Best Practices in NanoLeap

John Ristvey
www.mcrel.org/nanoleap
nanoleap@mcrel.org

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McREL

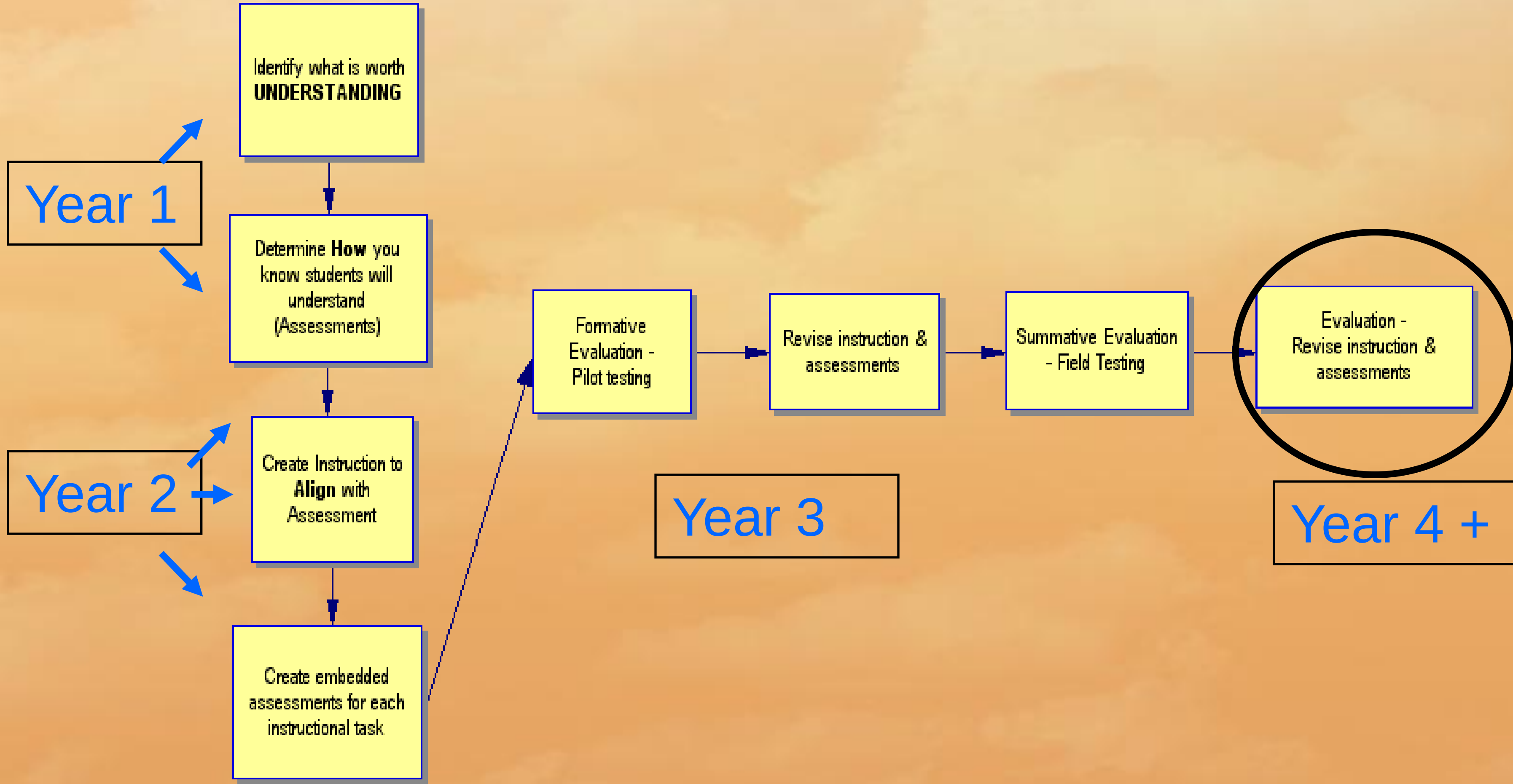
NanoLeap Partnership

- McREL, Education Research Laboratory
- Stanford Nanofabrication Facility
- Aspen Associates

NanoLeap Goals

- To explore where nanoscale science, technology, engineering, and mathematics concepts can fit into high school physical science and chemistry classes in a manner that supports students in learning core science concepts.
- To determine a viable approach for instructional materials development in the areas of nanoscale science, technology, engineering, and mathematics.

