



# Designing and Implementing Technology-Driven Solutions for Sustaining SMT Reforms: A Partnership Story

Highly  
Interactive  
Classrooms  
Curricula  
Computing  
in Education  
  
at the  
University  
of Michigan

- Joseph Krajcik  
–University of Michigan

# Thanks to Many

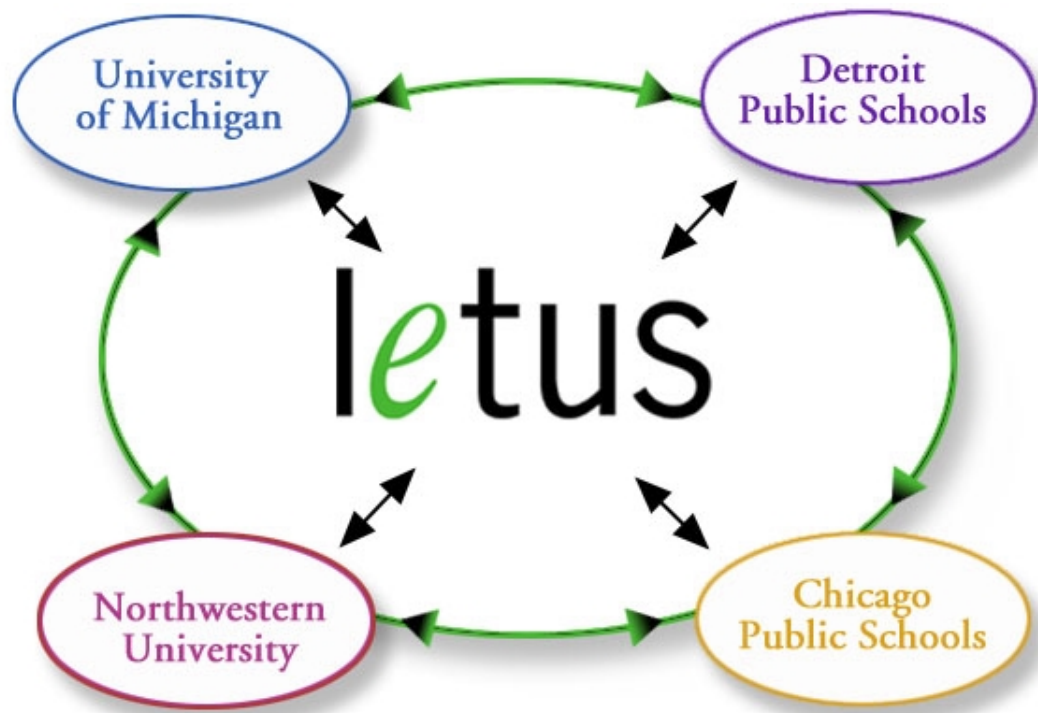
- Colleagues from UM
  - Ron Marx, Barry Fishman, Elliot Soloway, Phyllis Blumenfeld, Elizabeth Moje
- Colleagues from Detroit
  - Juanita Clay-Chambers, Deborah Peek-Brown
- Many Teachers from Detroit
- Many Graduate Students from Michigan



# Center for Learning Technologies in Urban Schools

## & Detroit's Urban System Initiative

### A Collaborative Effort



- Partnership between school districts and research universities
  - Detroit Public Schools
  - University of Michigan

Sponsored by the National  
Science Foundation



# Our work

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- Simultaneous attention to and coordination of several elements
- Improve the teaching and learning of science
- Leverage the talents and expertise of practitioners and researchers
- Results in
  - theory based, technology infused curriculum
  - responsive to needs of schools, teachers and students



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# Goals

- Improve the teaching and learning of science for all students
- Embed the use of learning technologies to improve the motivation and learning of all students
- Improve the teaching for All teachers through extend professional development
- Support standards-based systemic change



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## Clear message from teachers:

- We need curriculum if we are to use the technology!!



# Developing Understandings: Ideas from Learning Theory



- **Situated**
  - Connected to students' lives,
- **Consideration of prior experiences**
  - Take into account what students know,
- **Active construction**
  - Scientific practices, Multiple representations, Interact with phenomena
- **Community of learners**
  - Collaboration, Negotiate Meaning
- **Cognitive tools**
  - Expands what we can do
- **Attention to literacy issues**



# Situate Learning

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- Students need to see the **importance** of what they are learning
- What students learn needs to **connected** to their **world**
- Implications beyond the classroom
- Students develop a need to know
- Do what scientist do



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# How it Works in the Classroom: Create Meaningful Environments

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- Driving questions
- Anchoring Experience
  - Experience Phenomena in Context
  - Case Studies
- Do what scientist do
  - Problems based in science
  - Present science as we know it today



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# Active Construction



- Learning is a continuous process requiring many experiences
- Ideas are formed by interacting and experiencing phenomena
- Understanding is constructed
  - Multiple representations
  - Use what we know
  - Apply scientific practices

# How it Works in the Classroom: Students Do Inquiry!

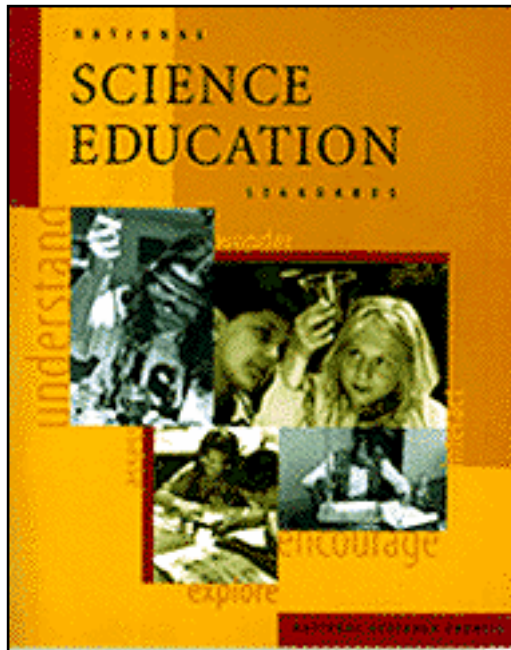
- Various Scientific Practices

- Asking questions
- Finding information
- Designing and planning research
- Conducting research
- Analyzing findings
- Making explanations
- Presenting findings



A recursive and  
dynamic process!

