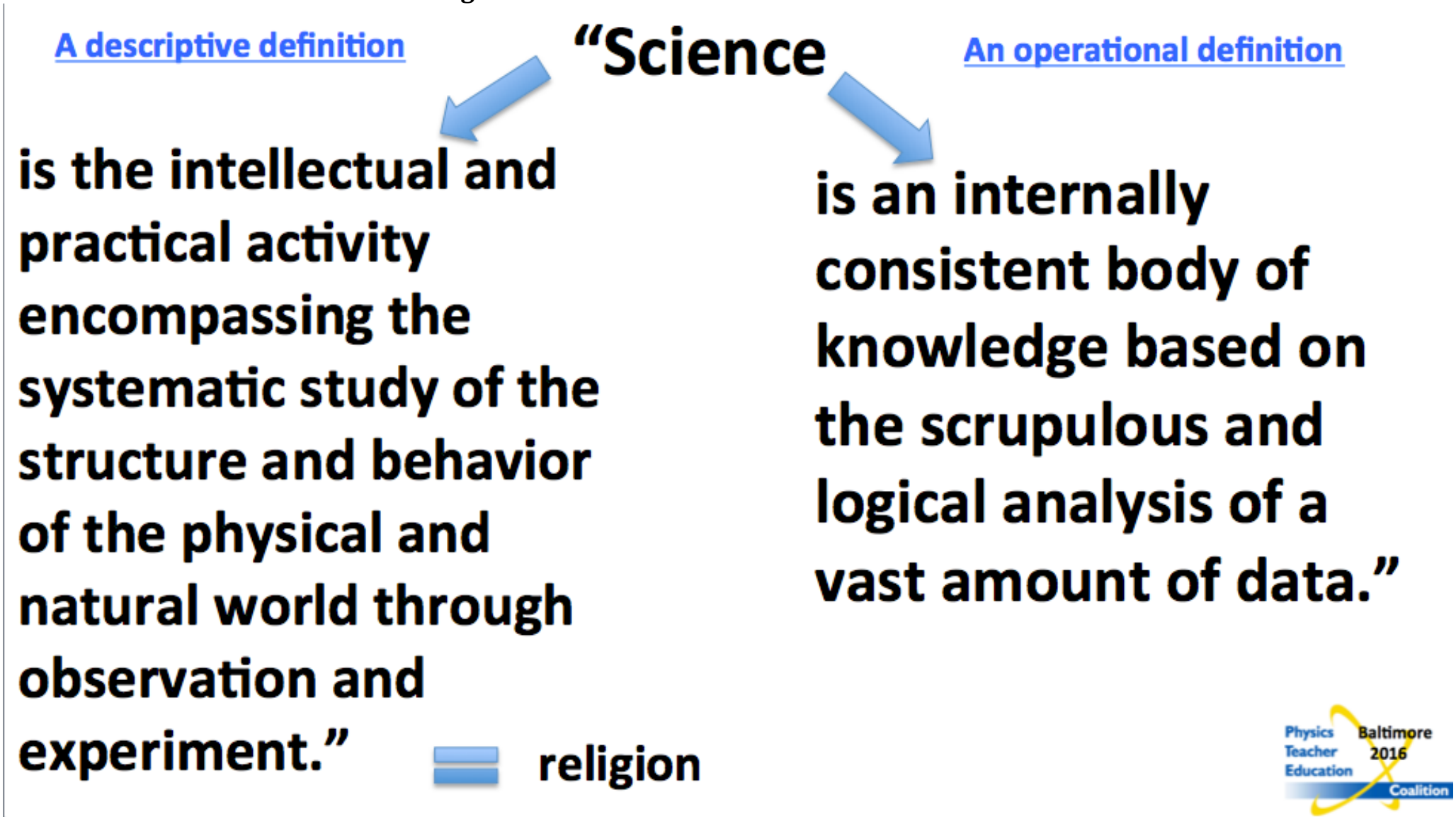
(6) Personally, I do not like descriptive definitions like "science is the intellectual and practical activity encompassing the systematic study of the structure and behavior of the physical and natural world through observation and experiment" (this is the top Google search result for "definition of science"). In fact, such a definition does not really allow to distinguish a science from a religion. I prefer operational definitions, like "A science is an internally consistent body of knowledge based on the scrupulous and logical analysis of a vast amount of data". In particular, this definition allows us to see when a school of thoughts becomes a science.



