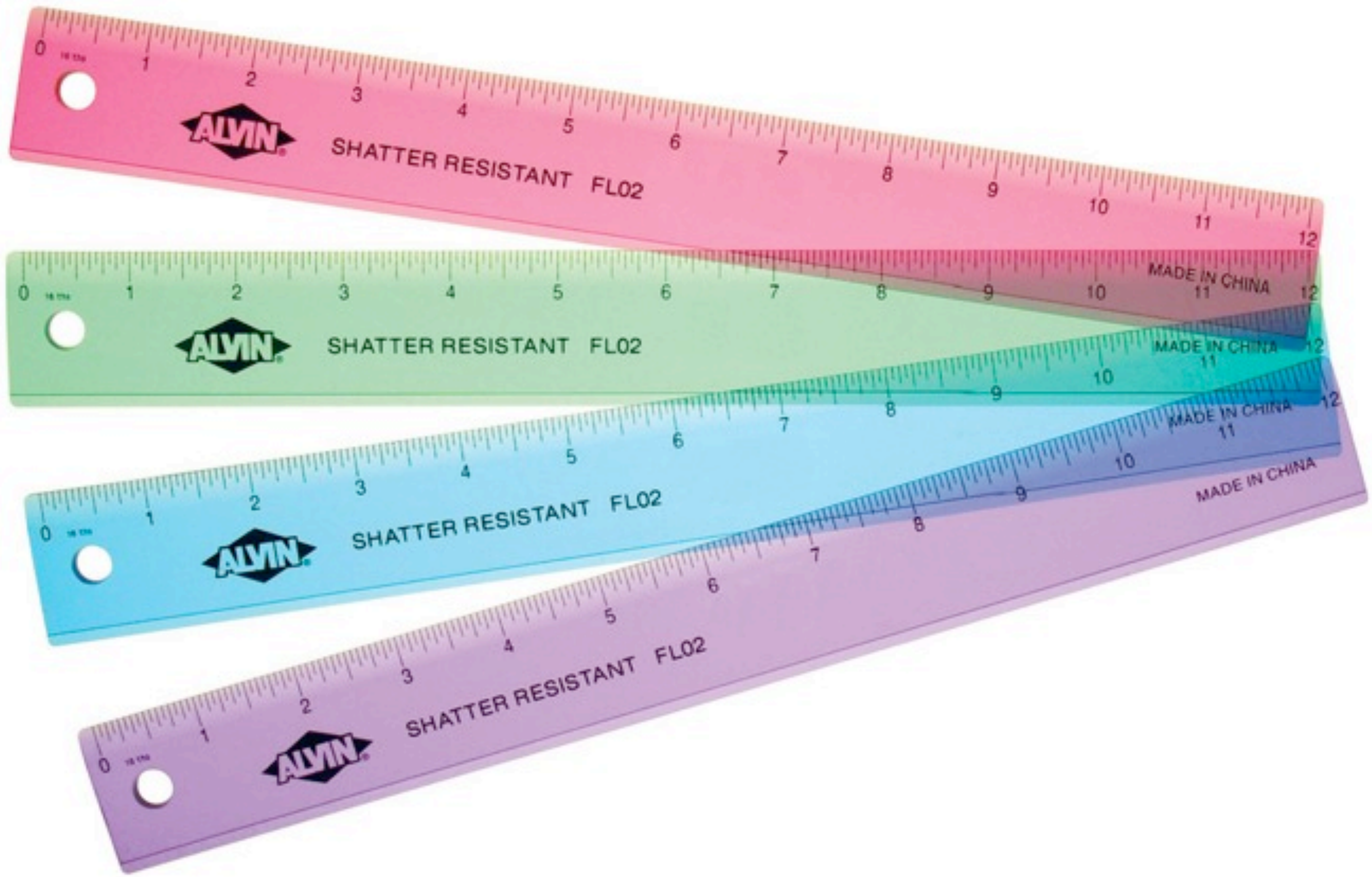
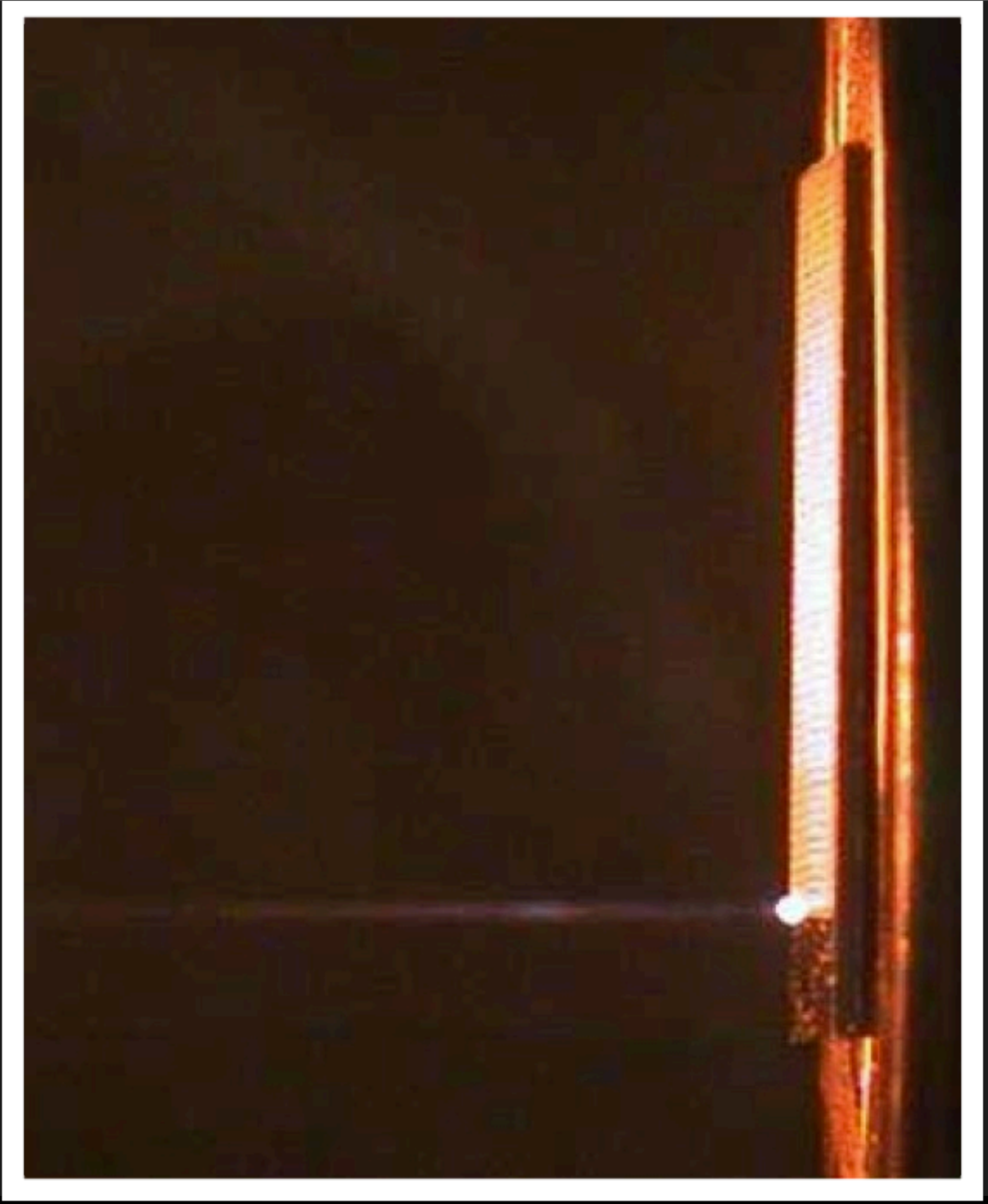
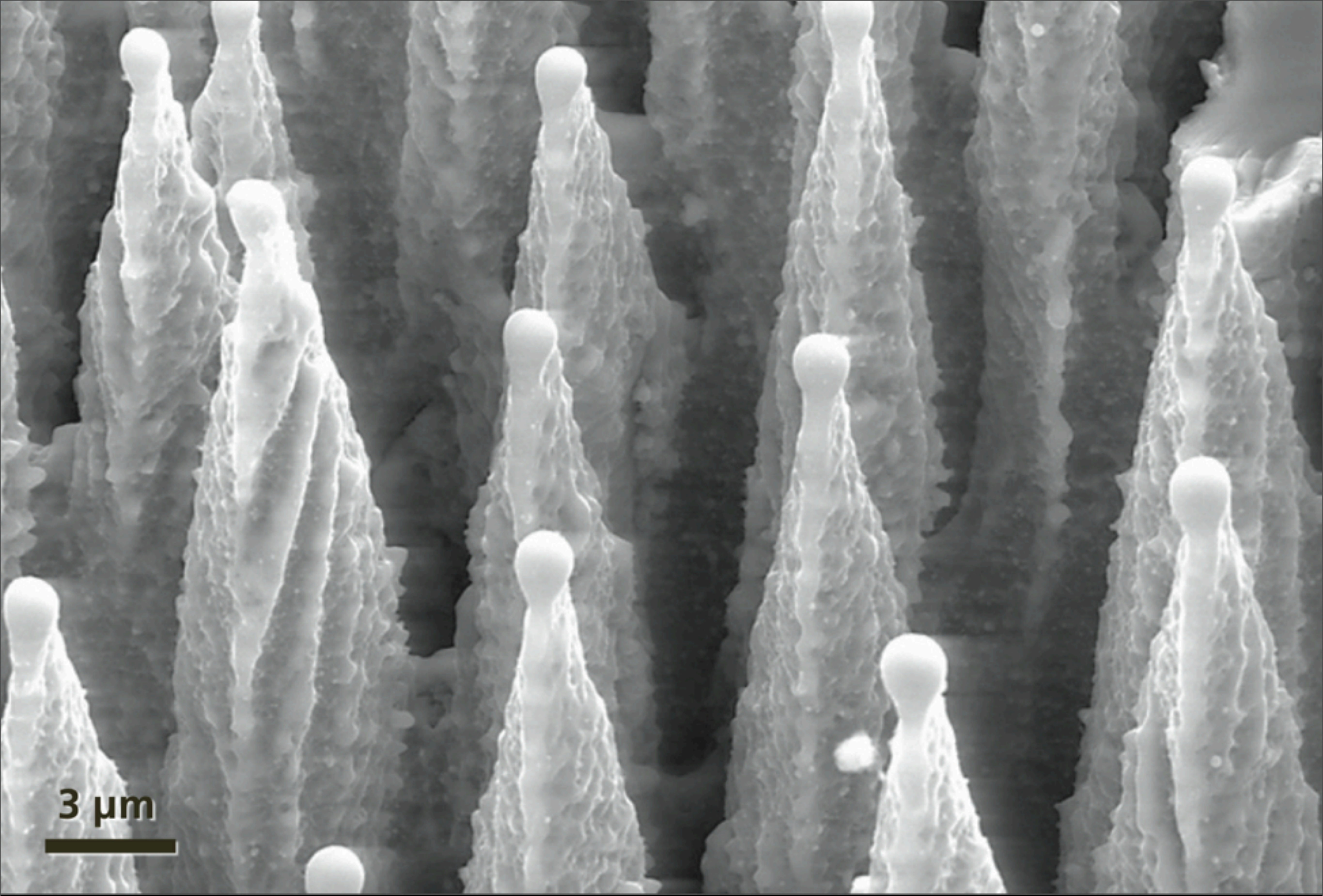
Multidimensional Measurement in Education