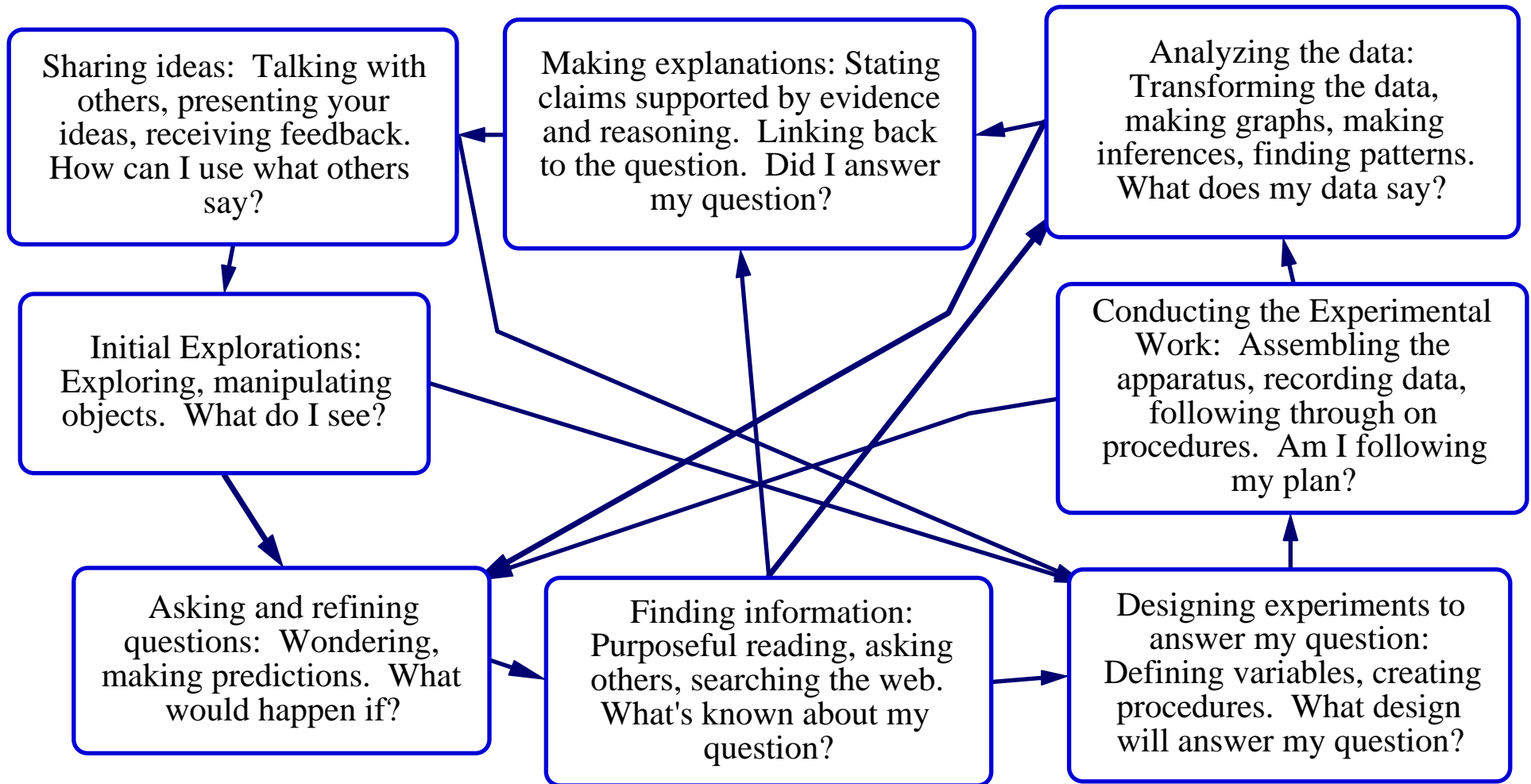
# Inquiry - the Preferred Method

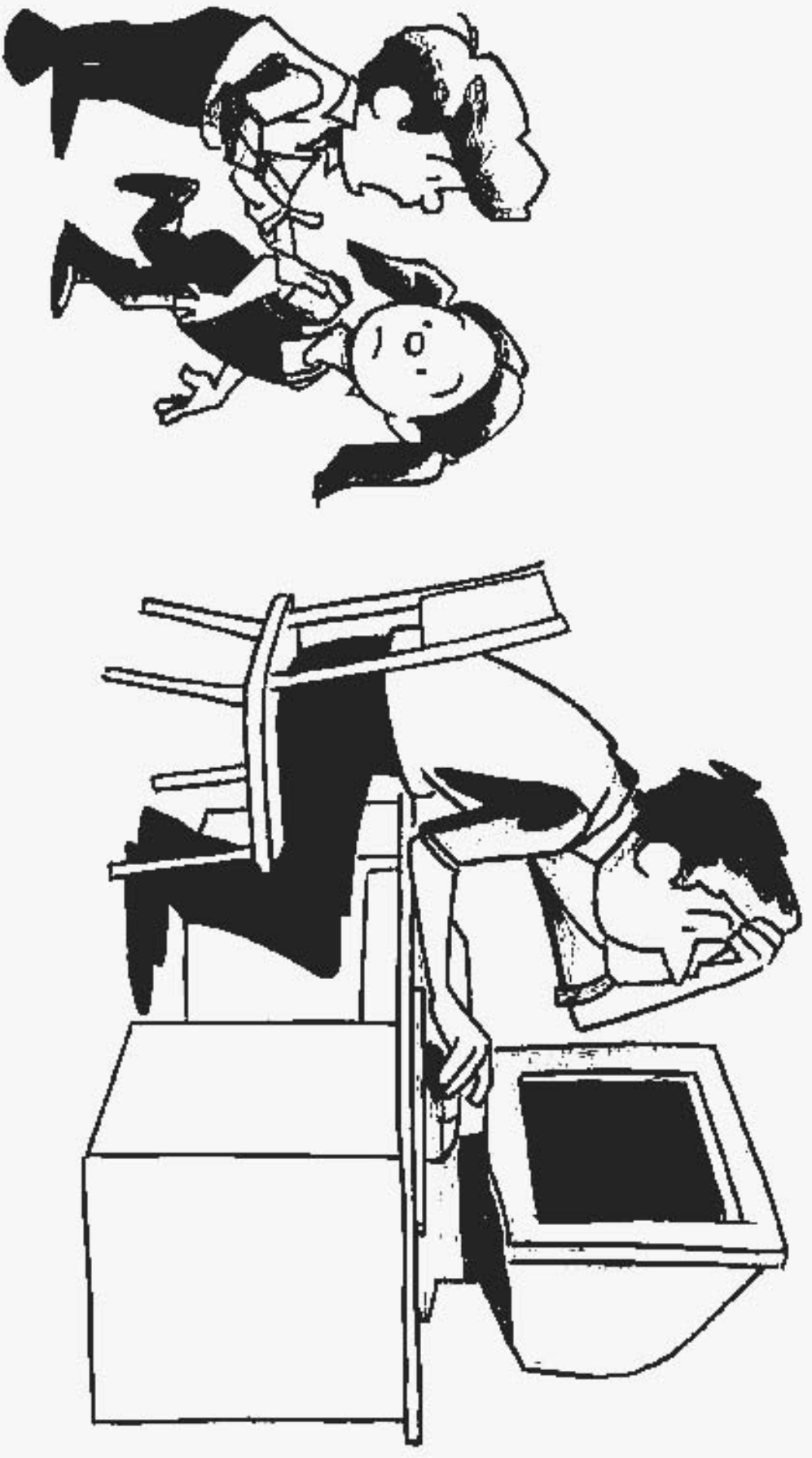


The content of science should be learned as a process.

"Inquiry into authentic questions generated from student experience is the central strategy for teaching science. Teachers focus inquiry predominately on real phenomena, in classrooms, outdoors, or in laboratory settings, where students are given investigations or guided toward fashioning investigations that are demanding but within their capacities."

# Scientific Practices -- A Recursive Process



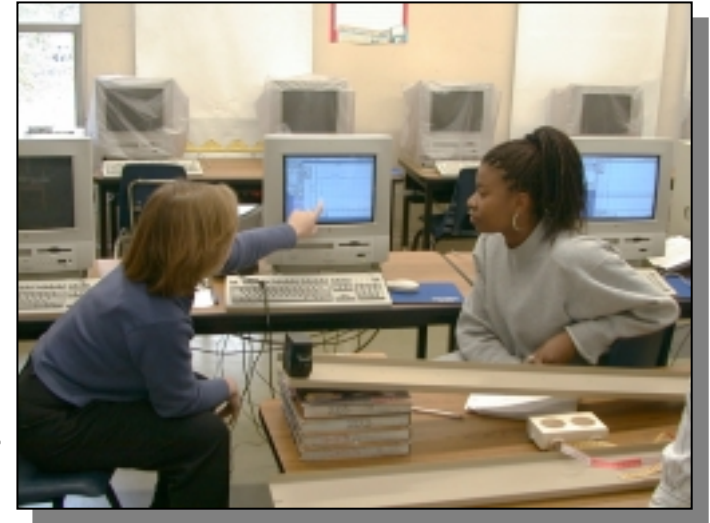


**"No...If we don't let him make his own mistakes,  
he's never going to learn."**



# Cognitive Tools

- Expands what we can learn!