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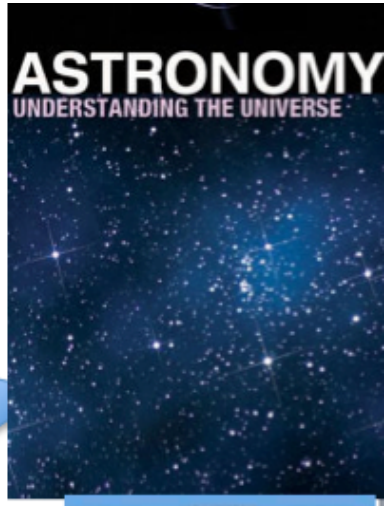
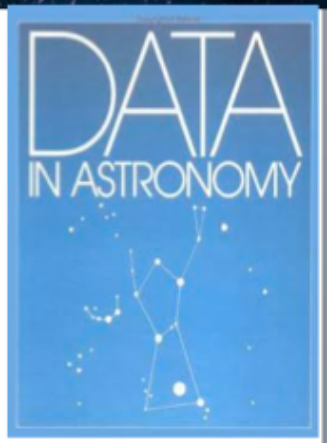
(7) For example, Astronomy dropped Astrology and became a science when Kepler finished his analysis of huge amount of data collected before him, and wrote his famous laws. Of course, in reality there is always back and forth between theorizing and data collecting, or as we call it today – data mining, but in the end,

Data mining

More data mining

Kepler





Ptolemy

Copernicus

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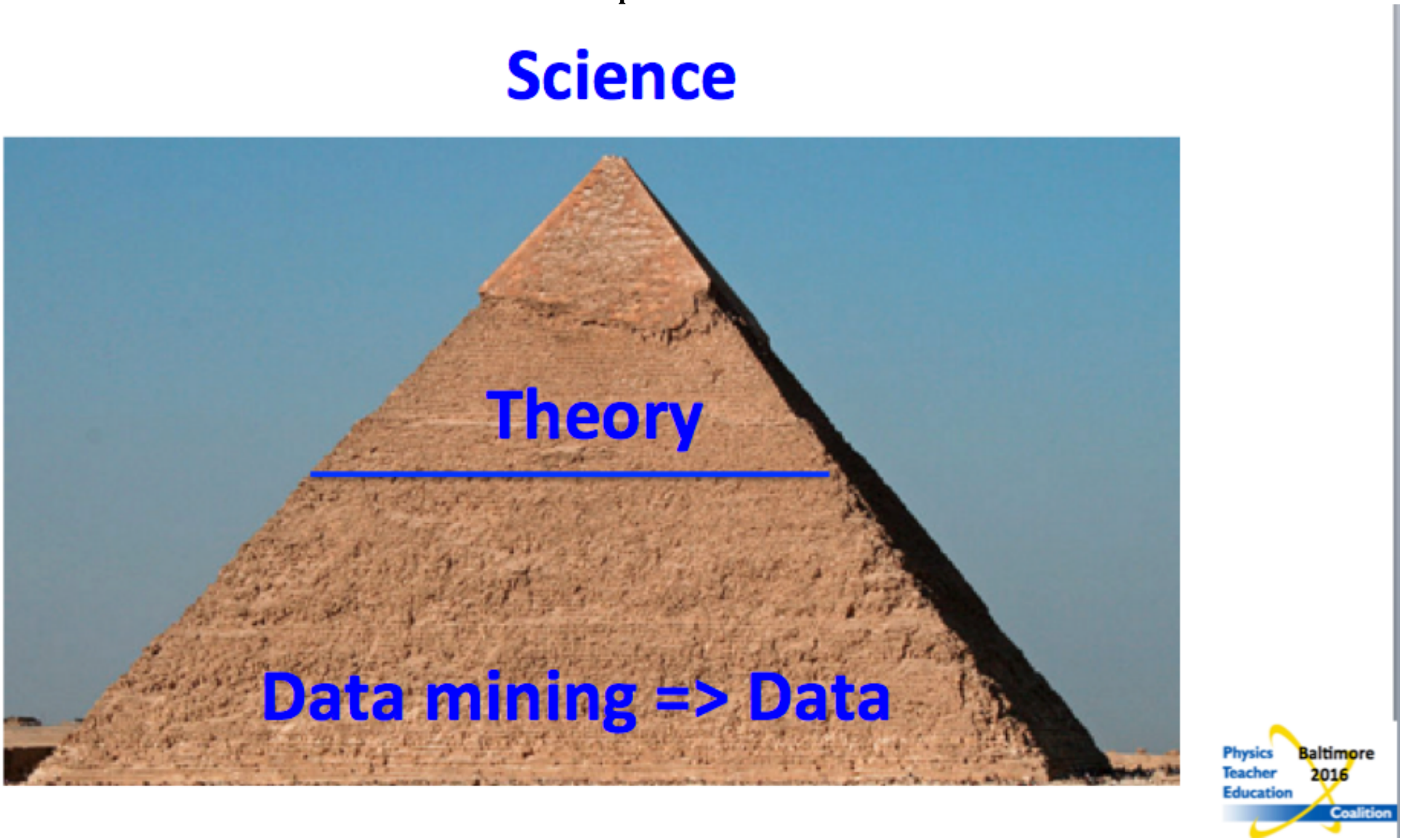
(8) every science is based on a solid foundation of the results of intensive data mining.
If teaching physics is not a science, can it become such?
Of course. All we need is to mine a lot of reliable and comparable data.