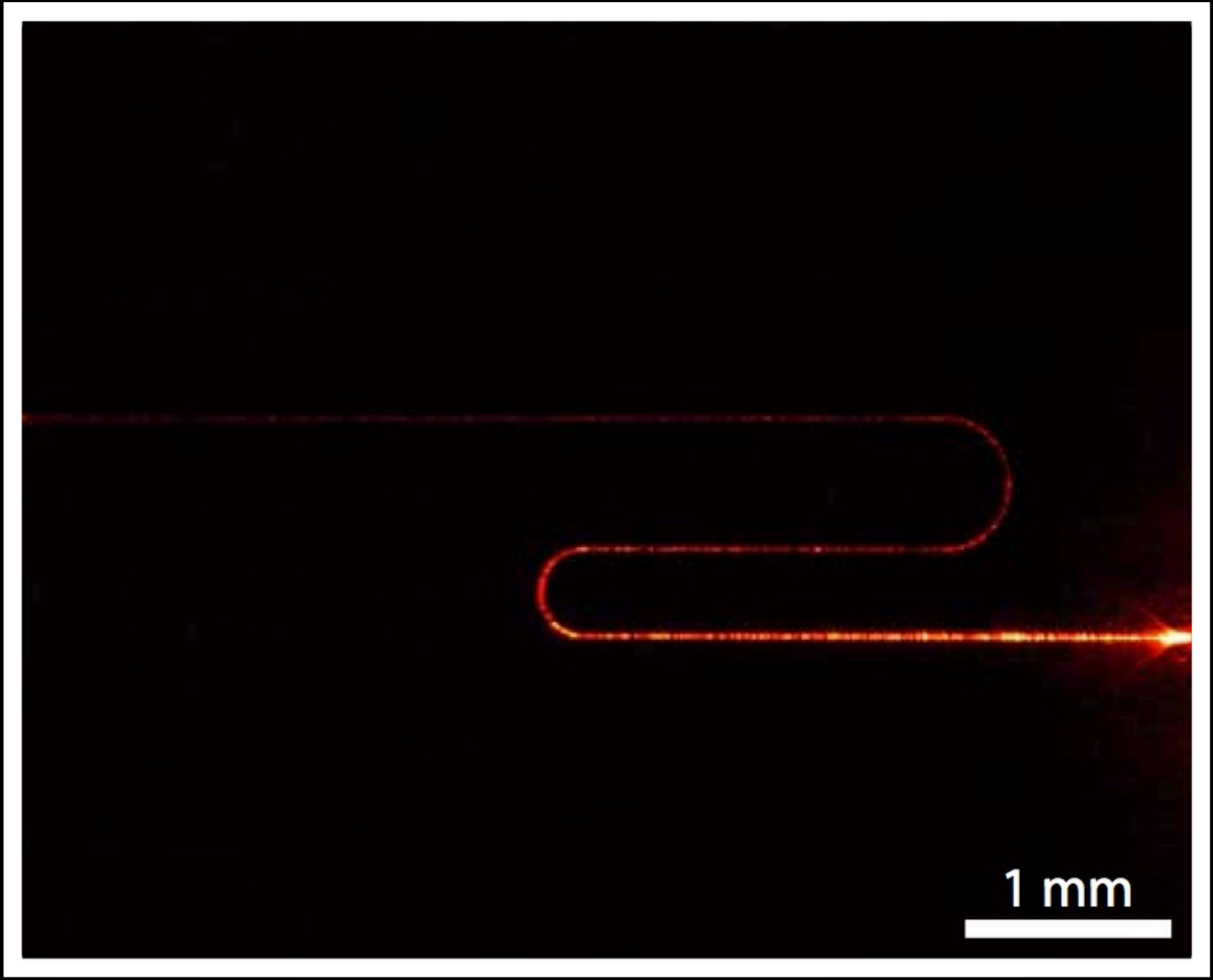
Laura Tucker, Mazur Group
Harvard Physics Postdoc Retreat, 10/18/2013