- Learning Tools:
  - Visual displays
    - Graphs
    - Graphical Organizers
      - Concept maps
  - Learning Technologies
    - Computational
    - Communications



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## How it works in the classroom: Students Use Learning Tools



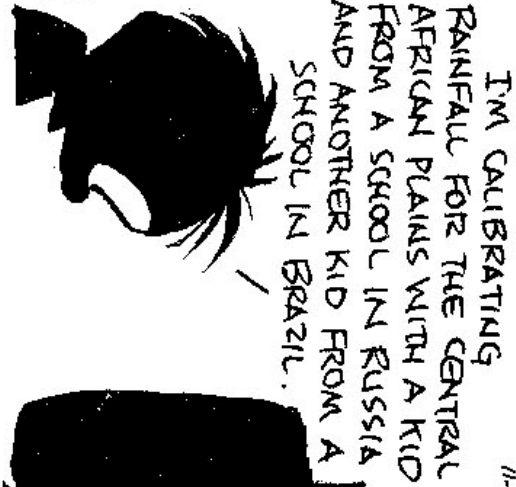
Extends what is possible in the science classroom

- Allows for exploration not possible in the science classroom
- Provides dynamic visuals to represent abstract concepts
- Provides opportunities to ask “What if?” questions
- Provides opportunities to plan, synthesize, question, predict and apply
- Allows students to do practices that scientists do, such as dynamic modeling.