Understanding By Design



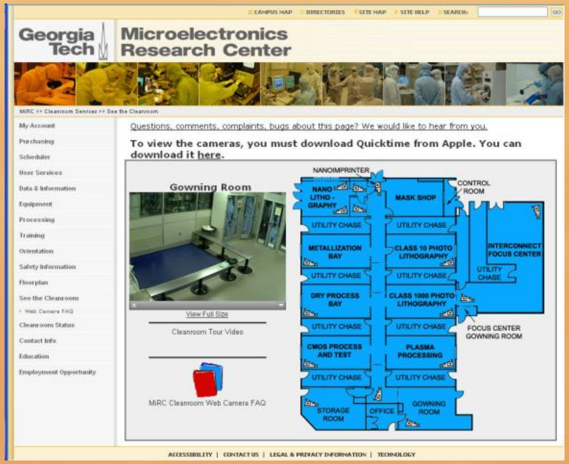
NanoLeap Modules


- *Exploring the Mystery of the Gecko*
- Physical Science:
  - “What factors affect force measurements between interacting surfaces?”
- *Nanoscale Materials and their Properties*
- Chemistry:
  - “How and why do the chemical and physical properties of nanosamples differ from those of macrosamples of the same substance?"

NanoLeap A-Team

NanoLeap Multimedia

NanoLeap Remote Access

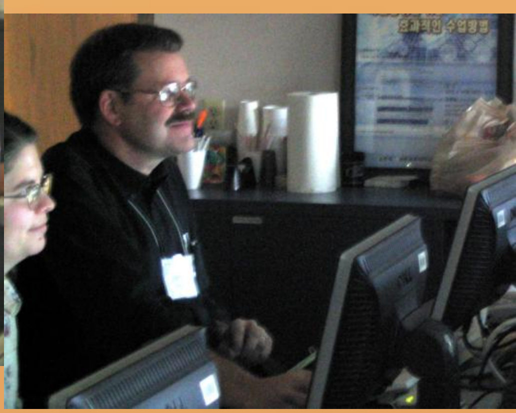


http://www.mcrel.org/nanoleap/remote_access/cleanroom.asp

Best Practices in NanoLeap

- Identify Big Ideas/Essential Understandings
- Alignment to STEM Standards
- Identify Transitional Content and Processes and develop assessments and instruction that bridges the gap
- Work collaboratively with master teachers



Best Practices in NanoLeap

- Employ iterative content and pedagogical review along the way
- Pilot testing with master teachers
- Field testing treatment and control teachers (n ~ 100) representing broader population
- Following pilot and field tests, make revisions using multiple data sources
    - Classroom Observations/Video
    - Student Work Samples
    - Assessment Results
    - Fidelity Checklist Results

Back up slides

- Core Science concepts include those items on the assessment that typically are addressed in high school science and measure student understanding of macroscale objects, comparisons, and phenomena.
- Transition to Nanoscale Science concepts include those items on the assessment that typically ARE NOT addressed in high school science and measure student understanding of macroscale and nanoscale objects, comparisons, and phenomena.
- Nanoscale Science concepts include those items on the assessment that typically are not addressed in high school science and measure student understanding of nanoscale objects, comparisons, and phenomena.

Flow from Standard to Transitional Concept to Big Idea

Standard: Physical Science, Motion and Forces Grades 9-12

"The electric force is a universal force that exists between any two charged objects. Opposite charges attract while like charges repel."

–excerpt *National Science Education Standards,* page 180

Transitional Concept

"The attractive intermolecular forces between and within molecules cause the gecko to adhere to a vertical surface."

–derived from NanoLeap Physical Science Module Objective, Lesson 8

Big Idea in Nanoscience: Electrical Forces

"All interactions can be described by multiple types of forces, but the relative impact of these forces changes with scale. On the nanoscale, a range of electrical forces with varying strength tends to dominate the interactions between objects."