Ultrafast laser physics

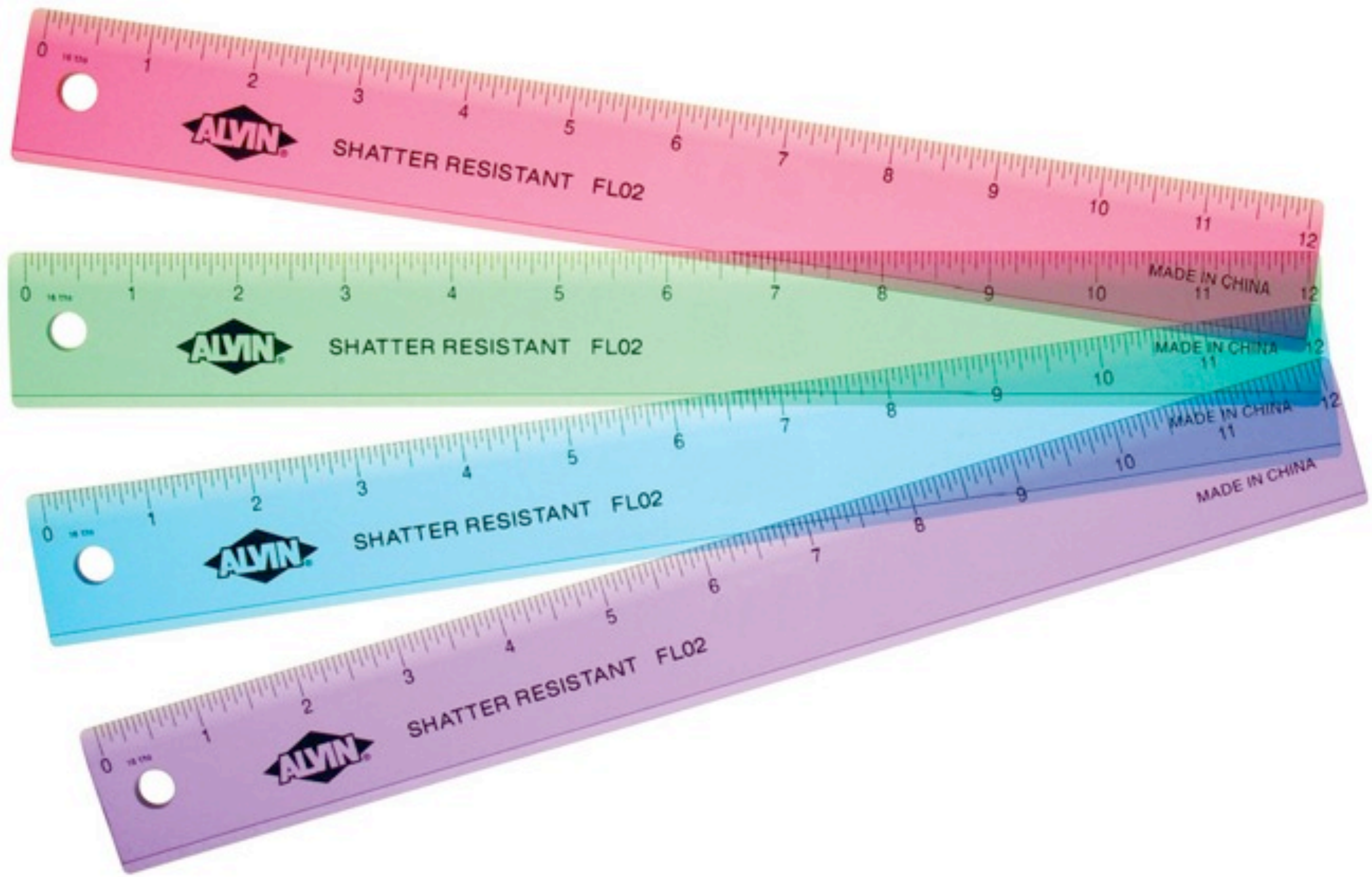


Ultrafast laser physics



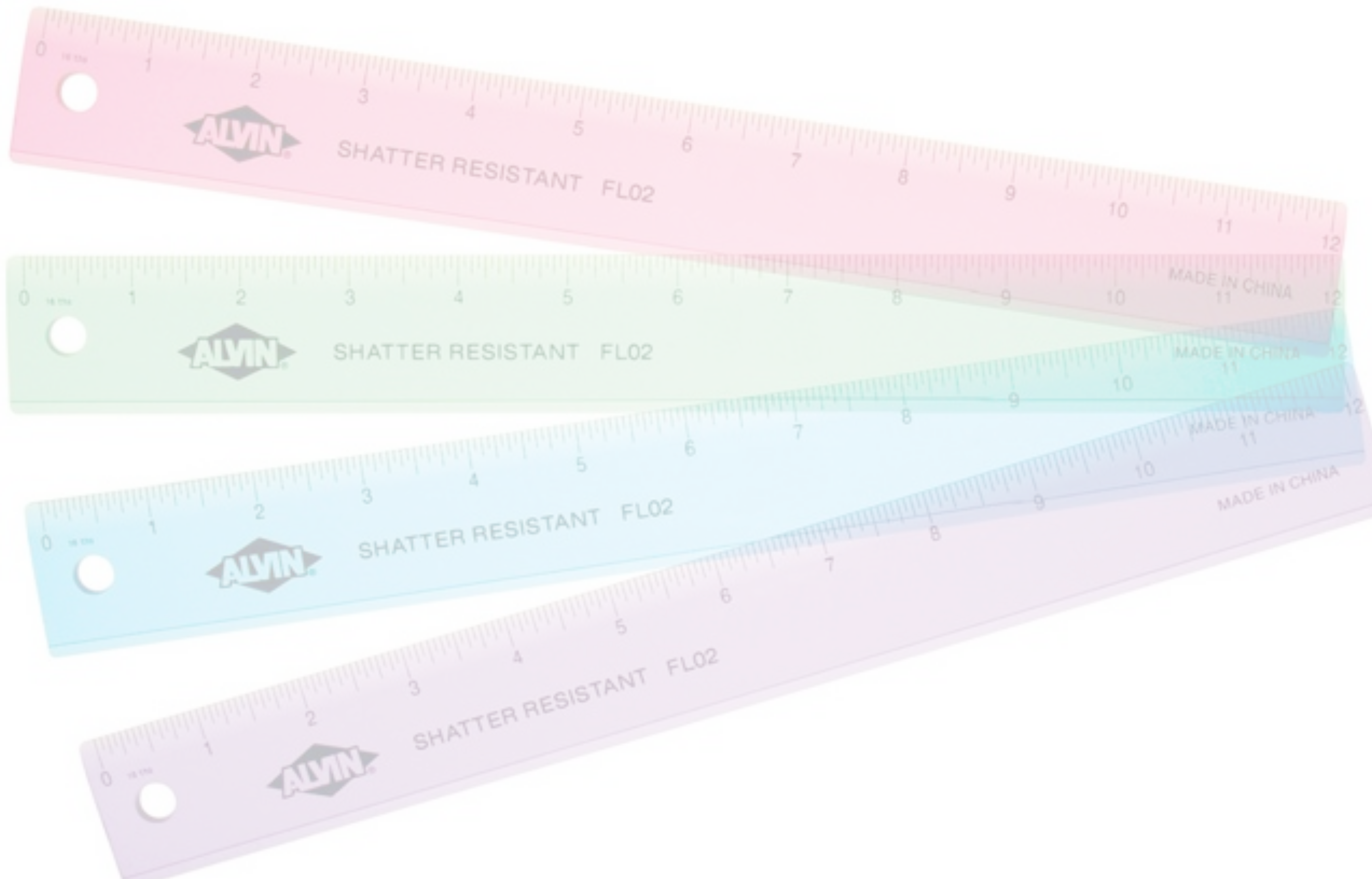
Ultrafast laser physics

Why multidimensional measurement?



Why multidimensional measurement?

Learning



Why multidimensional measurement?

Learning : Standardized tests

Force concepts (FCI)

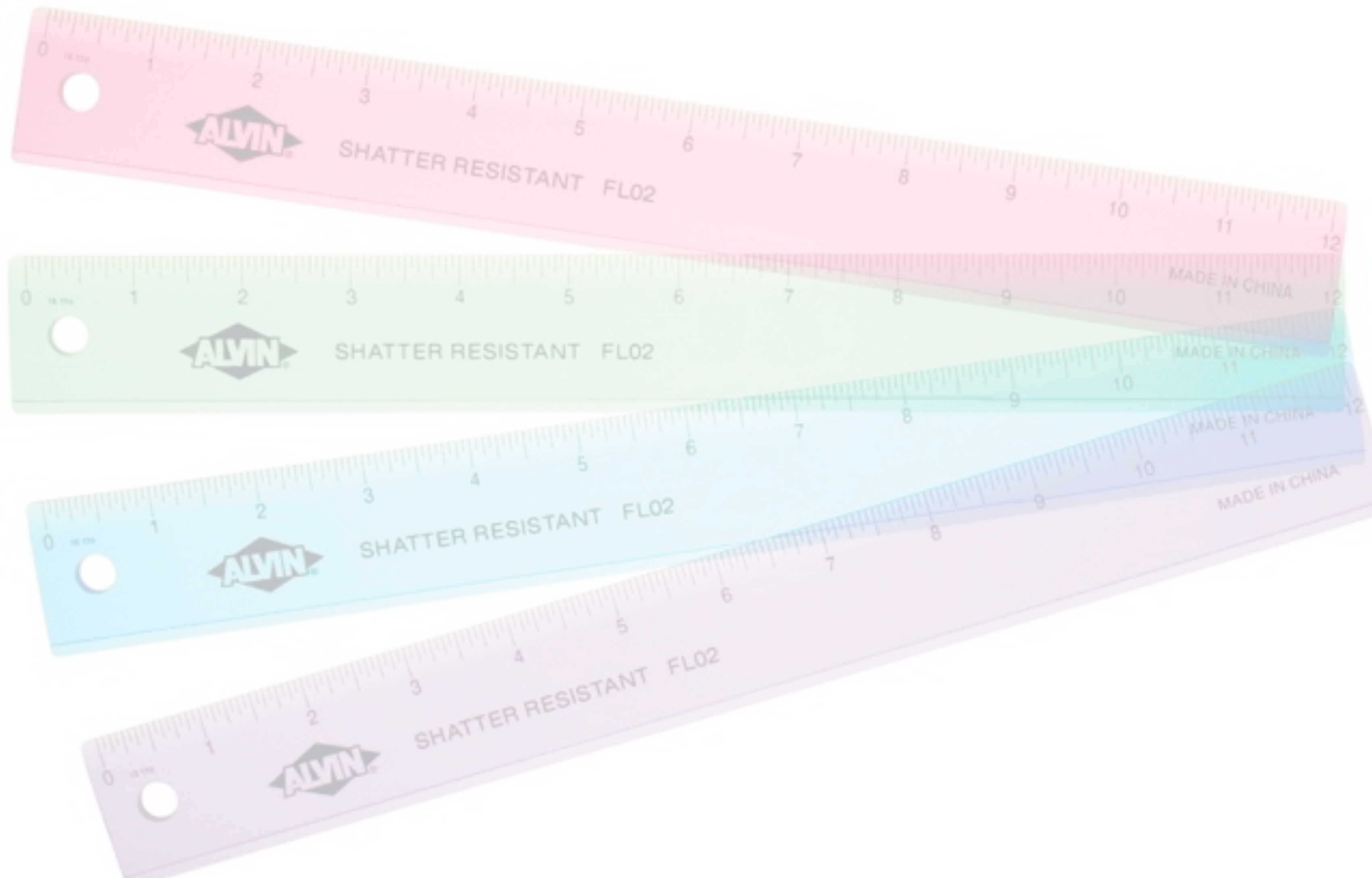
Mechanics concepts and problem-solving (MBT)

Hestenes, et. al. 1992; Hestenes & Wells. 1992

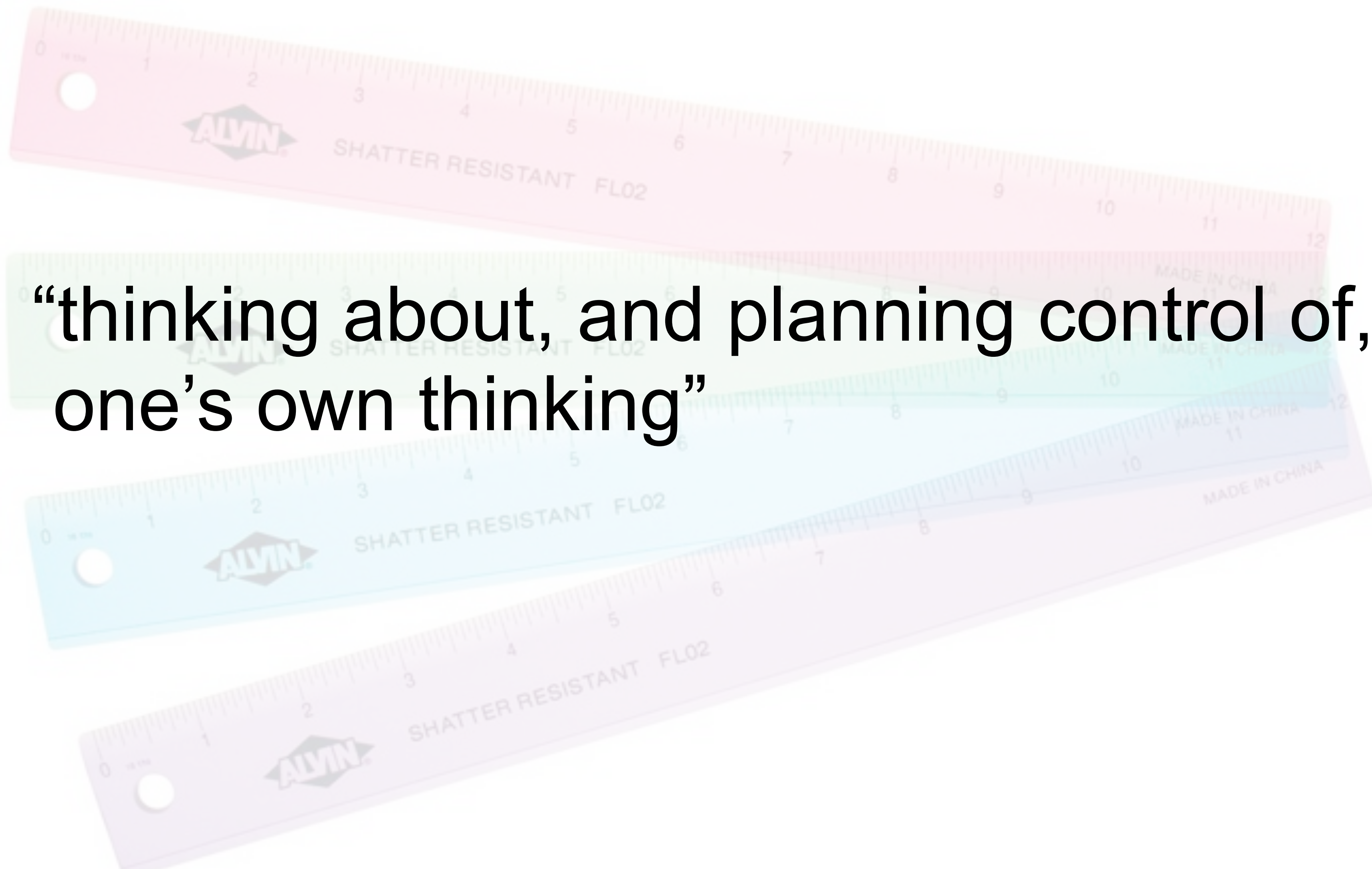
Why multidimensional measurement?