ADAM



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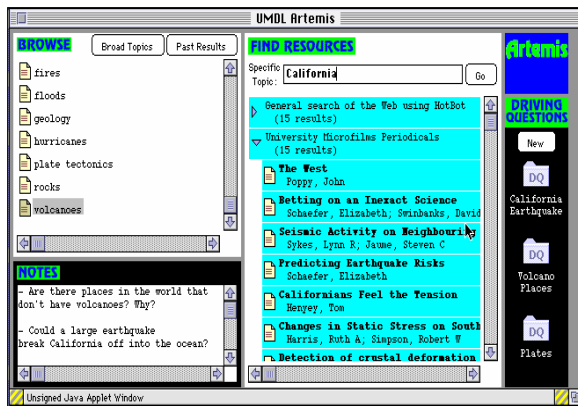
# Technology as Learning Tool

- Tools for science learning
  - Data gathering
  - Information Search
  - Data Analysis
  - Modeling
  - Representation and Sharing
- Tool use recurs throughout the curriculum

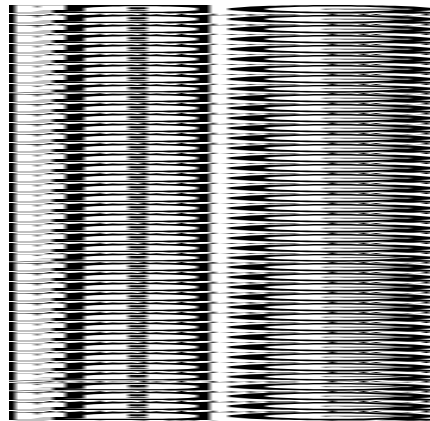


# Tools to Support Inquiry

## UMDL/Artemis



## Probes to collect & analyze data



## Hypermedia Construction

### Our Procedure

- What we need:
- 3 Bean Plants
- 3 Different colored lights
- Methanol test for starch amounts



The image shows a slide titled 'Our Procedure' with a list of materials needed for an experiment. The materials are: 'What we need:', '3 Bean Plants', '3 Different colored lights', and 'Methanol test for starch amounts'. To the right of the list is a photograph of three bean plants in pots, each under a different colored light (blue, red, green).

## Palm Applications



## eChem



## Model - It

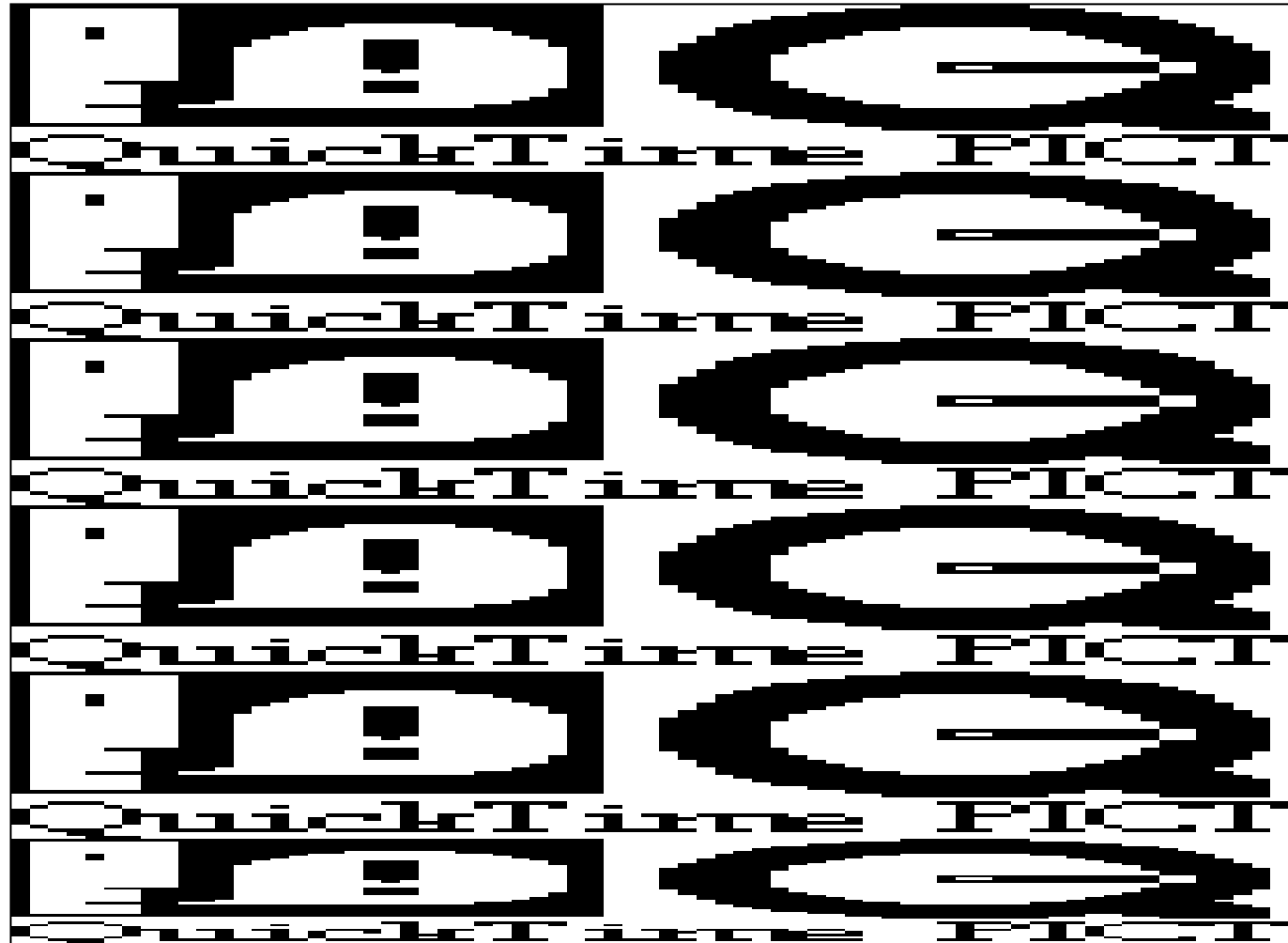


# Example: Technology Innovation



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# Inquiry-based, technology rich curriculum