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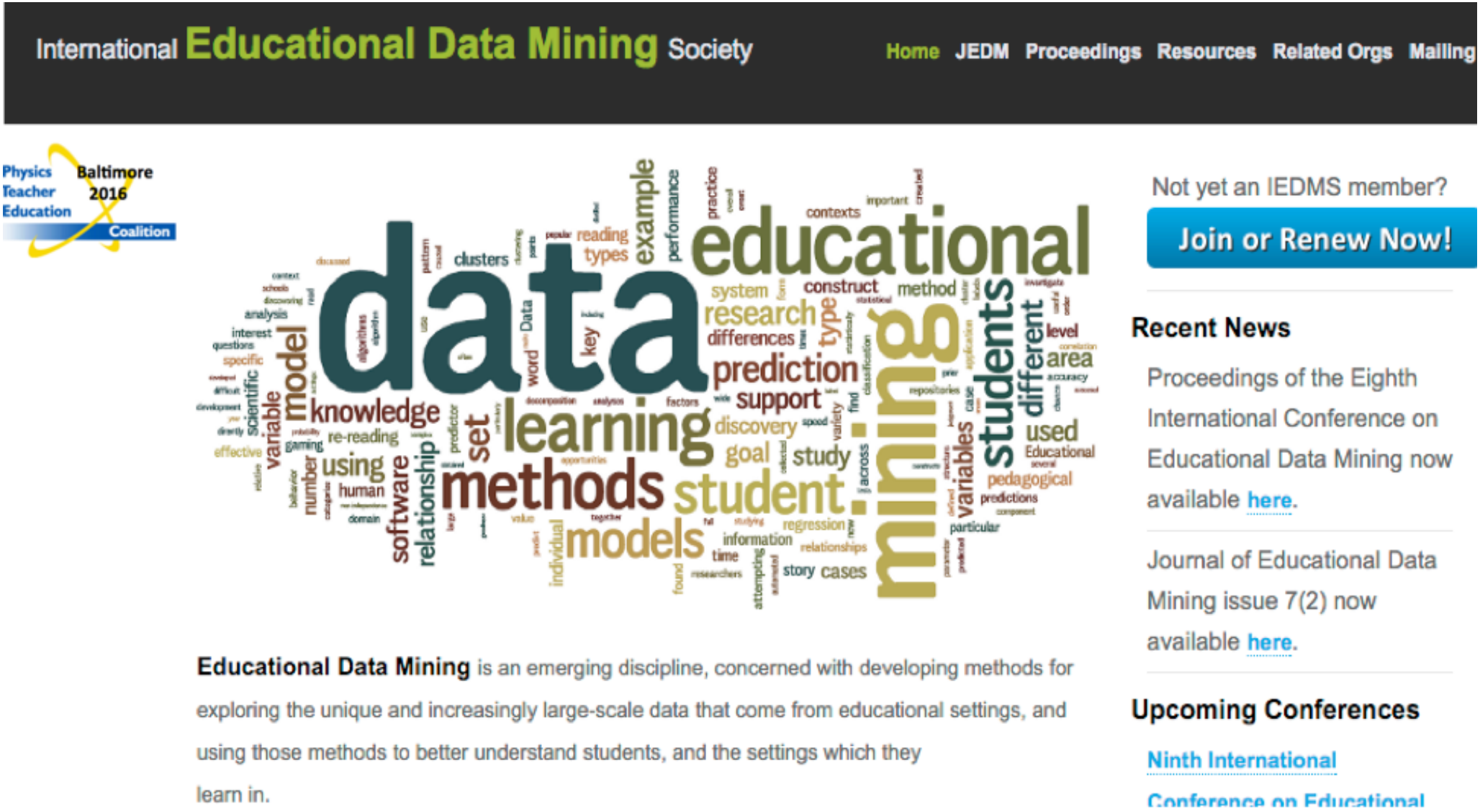
(9) I want to stress the latter word – comparable. Educational data mining is a young field. It starts producing a large amount of data.