Learning

Metacognition



Why multidimensional measurement?



Metacognition : "thinking about, and planning control of, one's own thinking"

Girash, J. (2013)

Why multidimensional measurement?

Metacognition : “thinking about, and planning control of, one’s own thinking”

related to transfer of learning to new situations

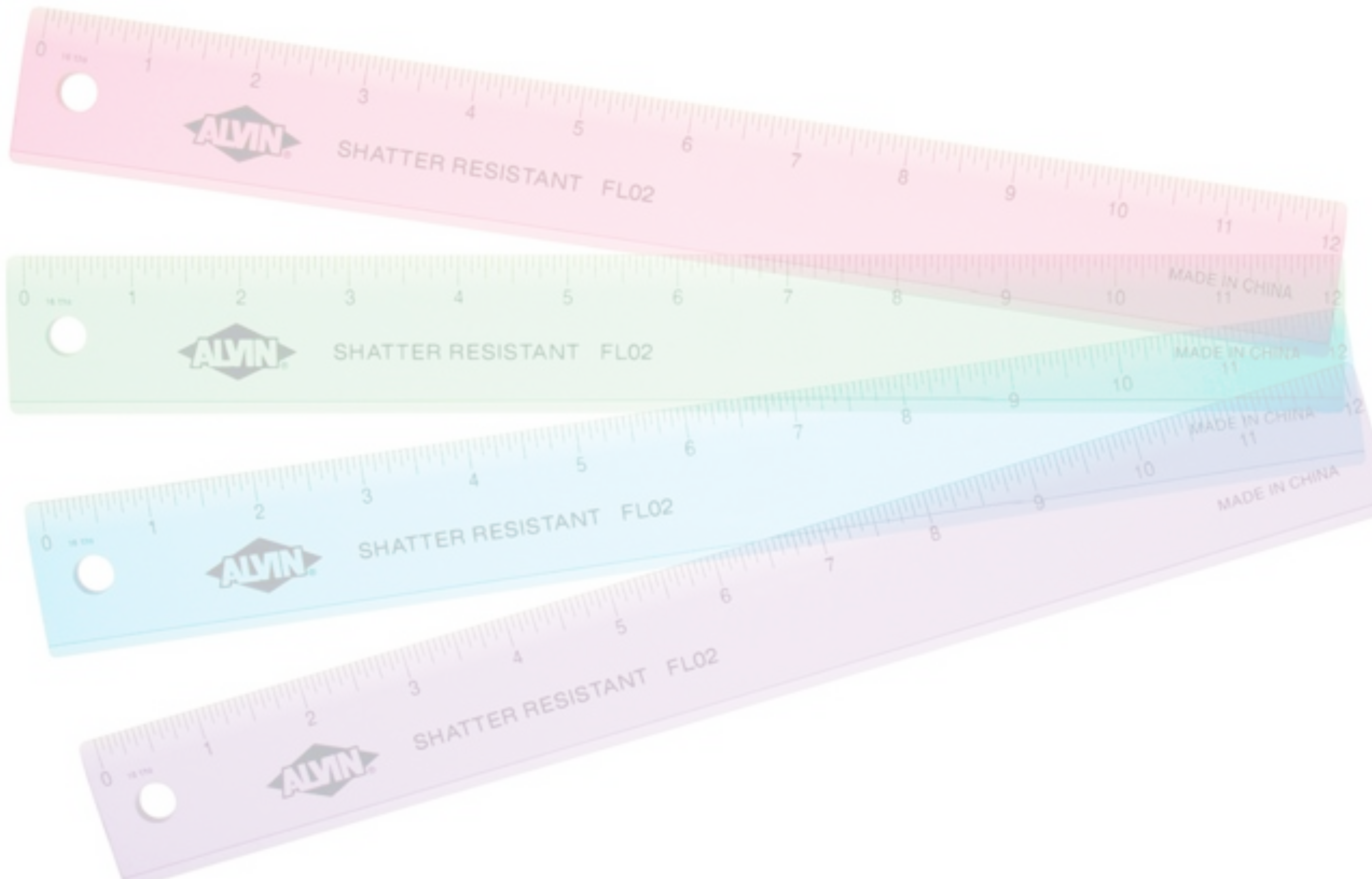
The National Research Council (2000)

Why multidimensional measurement?

Learning

Metacognition

Interaction



Why multidimensional measurement?

"new perspective, corrective feedback, ...
line of reasoning to pursue"

Interaction :

Chi (2009)

Why multidimensional measurement?

“new perspective, corrective feedback, ...
line of reasoning to pursue”

Interaction :

“create a shared mental model...
neither...may have been able to come up with the shared understanding on her own”

Chi (2009)

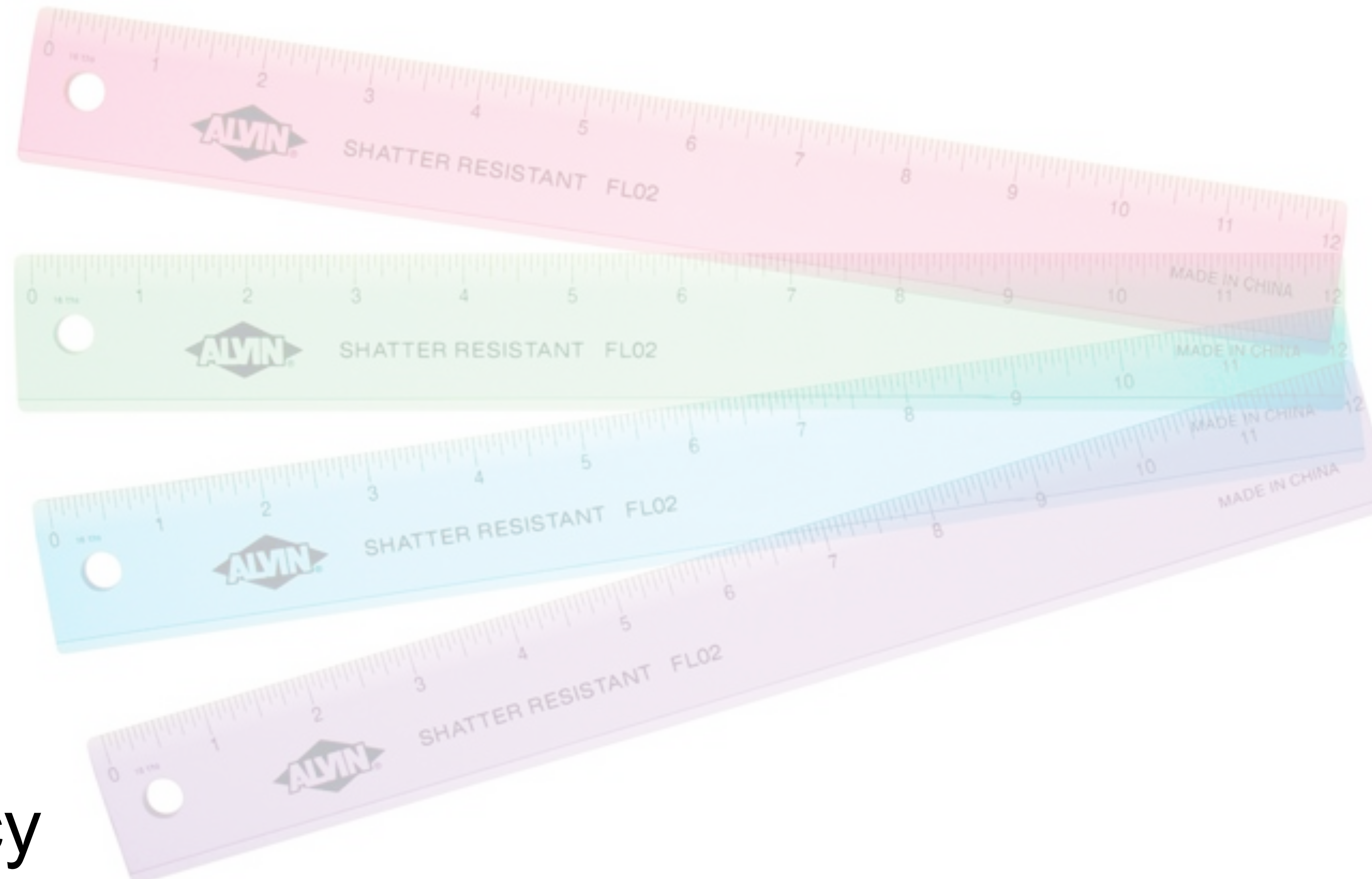
Why multidimensional measurement?

Learning

Metacognition

Interaction

Self-efficacy



Why multidimensional measurement?

“a person’s situation-specific belief that he or she can succeed in a given domain”

Self-efficacy :

Fencl & Scheel (2005)

Why multidimensional measurement?