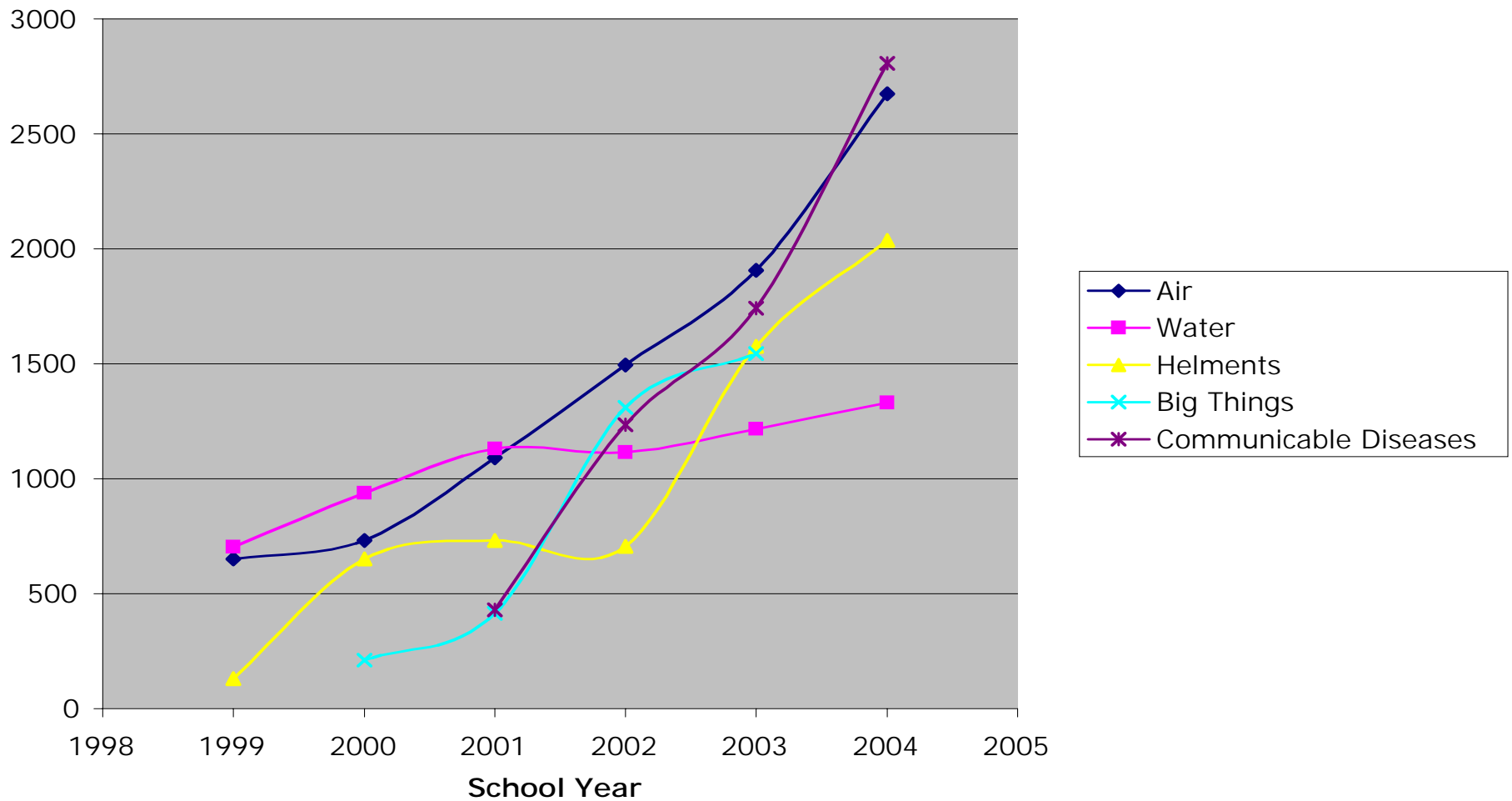
**Highly specified and developed but adaptable materials aligned with districts goals and needs.**



- **How Do Machines Help Me Build Big Things?**
  - Mechanical advantage - Sixth Grade
- **What Affects the Quality of Air in My Community?**
  - Basic Chemistry Principles - Seventh Grade
- **How Can Good Friends Make You Sick?**
  - Communicable Diseases - Seventh/Eighth Grade
- **What is the Quality of Water in Our River?**
  - Water Ecology - Seventh Grade
- **Why do I need to Wear a Bicycle Helmet?**
  - Motion and Force - Eighth