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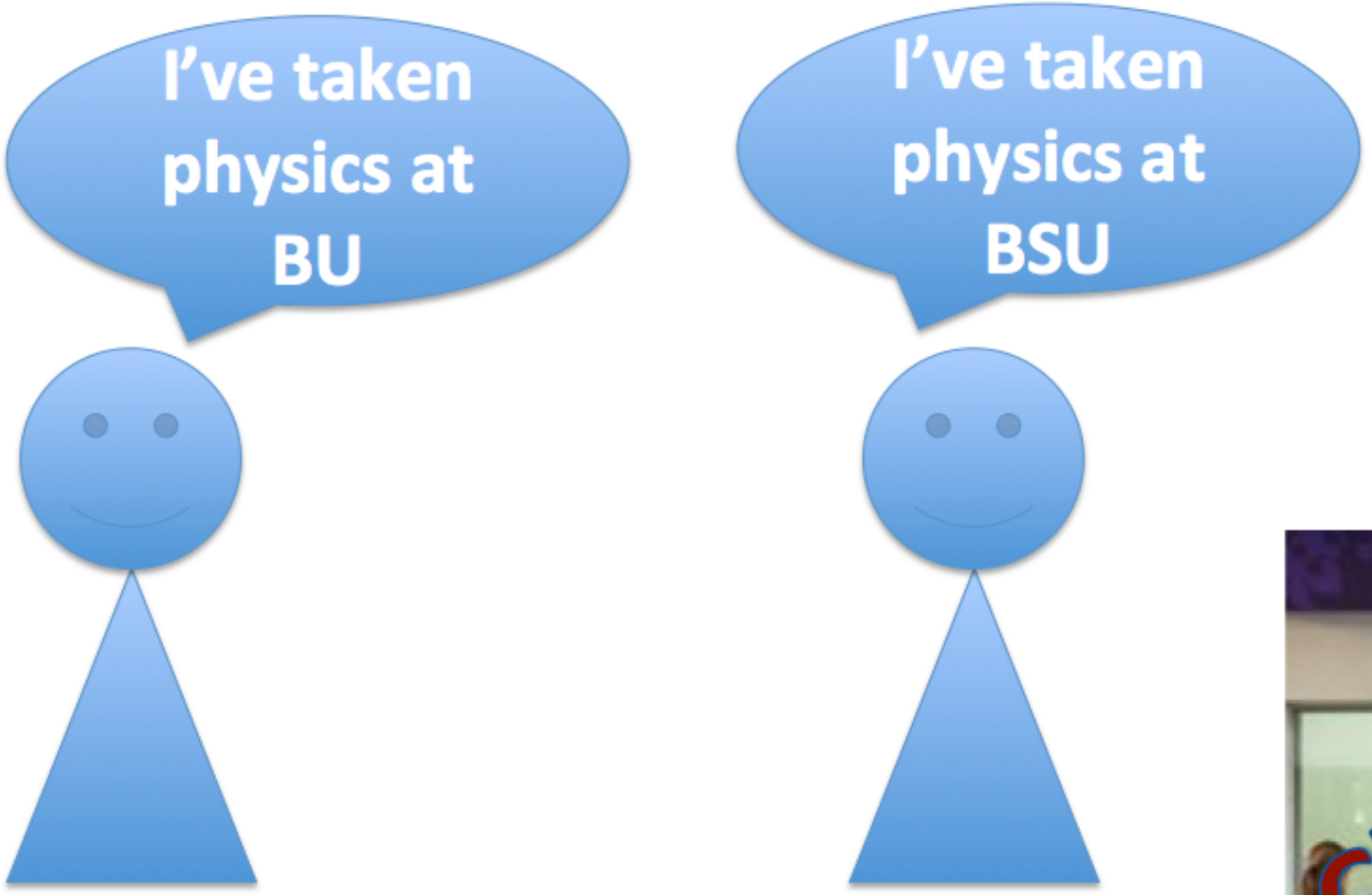
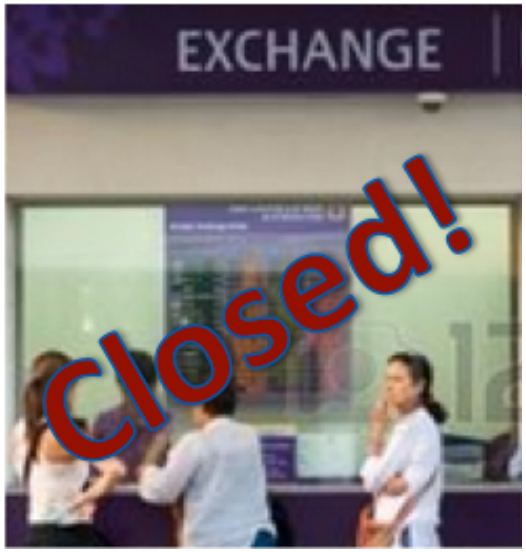
(10) However, having a lot of data without being able to make a comparison is like using different currencies without establishing exchange rates.