"a person's situation-specific belief that he or she can succeed in a given domain"

Self-efficacy: "useful predictor for grades and persistence"

Fencl & Scheel (2005)

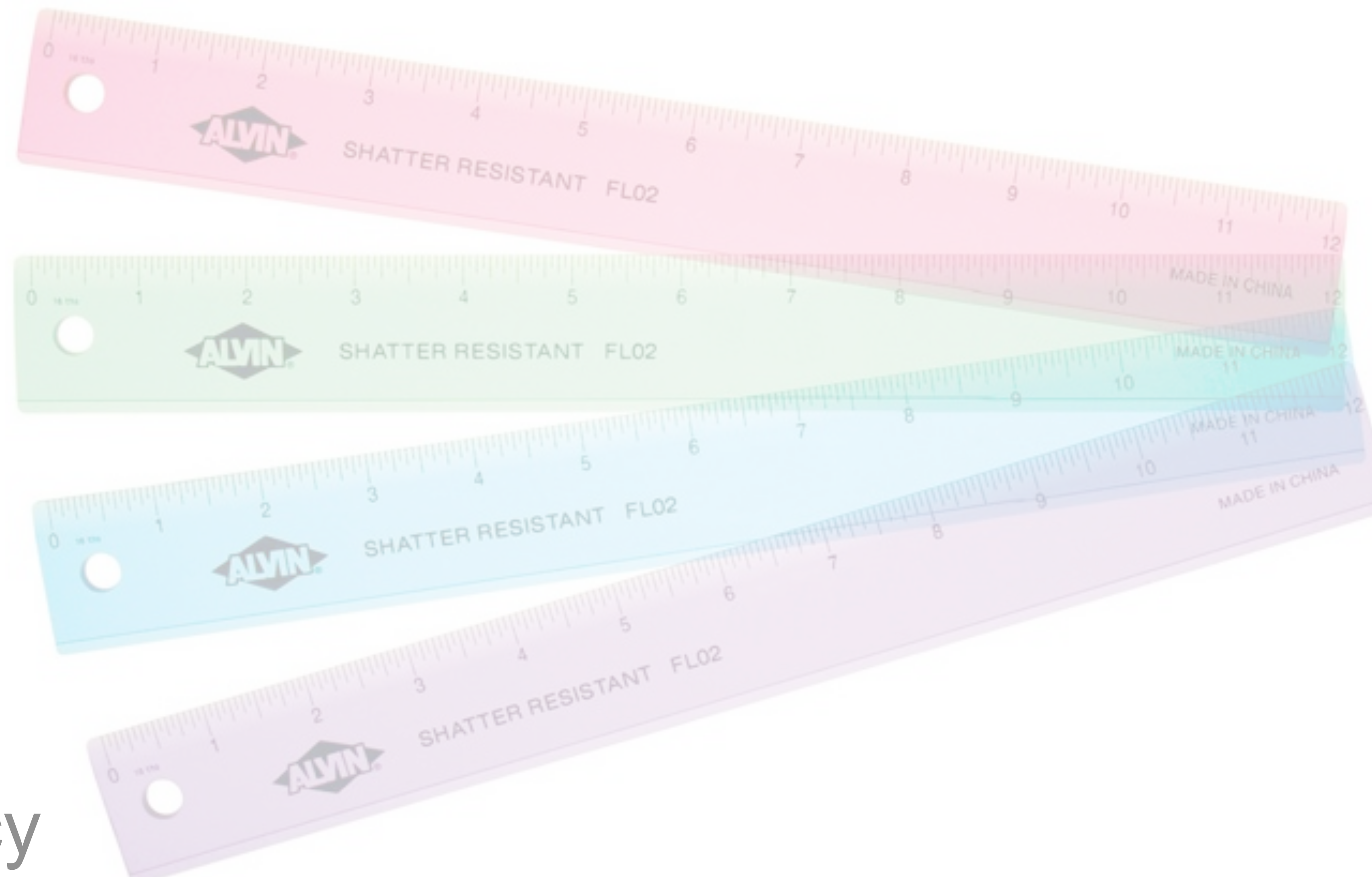
Why multidimensional measurement?

Learning

Metacognition

Interaction

Self-efficacy



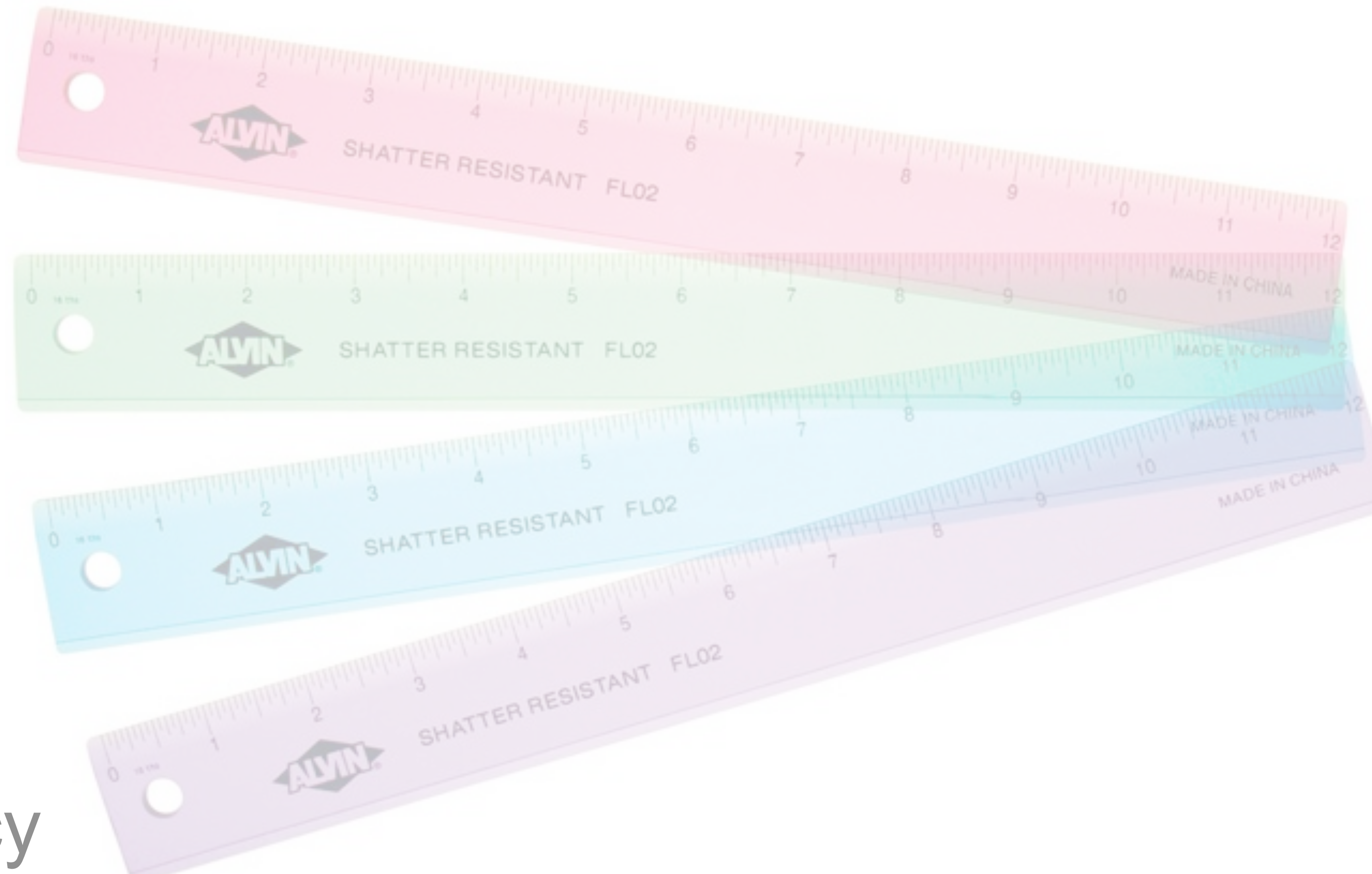
Why multidimensional measurement?