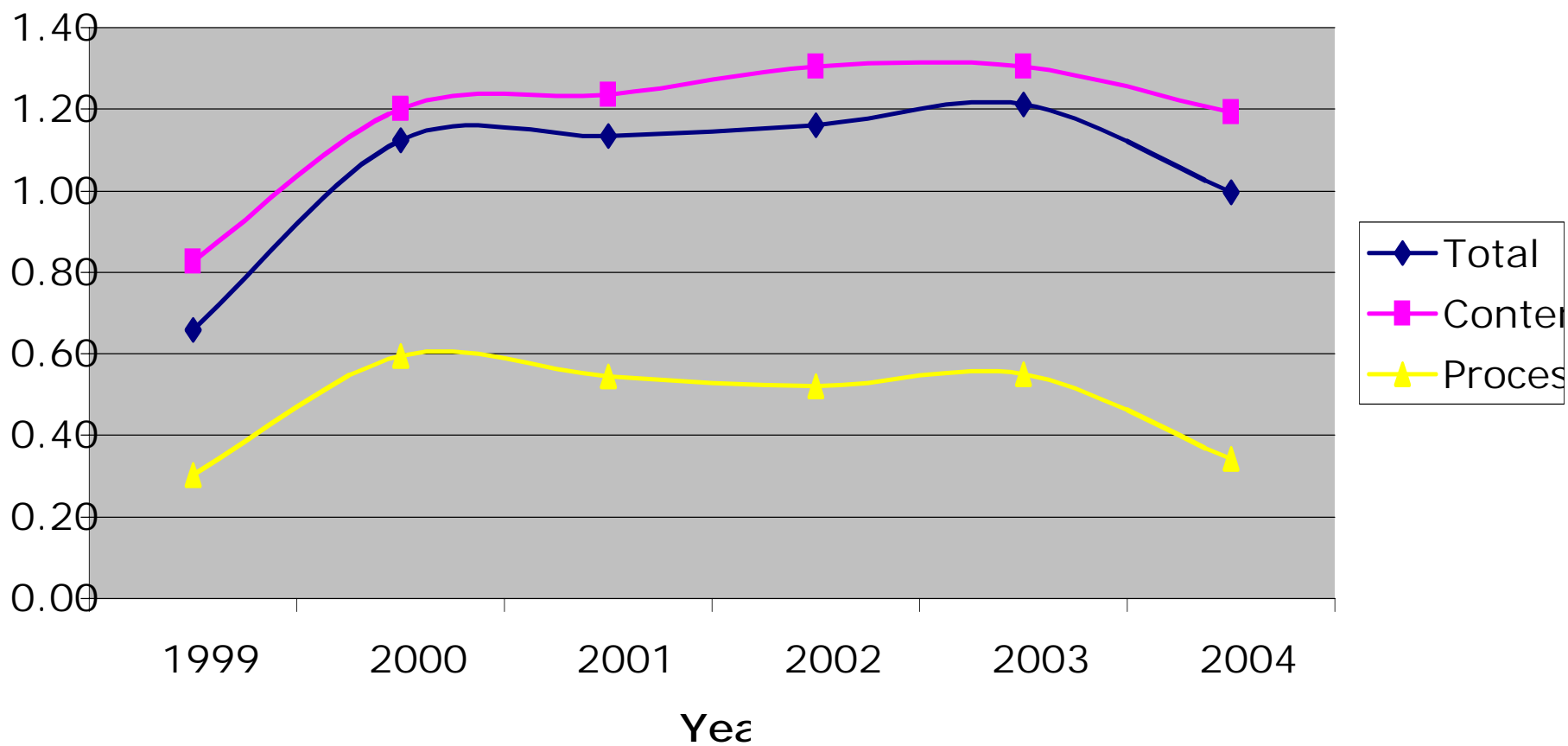
# Does it Scale? Teachers and Classroom Enactments

