The Research Rationale and Process for the SLIDER Project

Donna C. Llewellyn, Ph.D.
Georgia Tech
Center for the Enhancement of Teaching and Learning

What is SLIDER?

- Science Learning: Integrating Design, Engineering and Robotics
- NSF DR-K12 Program
- $3.5 M over 5 years, began 10/1/09

SLIDER

- Georgia Tech in collaboration with 3 middle schools: urban, suburban, rural; and the Georgia Department of Education
- Curriculum design, development, implementation, research

Who is on the team?

- PI: Richard Millman

- Co-PIs:
  - Donna Llewellyn, Research
  - Marion Usselman, Project Director
  - Juan Aguilar, GA DOE

The Team

- Curriculum Development:
  - Mike Ryan and Jeff Rosen
- Researchers:
  - Barbara Fasse and Richard Catrambone
- Implementation:
  - Teacher coaches: Doug Edwards, Fred Stillwell, Jess Bush
  - 6 Graduate Student “SLIDER Fellows”

Why do we need a new curriculum?

- Current curriculum not doing the job!

- For example:
  - New Georgia standards promote process skills and deeper learning
  - In 2007, 40% students failed the 8th grade CRCT in Physical Science

Why Engineering Design Scenarios?

- Proven way to engage learners
- Provides context for learning
- Embodies content and skill knowledge
- Provides opportunities to
  - Innovate
  - Create original solutions
  - Experience what real engineers do

Why Robotic-based Actitives?

- Can be correlated with
  - Over 75% of math content standards
  - Over 60% of physical science content standards

Why Legos?

- Affordable
- Accessible
- Adaptive
- Reliable
- Reusable
- Long-lasting
- Non-intimidating
- Associated with fun

What are our research questions?

1. Can research-based physical science instructional materials that use problem-based, inquiry learning in the context of engineering design scenarios empower a broad range of middle school learners to learn physical science content and reasoning skills?

Research Questions, cont'd.

2. Can these educational materials lead to increased engagement, motivation, aptitude, creativity and interest in STEM fields, and if so, does this effect persist as students move into high school?

Research Questions, cont'd.

3. Do students engage with the materials differently depending upon their gender, race, socioeconomic status, prior academic achievement level, or location (urban, suburban, rural)?

Secondary Research Questions

4. How should the learning that takes place best be assessed in the classroom, and how does this assessment impact student performance?

Secondary Research Questions, cont'd.

5. What type of support, both in instructional materials and professional development, is necessary to adequately prepare teachers to deliver this type of curriculum?

Why those questions?

- Nobody has attempted to study them yet
- The answers are needed to justify revamping the curriculum more widely and spending money on legos, etc.
- They are interesting

What will we do – Curriculum Development?

Based on paper by D. H. Clement:

"Curriculum Research: Toward a Framework for 'Research-based Curricula," *Journal for Research in Mathematics Education*, 38 (1), pp. 35-70, 2007.

Basic Steps

1. Subject Matter A Priori Foundation
   - Georgia Performance Standards
   - Task Analysis
2. General A Priori Foundation
   - Problem-based Learning (PBL)
3. Pedagogical A Priori Foundation
   - Learning by Design ™ (LBD)

Basic Steps continued

4. Structure According to Specific Learning Models
   - Engineering Design to teach STEM content and “agency” (Bandura)
5. Market Research
   - Robotics
   - Theme: “How Can We Design Solutions to Problems Facing People, Communities, and our World?”

Basic Steps, continued

6. Formative Research: Small Group
   - After school, summer camp sessions, etc.
7. Formative Research: Single Classroom
   - Teacher coaches
   - “Tester” classrooms
8. Formative Research: Multiple Classrooms
   - Pilot year in three schools (6 classrooms)

Final Steps

9. Summative Research: Small Scale
   - Qualitative analysis of three school roll-out
10. Summative Research: Large Scale
   - Beyond the scope of this project