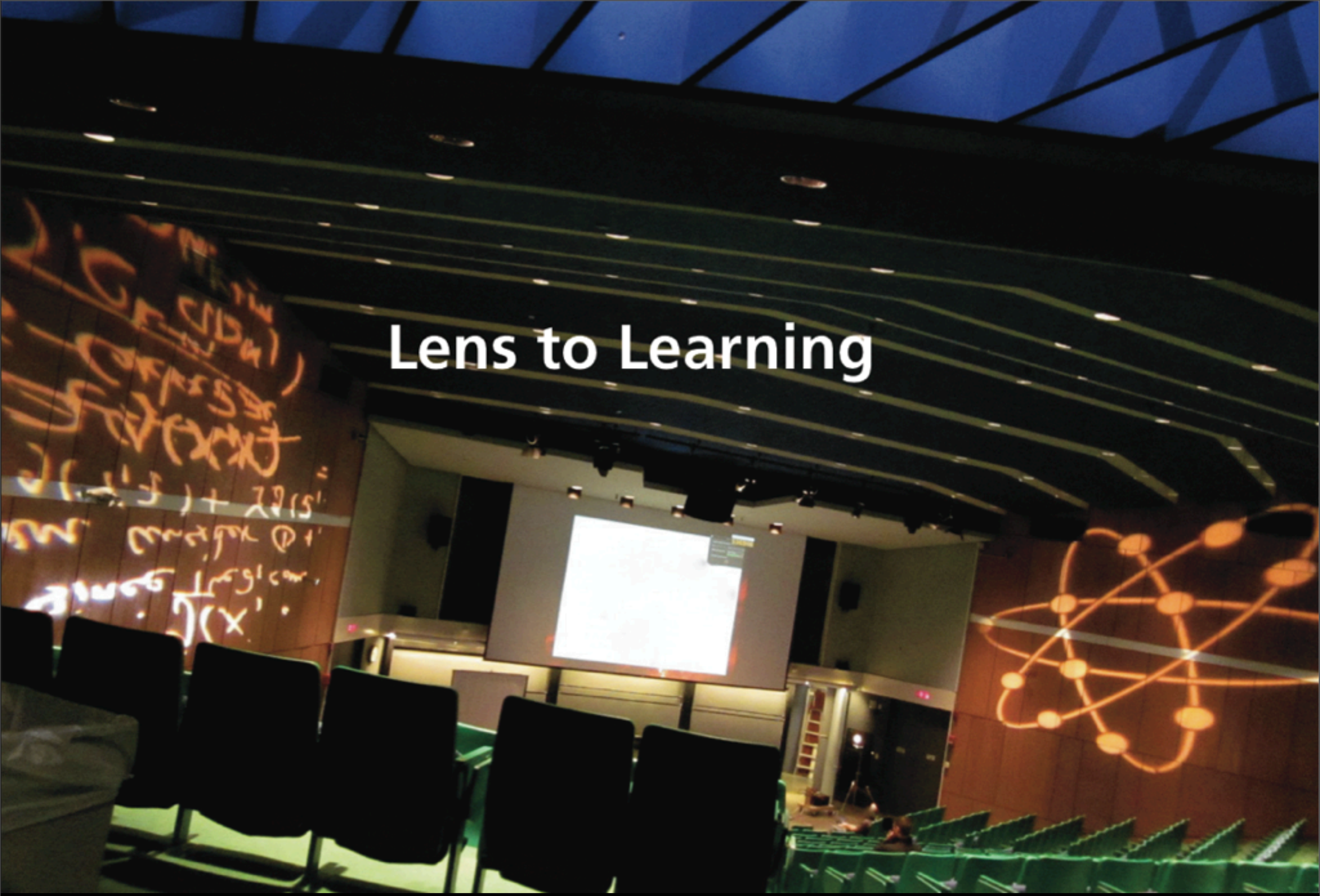
Learning

Metacognition

Interaction

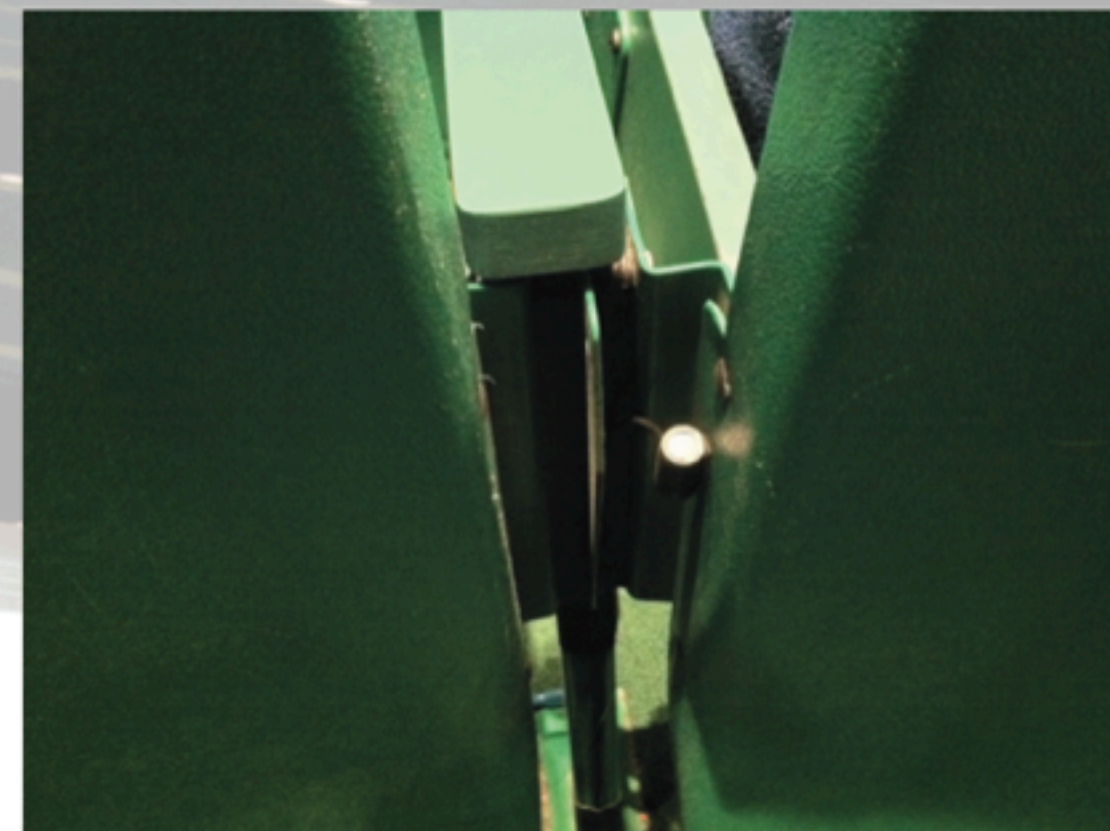
Self-efficacy




Lens to Learning

Measurement

Interaction



Measurement

Interaction

Measurement

Interaction

Group exams

Peer Assessment

Home › Check self/peer accessment

Check self/peer accessment

Title *

Peer Evaluate 'Fauzy Wan'

Participation *

- Never
- Rarely
- Sometimes
- About half the time
- Most of the time
- All the time

Participates fully in team activities.

Well-prepared *

- Never
- Rarely
- Sometimes
- About half the time
- Most of the time

Measurement

Interaction

Peer Assessment

Home › Check self/peer accessment

Check self/peer accessment

Team	Teammate Name	Relative Contribution
Team 19	Jerry	* -3 -2 -1 0 1 2 3 (1 selected)
Team 19	Duo	* -3 -2 -1 0 1 2 3 (2 selected)
Team 19	Helan	* -3 -2 -1 0 1 2 3 (0 selected)

Measurement Interaction

Positive dynamics:

Partnering. Good at motivating others to work long hours to meet a deadline

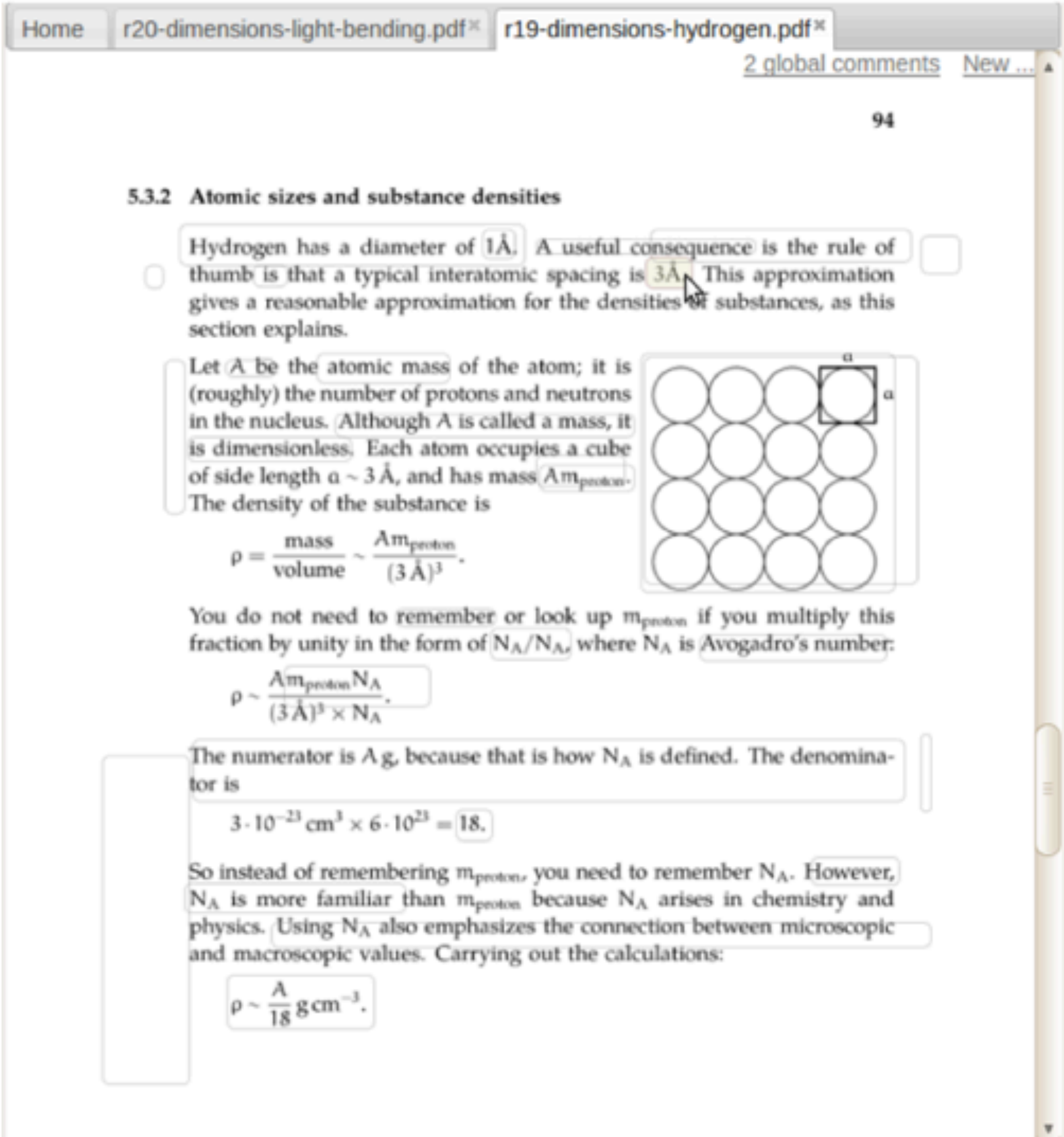
Empathizing. Takes time to understand perspectives when differences of opinion occur

Negative dynamics:

Dismissive. Makes an effort to listen to team members' ideas (not dismissive)

Altringer, B. (2013)

The NB system: text annotation



Home | r20-dimensions-light-bending.pdf | r19-dimensions-hydrogen.pdf

2 global comments New ...

94

5.3.2 Atomic sizes and substance densities

Hydrogen has a diameter of 1Å. A useful consequence is the rule of thumb is that a typical interatomic spacing is 3Å. This approximation gives a reasonable approximation for the densities of substances, as this section explains.