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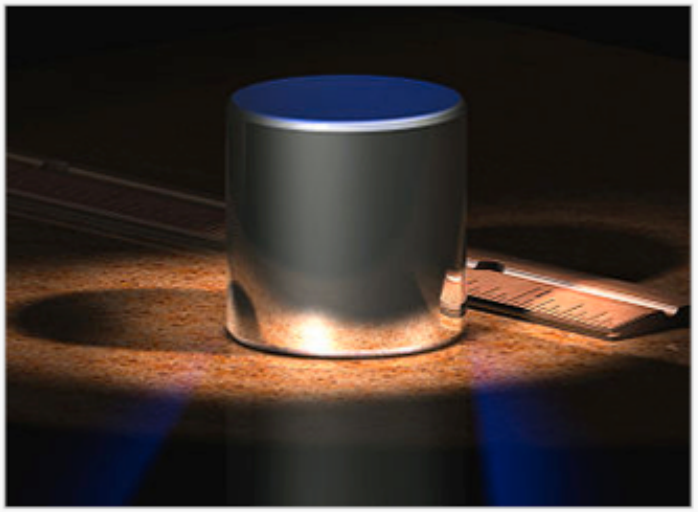
(11) The history of physics shows us a means for establishing the comparability we need – such means are called standards.

Standard (metrology)

From Wikipedia, the free encyclopedia

In metrology (the science of measurement), a **standard** (or **etalon**) is an object, system, or experiment that bears a defined relationship to a unit of measurement of a physical quantity.[1] Standards are the fundamental reference for a system of weights and measures, against which all other measuring devices are compared. Historical standards for length, volume, and mass were defined by many different authorities, which resulted in confusion and inaccuracy of measurements. Modern measurements are defined in relationship to internationally-standardized reference objects, which are used under carefully controlled laboratory conditions to define the units of length, mass, electrical potential, and other physical quantities.



The International Prototype Kilogram (IPK) is an artifact standard or prototype that is defined to be exactly one kilogram mass.

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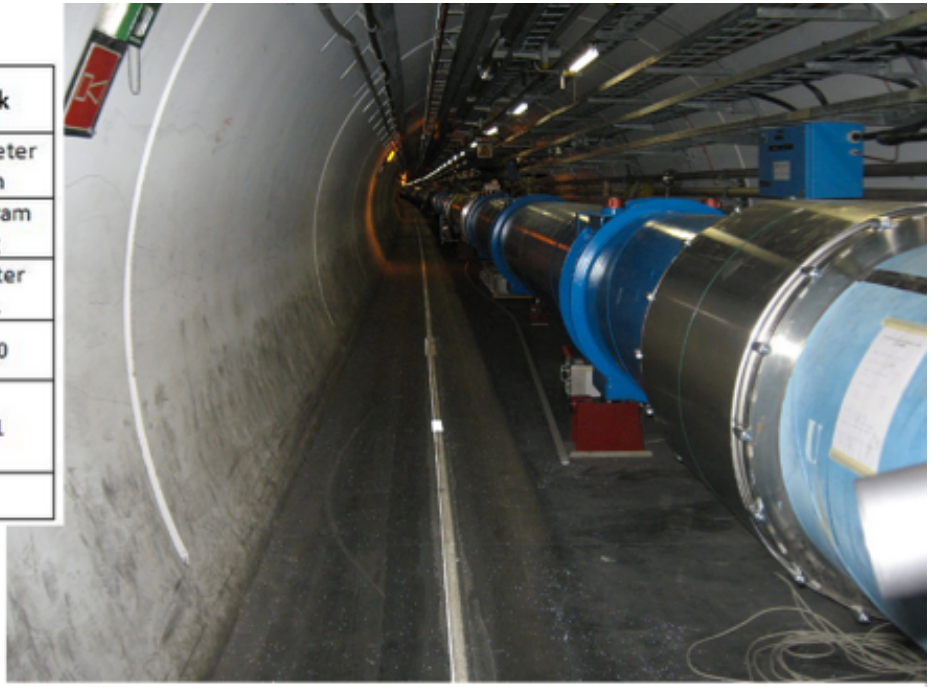
(12) We would have never had a hadron collider built in Geneva if after an almost hundred year long journey physicists would not agree on a set of common standards.

KING HENRY DIED DRINKING CHOCOLATE MILK

Mnemonic	King	Henry	Died	Base Unit	Drinking	Chocolate	Milk
Length: Abbreviation:	Kilometer km	Hectometer hm	Decameter dam	Meter m	Decimeter dm	Centimeter cm	Millimeter mm
Weight: Abbreviation:	Kilogram kg	Hectogram hg	Decagram dag	Gram g	Decigram dg	Centigram cg	Milligram mg
Volume: Abbreviation:	Kiloliter kL	Hectoliter hL	Decaliter daL	Liter L	Deciliter dL	Centiliter cL	Milliliter mL
How many are in **1** meter/gram/liter	.001	.01	.1	1	10	100	1000
How many meters/grams/liters are in this unit?	1000	100	10	1	.1	.01	.001
	⇦ BIGGER				SMALLER ⇨		