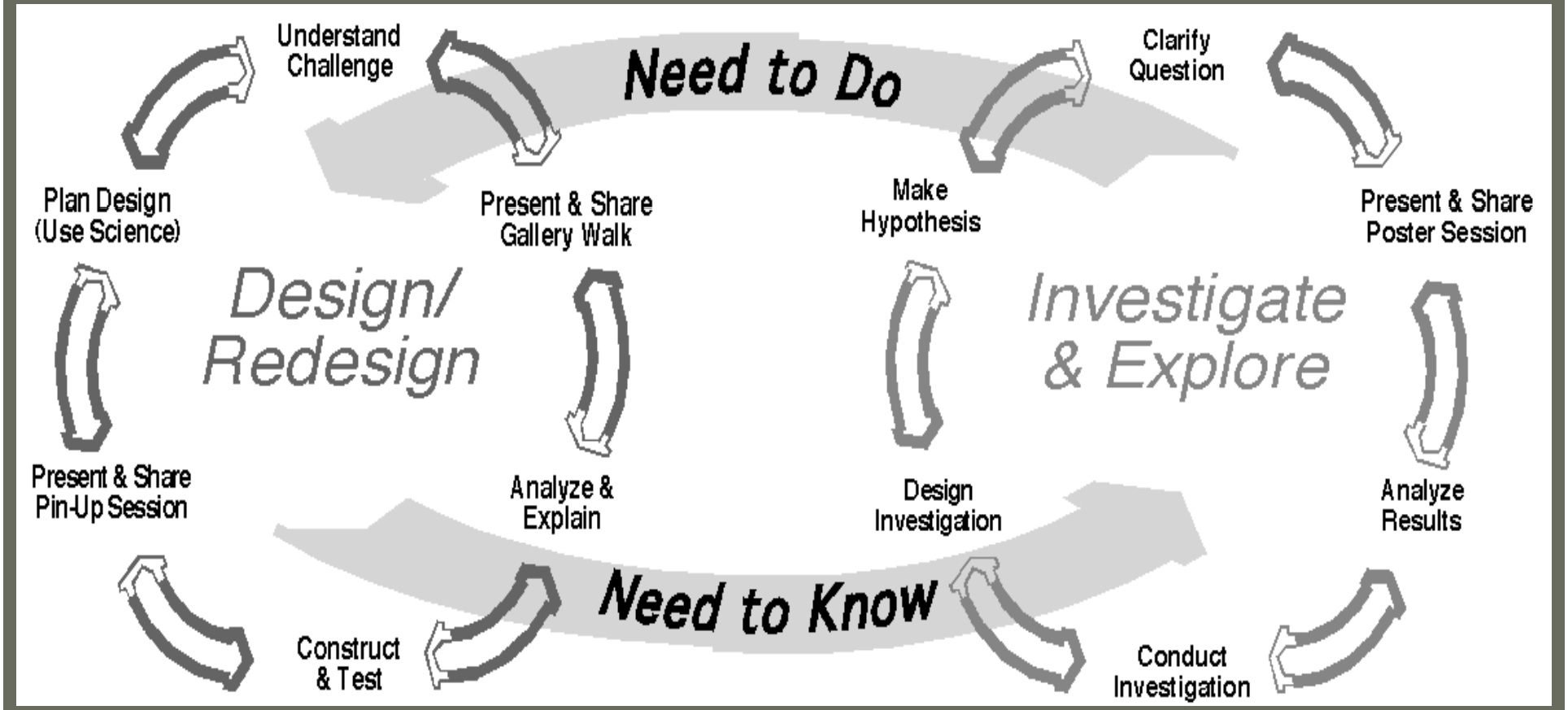
What will we do – Science Learning Research?

- Learning By Design ™
  - Inquiry, PBL approach to middle school science education
  - Grounded in constructivist learning theory
  - Addresses the social and cognitive aspects of learning
  - Case-based reasoning

More on LBD ™

Students working with a “design artifact”

- Attempt to solve a problem or meet a challenge
- Redesign the artifact to meet the criterion of the design problem
- Engage in behaviors and activities of designers, engineers, and architects:
  - Analyze a challenge, build or test models to obtain feedback, reflect, redesign based on the feedback, iterate



LBD Cycles of Activities (from Kolodner, Gray, and Fasse, 2003)

Kolodner, J. L., Gray, J. & Fasse, B.B. (2003). Promoting Transfer through Case-Based Reasoning: Rituals and Practices in Learning by Design Classrooms. *Cognitive Science Quarterly*, Vol. 3, No. 2, pp. 183 – 232.

How do these two relate?

- Where does curriculum development stop and science learning research begin?
- And, where does assessment fit in with each of these?

What are some of our challenges?

- IRB
- Teacher turn over
- Being all over the state
- Observing without influencing
- Controls
- Comparisons
- Many, many small pieces of legos

Discussion

Contact Info

- Donna Llewellyn
- 404-894-2340
- donna.llewellyn@cetl.gatech.edu