– excerpt from *Big Ideas of Nanoscience*, page 28

NanoLeap Field Test

A total of 1,380 students participated in the *NanoLeap* field test. Of these 766 students participated in the physical science field test, 315 in the treatment group and 451 in the control group. Another 614 students participated in the chemistry field test; 299 in the treatment group and 325 in the control group.

Physical Science	Treatment (n=306)			Control (n=343)			Difference Treatment - Control		
Mean (S.D.)	Pre	Post	Gain Score	Pre	Post	Gain Score	Pre	Post	Gain Score
Total Score (42 items)	19.5 (6.2)	24.9 (8.0)	5.4 (6.1)	18.7 (6.0)	19.5 (7.6)	0.8 (6.1)	0.9 (0.5)	5.5 (0.6)	4.6 (0.5)
Effect Size			**0.76***			0.12	0.13	**0.69***	**1.02***
Core Science (21 items)	10.3 (3.5)	12.4 (4.2)	2.1 (3.7)	9.9 (3.7)	10.3 (4.4)	0.4 (3.6)	0.4 (0.3)	2.1 (0.3)	1.7 (0.3)
Effect Size			**0.55***			0.10*	0.11	**0.49***	**0.47***
Transition to Nanoscale Science (11 items)	5.9 (2.2)	7.4 (2.6)	1.5 (2.4)	5.7 (2.3)	5.7 (2.6)	0.0 (2.5)	0.2 (0.2)	1.7 (0.2)	1.5 (0.2)
Effect Size			**0.63***			0.00	0.09	**0.65***	**0.61***
Nanoscale Science (10 items)	3.4 (1.7)	5.1 (2.2)	1.7 (2.2)	3.1 (1.5)	3.5 (1.8)	0.4 (2.0)	0.3 (0.1)	1.7 (0.2)	1.4 (0.2)
Effect Size			**0.87***			0.24*	0.19*	**0.80***	**0.62***

Chemistry	Treatment (n=365)			Control (n=290)			Difference Treatment - Control		
Mean (S.D.)	Pre	Post	Gain Score	Pre	Post	Gain Score	Pre	Post	Gain Score
Total Score (40 items)	15.9 (4.2)	19.9 (7.3)	4.0 (5.9)	14.7 (4.4)	13.7 (4.6)	-1.0 (4.8)	1.3 (0.3)	6.3 (0.5)	5.0 (0.4)
Effect Size			**0.70***			-0.22*	**0.30***	**1.04***	**0.92***
Core Science (16 items)	6.9 (2.4)	7.5 (2.9)	0.6 (2.5)	6.4 (2.5)	6.1 (2.5)	-0.3 (2.8)	0.5 (0.2)	1.4 (0.2)	0.9 (0.2)
Effect Size			0.23*			-0.12*	0.20*	**0.52***	**0.34***
Transition to Nanoscale Science (8 items)	2.8 (1.4)	4.0 (2.0)	1.2 (2.0)	2.7 (1.5)	2.4 (1.5)	-0.3 (1.8)	0.1 (0.1)	1.5 (0.1)	1.4 (0.2)
Effect Size			**0.71***			-0.20*	0.07	**0.86***	**0.74***
Nanoscale Science (16 items)	6.2 (2.2)	8.5 (3.6)	2.2 (3.5)	5.5 (2.2)	5.1 (2.1)	-0.4 (2.4)	0.7 (0.2)	3.4 (0.2)	2.6 (0.2)
Effect Size			**0.76***			-0.19*	**0.32***	**1.19***	**0.88***

Outcome #3: Students in classrooms where teachers fully implement the *NanoLeap* materials (treatment group) will demonstrate a level of understanding of core science concepts that is at least equal to, if not greater than, that of students in classrooms where the *NanoLeap* materials are not implemented (control group).

Finding #3: Students in the physical science treatment group significantly outperformed their peers in the control group in terms of the gain in knowledge demonstrated from the pre- to the post-test.

Outcome #4: Students in classrooms where teachers fully implement the NanoLeap materials (treatment group) will demonstrate an increased understanding of nanoscale science, technology, engineering, and mathematics concepts, applications, and careers.

Finding #4: Students in the chemistry treatment group significantly outperformed their peers in the control group in terms of the gain in knowledge that was demonstrated from the pre- to the post-test.