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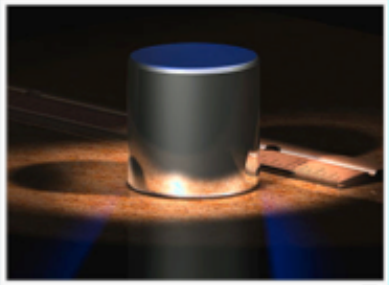

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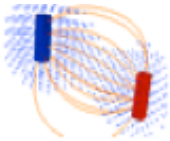
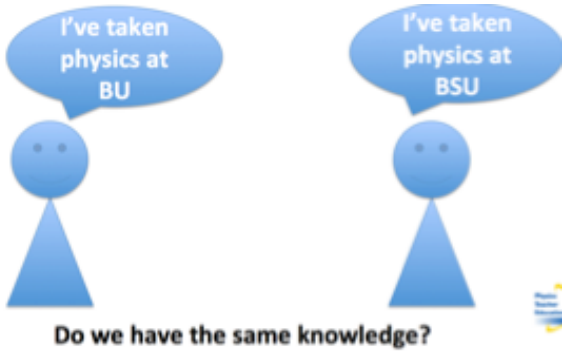
(13) There are standards in education, too. But when an educator says "a standard", he or she means something very different from what it meant in physics. In education, a standard is a description of "the learning goals for what students should know and be able to do at each grade level".
However, people using the same educational standards still can use different measuring procedures leading to incomparable results.

PHYSICS STANDARDS





Motion and Forces

1. Newton's laws predict the motion of most objects. As a basis for understanding this concept:

a. *Students know* how to solve problems that involve constant speed and average speed.

b. *Students know* that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's first law).

c. *Students know* how to apply the law *F=ma* to solve one-dimensional motion problems that involve constant forces (Newton's second law).

d. *Students know* that when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction. (Newton's third law).

Do we use the same measuring procedure?

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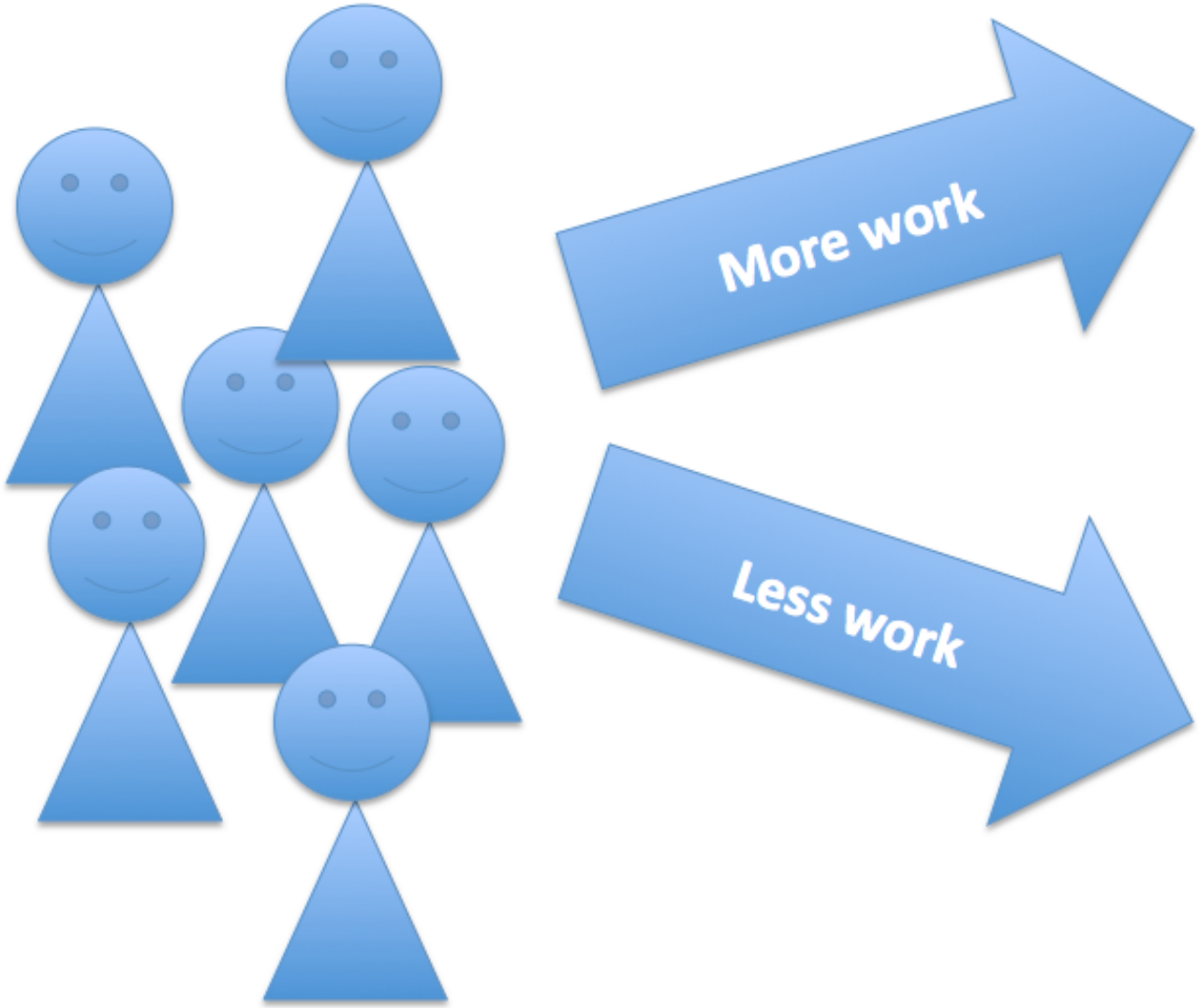
(14) Based on those results all we can conclude so far is that: if we take two large groups of similar students, and one group of students will have a more extensive or divers learning experience (for example, more contact hours, or more time spent on certain exercises, or training through more different exercises, etc.) students from that group, on average, will demonstrate better learning outcomes than the students in a controlled group.