Let A be the atomic mass of the atom; it is (roughly) the number of protons and neutrons in the nucleus. Although A is called a mass, it is dimensionless. Each atom occupies a cube of side length $a \sim 3\,\text{Å}$, and has mass Am_{proton}. The density of the substance is

$$\rho = \frac{\text{mass}}{\text{volume}} \sim \frac{Am_{\text{proton}}}{(3\,\text{Å})^3}.$$

You do not need to remember or look up m_{proton} if you multiply this fraction by unity in the form of N_A/N_A, where N_A is Avogadro's number:

$$\rho \sim \frac{Am_{\text{proton}}N_A}{(3\,\text{Å})^3 \times N_A}.$$

The numerator is A g, because that is how N_A is defined. The denominator is

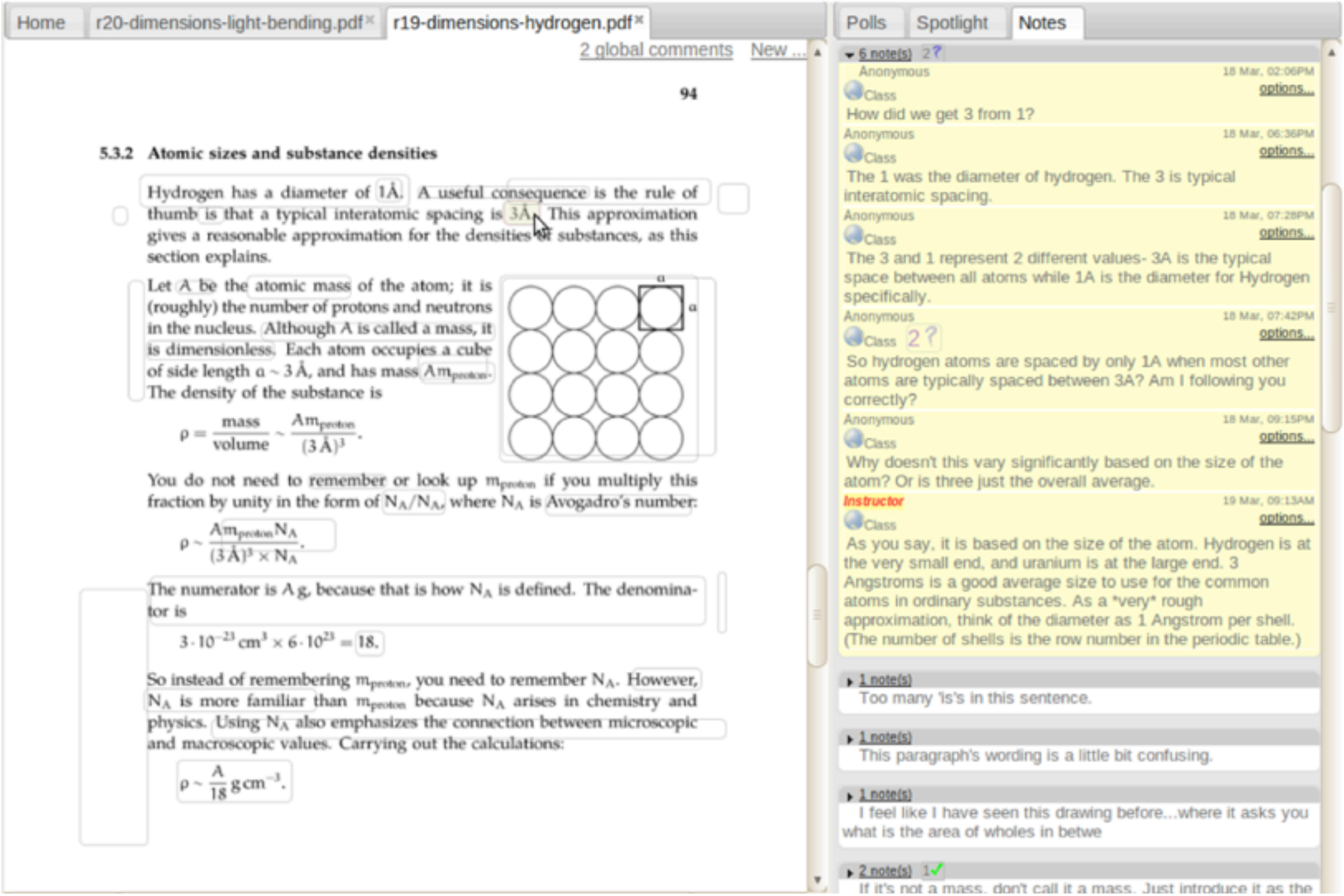
$$3 \cdot 10^{-23}\,\text{cm}^3 \times 6 \cdot 10^{23} = 18.$$

So instead of remembering m_{proton}, you need to remember N_A. However, N_A is more familiar than m_{proton} because N_A arises in chemistry and physics. Using N_A also emphasizes the connection between microscopic and macroscopic values. Carrying out the calculations:

$$\rho \sim \frac{A}{18}\,\text{g}\,\text{cm}^{-3}.$$

Zyto et. al.

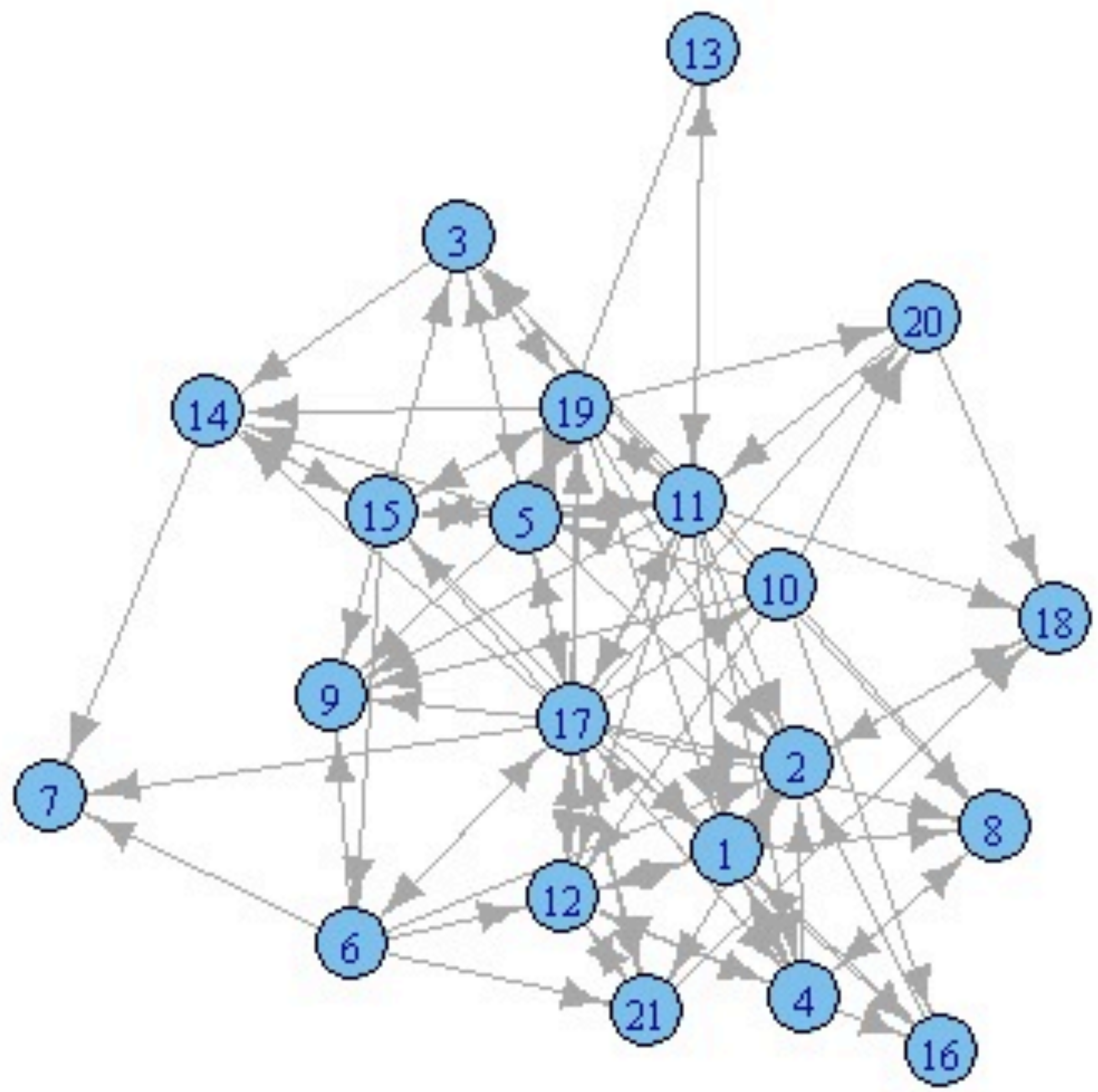
The NB system: text annotation



Zyto et. al.