Scale of students across years

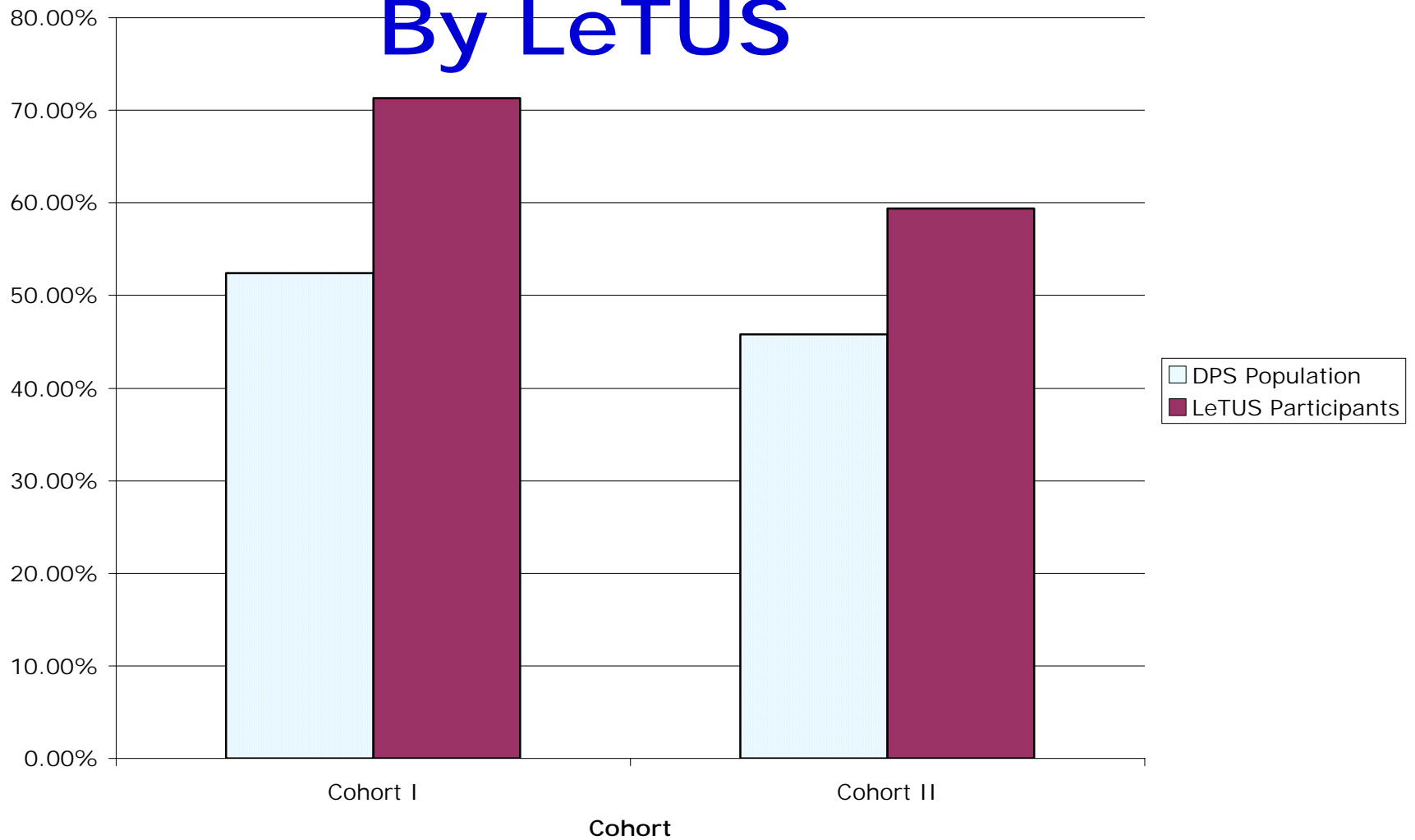


# Learning gains reported in effect size

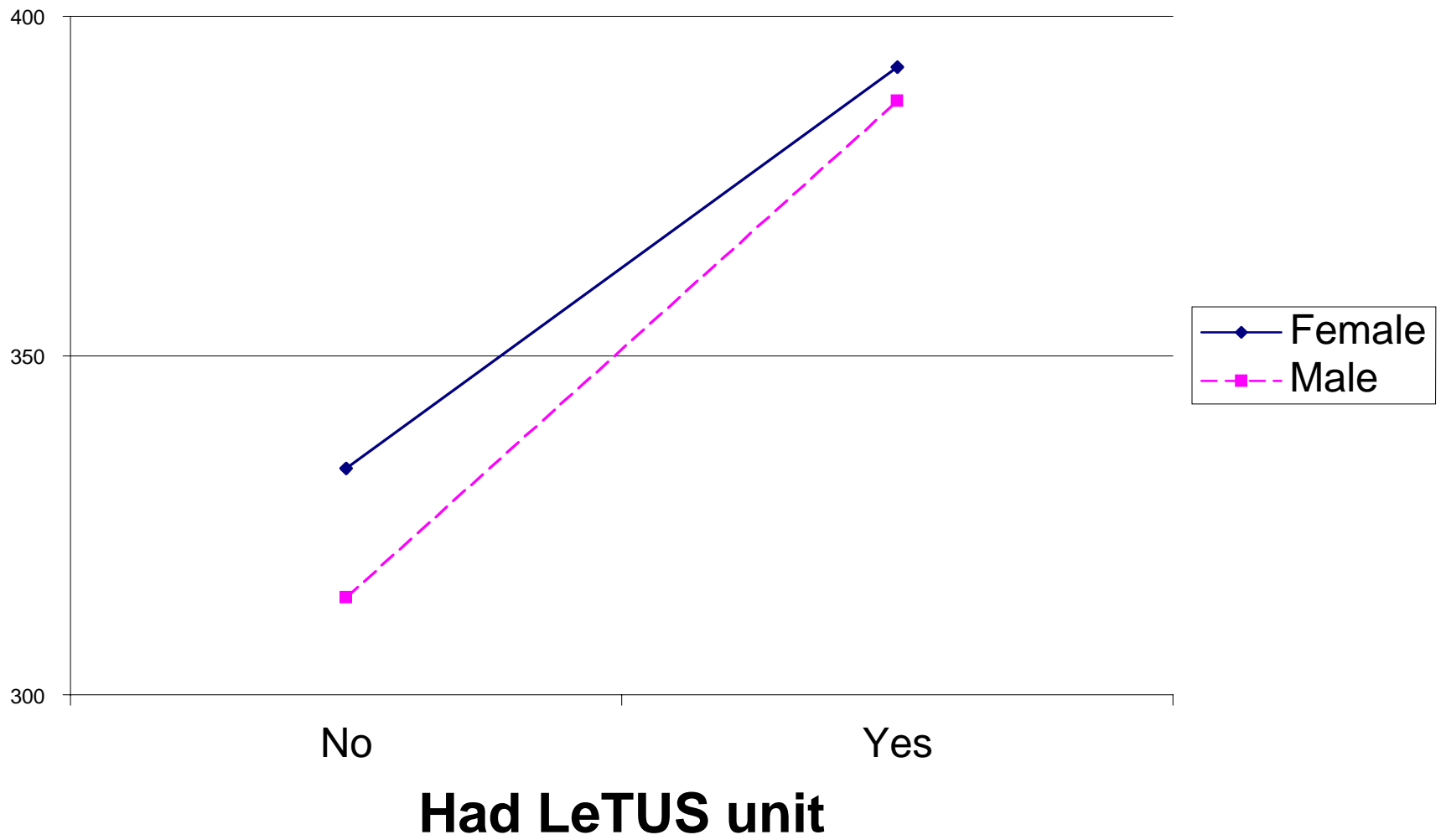
Figure 1. Weighted Average Effect Sizes for Process Scores