Higher learning outcomes

Lower learning outcomes

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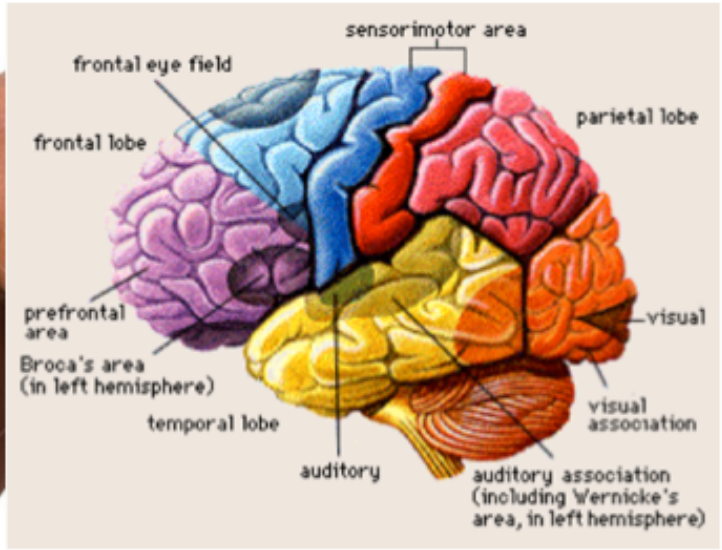
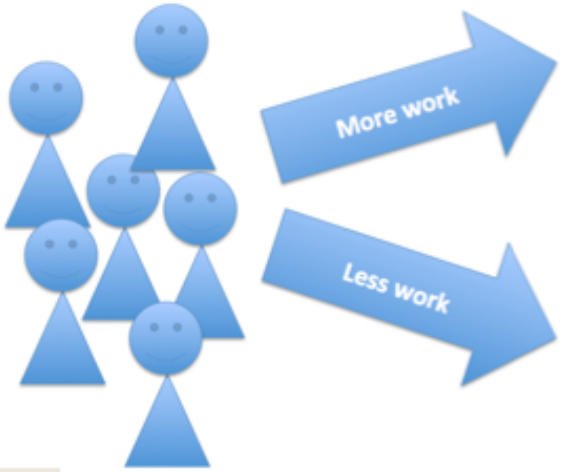
(15) This conclusion becomes almost obvious if we employ the notion that a brain is basically a muscle, or a collection of muscles, the development of which strongly correlates with the variety and intensity of exercises it goes through.