Measurement Interaction Learning

The NB system: text annotation



The NB system: text annotation

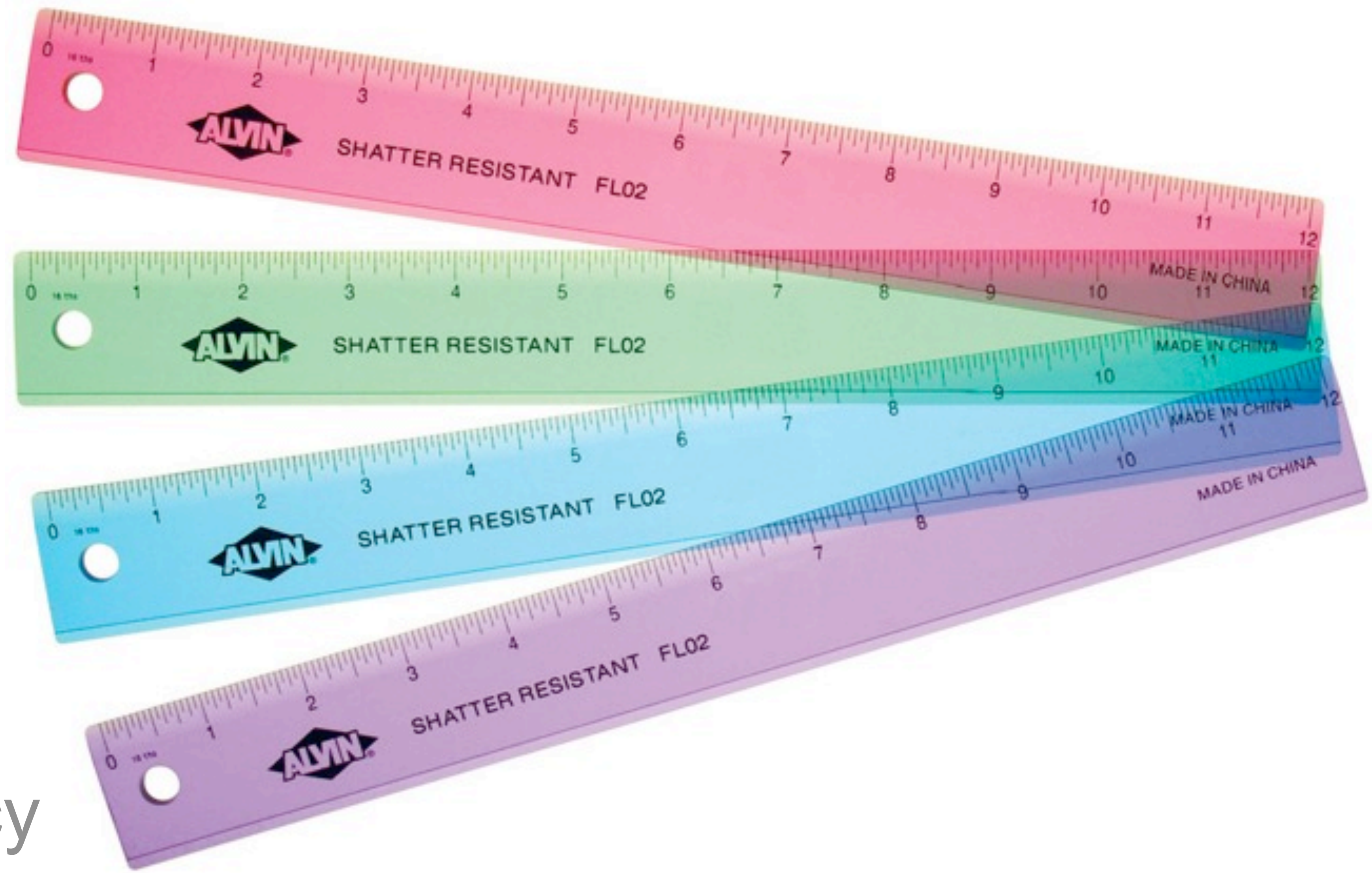
Score	Description & Criteria
2	Demonstrates thorough and thoughtful reading AND insightful interpretation of the text.
1	Demonstrates reading, but no (or only superficial) interpretation of the text.
0	Does not demonstrate any thoughtful reading of the text.

Learning

Metacognition

Interaction

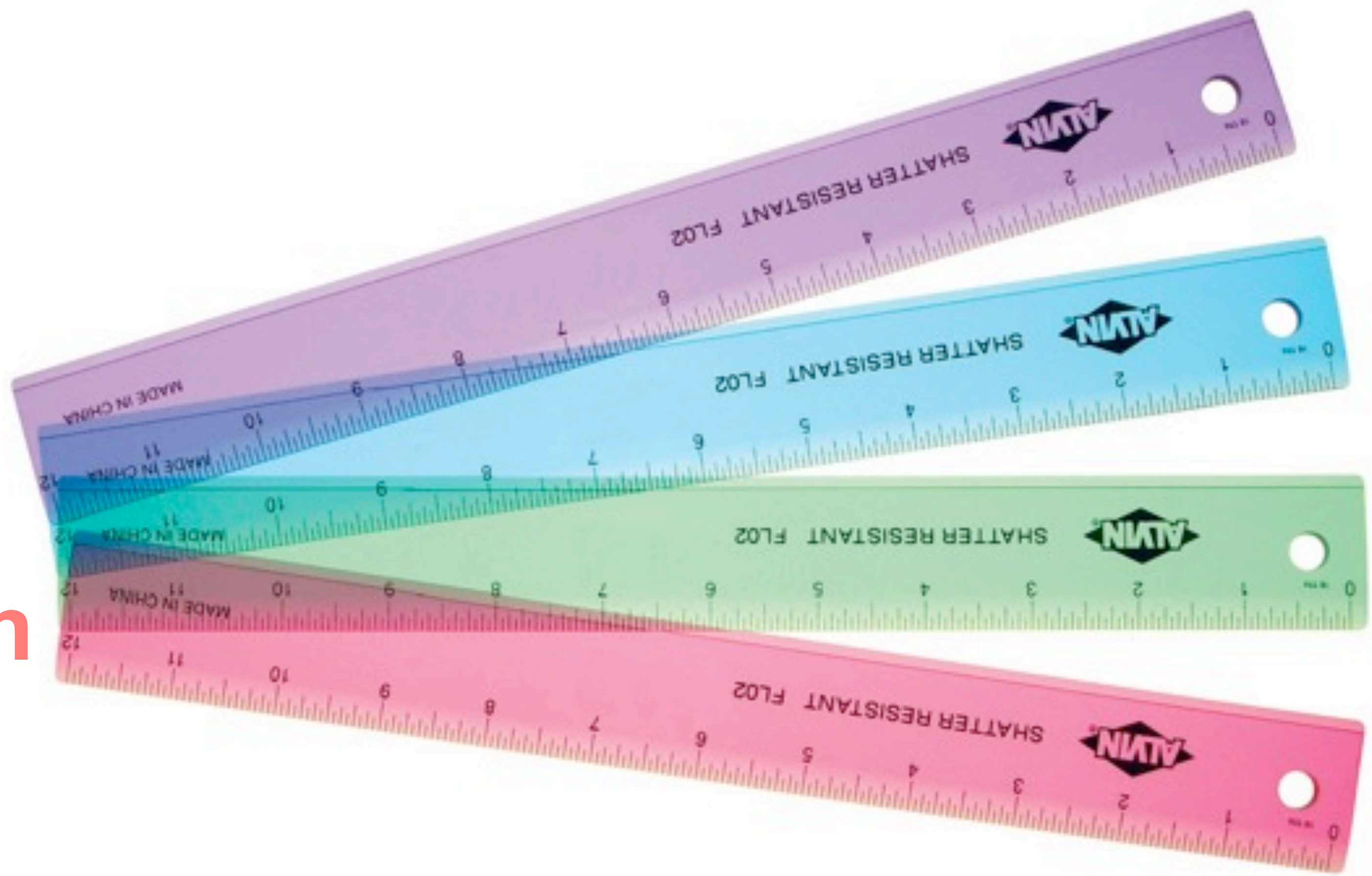
Self-efficacy



NB annotations

Learning

Interaction



Lens to Learning videos

Group exams

Social networks

Peer assessments

Eric Mazur
Todd Zickler
Rachel Scherr (Seattle Pacific University)

Carolann Koleci
Marinna Madrid
Kelly Miller
Youngjin Seo
Sumalee Waiyarod
Fauzy Wan
Helan Wu
Junehee Yoo

Beth Altringer
NB Team

Mazur Group
John Brunelle and Harvard FAS Research Computing

NSF
Hauser Initiative for Learning and Teaching (HILT)
Harvard School of Engineering and Applied Sciences

Talk credits

Hestenes, et. al. 1992. Hestenes, D., Wells, M., & Swackhamer, G. (1992). Force concept inventory. The physics teacher, 30, 141.

Hestenes & Wells. 1992. Hestenes, D., & Wells, M. (1992). A mechanics baseline test. The physics teacher, 30, 159.

Girash, J. (2013). Girash, J. "Metacognition and Instruction". In Benassi, V. A., Overson, C. E., & Hakala, C. M. (forthcoming, 2013). Applying the Science of Learning in Education: Infusing psychological science into the curriculum. Society for the Teaching of Psychology (American Psychological Association, Division 2).

National Research Council, 2000. How People Learn: Brain, Mind, Experience, and School: Expanded Edition. (n.d.). Retrieved October 17, 2013, from http://nap.edu/openbook.php?record_id=9853

Chi (2009). Chi, M. T. H. (2009). Active-Constructive-Interactive: A Conceptual Framework for Differentiating Learning Activities. Topics in Cognitive Science, 1(1), 73–105. doi:10.1111/j.1756-8765.2008.01005.x

Fencl & Scheel (2005). Fencl, H., & Scheel, K. (2005). Engaging Students: An Examination of the Effects of Teaching Strategies on Self-Efficacy and Course Climate in a Nonmajors Physics Course. Journal of College Science Teaching, 35(1), 20–24.

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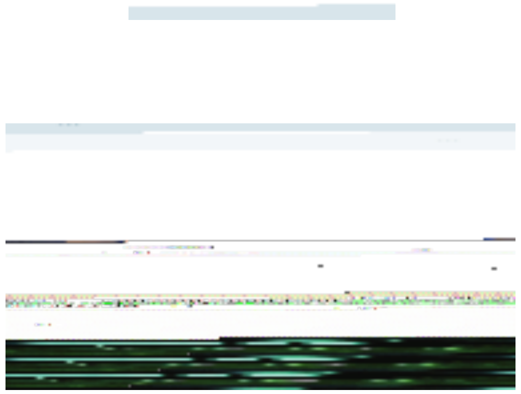
Zyto et. al. Syto, S, Kargar, D., & Ackerman, M. Successful Classroom Deployment of a Social Document Annotation System. retrieved from http://oeit-dev.mit.edu/sites/default/files/cscl1.pdf on 0ct. 18, 2013.

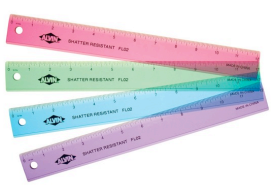
Citation credits

Sue Borchardt, 2011



http://www.youtube.com/watch?v=Wzs2zXI_aZc&noredirect=1

Helan Wu and Eric Mazur, 2013



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http://oeit-dev.mit.edu/sites/default/files/cscl1.pdf

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