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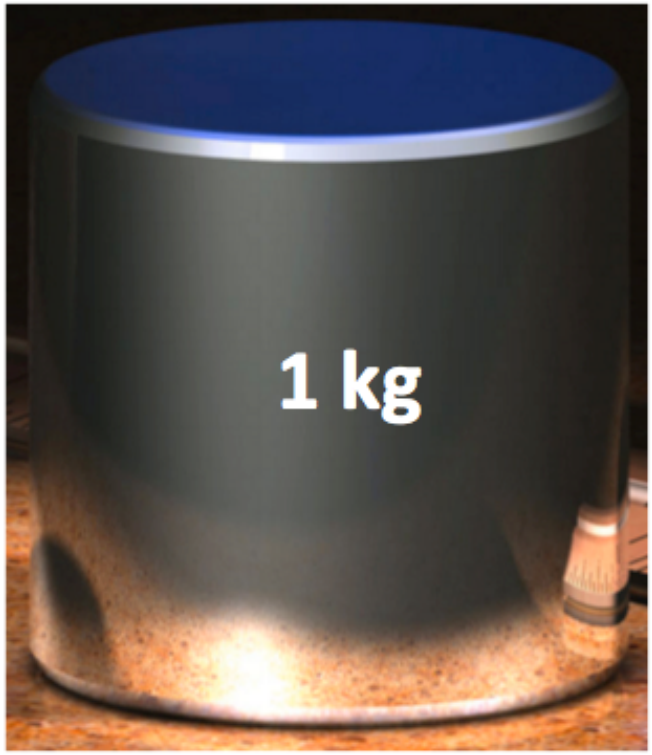
(16) In order to move beyond the obvious we need to adapt to teaching physics the same approach which had been adopted to doing physics. We need a standard which, like in physics, is an actual object, or a feature of an object, accompanied by a specific procedure which allows comparing similar features carried by other objects with the one of the standard (that is why "a standard" is also called "a prototype", or "an etalon"). For example, a standard of mass is an actual cylinder. A verbal description such as: "A standard of mass looks like a cylinder "with diameter and height of about 39 mm, and is made of an alloy of 90 % platinum and 10 % iridium" would not work as a standard, because it is impossible to compare the mass of an object with a sentence.

A standard is an object, or a feature of an object, accompanied by a specific procedure which allows comparing similar features carried by other objects with the one of the standard.



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"A standard of mass looks like a cylinder "with diameter and height of about 39 mm, and is made of an alloy of 90 % platinum and 10 % iridium"

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(17) I believe that "a standard" for measuring learning outcomes must satisfy the following five conditions:

(a) Every aspect of the development and the use of the standard has to be open to public and be able to be examined by *anyone*.

(b) The use of the standard must lead to gradable information on student's skills and knowledge.

(c) The use of the standard must lead to gradable information on student's skills and knowledge, AND must not depend on any specific features of teaching or learning processes.

(d) The use of the standard must lead to gradable information on student's skills and knowledge, and must not depend on any specific features of teaching or learning processes, AND must allow to compare on a uniform basis the learning outcomes of any and all students using the standard.

(e) Any institution adopting the standard should automatically become an active member of the community utilizing the standard and can propose possible alternations to the standard to accommodate changes in the understanding of what students should know and be able to do.

And I am using this professional development event in part to find people who share the same belief.

(a) Every aspect of the development and the use of the standard has to be open to public and be able to be examined by *anyone*.

(b) The use of the standard must lead to gradable information on student's skills and knowledge.

(c) The use of the standard must lead to gradable information on student's skills and knowledge, AND must not depend on any specific features of teaching or learning processes.

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(e) Any institution adopting the standard should automatically become an active member of the community utilizing the standard and can propose possible alternations to the standard to accommodate changes in the understanding of what students should know and be able to do.

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(18) I have more than just a belief. I have developed a specific approach which will lead to designing such a standard. The approach is based on using MOCCs (MOCC stands for "a map of operationally connected categories"); the link on the screen leads to a detailed description of what MOCC is and ways to use it (http://teachology.xyz/mocc.htm).

A Map of Operationally Connected Categories as an instrument for classifying physics problems and a basis for developing a universal standard for measuring learning outcomes of students taking physics courses (a novel tool for measuring learning outcomes in physics).

By Valentin Voroshilov

http://teachology.xyz/mocc.htm

Abstract

Currently there is no tool for measuring learning outcomes of students, which would be broadly accepted by teachers, schools and district officials, by parents, policymakers. Educational standards cannot provide a basis for such a tool, since for an educator "a standard" means a verbal description of skills and knowledge which students should be able to demonstrate but not an actual object, or a feature of an object, accompanied by a specific procedure which allows comparing similar features carried by other objects with the standard one (like in physics). There is however an approach to standardization of measurement of physics knowledge similar to standardization of measurements in physics. This approach is based on a specific technique used for classification physics problems. At the core of such classification is the use of graphs, such that 1. every quantity represented by a vertex/node of a graph must have a numerical representation, i.e.

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(19) I believe that the time has come to create a coalition of individuals and institutions which goal is to developing the universal standard for measuring learning outcomes in physics (for starters). And that is one of the reasons why I am attending this conference.

An association for developing objective standards for measuring knowledge and skills in STEM subjects

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Thank you!

Dr. Valentin Voroshilov [www.*T*each*O*logy.xyz](http://www.TeachOlogy.xyz)

The link the video: https://youtu.be/sDO0kiodsRw

The link to the slides with narrations:

pdf www.teachology.xyz/FW.pdf

html www.teachology.xyz/FW.htm

The link to the article:
http://teachology.xyz/mocc.htm