# MEAP Passing Rate By LeTUS



# Cohort I Gender Convergence

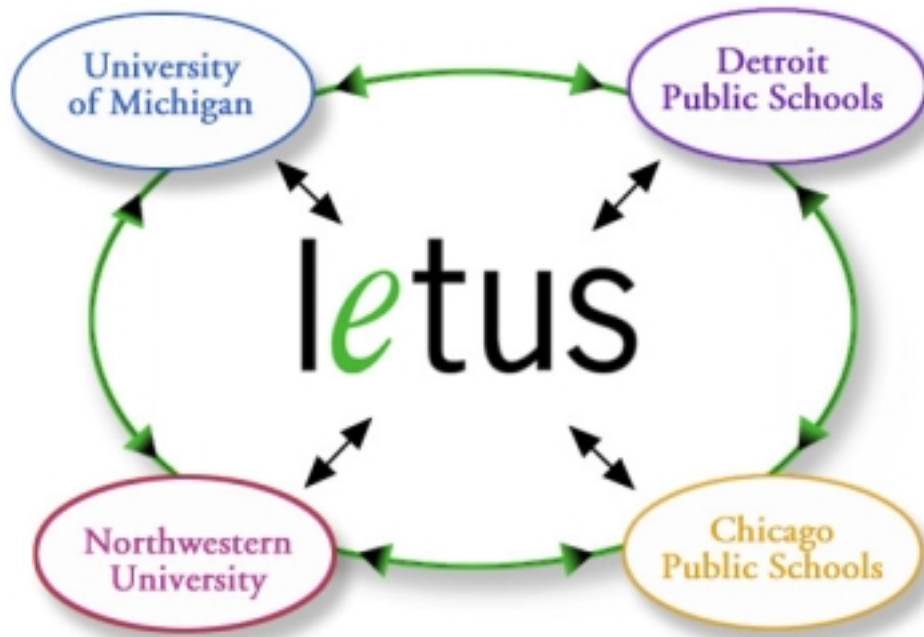


# Challenges Teachers Face in Using Inquiry-based, Technology-Rich Curriculum

- New models of practice!
- Pedagogical strategies
- New forms of content knowledge and PCK
- New Teaching Practice
- Knowledge of how to *use* technology
- Knowledge how *to teach* with technology
- Appropriate infrastructure and resources
- Materials that support the use of new scientific ideas and phenomena !

QuickTime™ and a Sorenson Video decompressor are needed to see this picture.

# Why the success of LETUS and Detroit's USI?



- Partnership
- Simultaneous attention to and coordination of several elements
  - Ambitious curriculum
  - Cutting-edge technology
  - On-going professional development
  - Administrative/technical/infrastructure assistance and collaboration
  - Continual documentation



# Professional Development


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- To learn how to enact and adapt inquiry-oriented, standards-based, technology-rich curricula
- To understand how learning theory forms the basis of the curriculum & technology
- To actively participate in the evaluation and adaptation of curriculum & technology



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# Our Approach: Working With Teachers

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- We contribute theory, ideas about teaching and learning
- Teachers contribute practical knowledge about classrooms
  - Challenges, strategies, warranted practice, required adaptations
- Mutual benefit
  - Teachers learn new approaches
  - Researchers ground theory in practice

# Professional Development



- Theory Driven
- Sustain
- Practiced based
- Collaborative
- Reflective
- Forms
  - Educative Curricula
  - Institutes & Workshops
  - In-class Support
  - On-line Support

# Educative Curriculum Materials

- Content Information
- Inquiry Support
- Framework/philosophy
  - Anchoring experience
  - Driving question
  - Collaboration
- Use of Technology
- Strategies
  - Predict, Observation, Explain Cycle
  - Concept mapping
  - KWL
- Assessment
- Students' conceptions
- Expected Student Outcomes

Materials that support teacher learning



# Policy & Management



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- Providing multiple and extended professional development opportunities
- Alignment with System
  - Aligned with Urban Systemic Program
  - Supported and affirmed by central office
  - Building principals buy in
- Standardized testing policies and practices
- Providing resources
  - Ready access to modern computers
  - Access to Internet
  - Computers need regular maintenance and support
  - Science materials

# Changes that took time to occur



- New ideas about teaching and learning
- The need to establish a learning community
  - Time for planning, opportunities to reflect, and occasions to share and create visions of their classroom
- The emergence of new and distributed leadership
  - The importance of local leaders
  - The importance of growth from within
- Fine tuning and adapting curriculum

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# Benefits of our mutual work!



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- Collaboration between individuals with diverse expertise to solve challenging problems
- Blend theory with practice
- Extended professional development opportunities
  - Teachers, graduate students, and researchers
- Impacted many students
- New understandings (models, principles) to inform others

# Concluding Comment

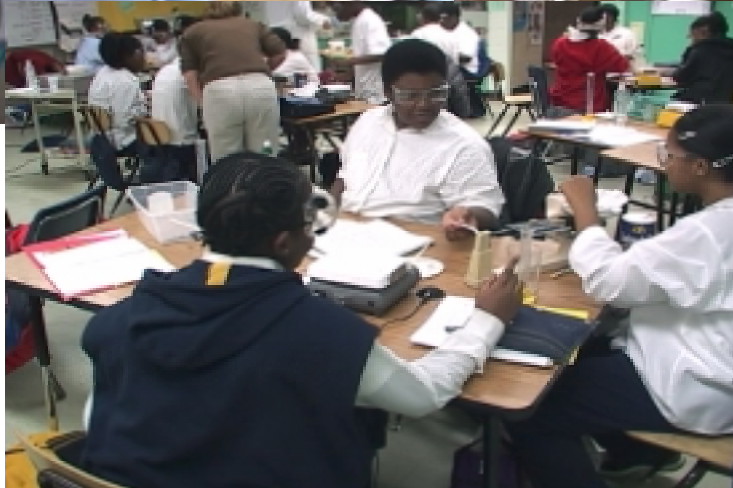
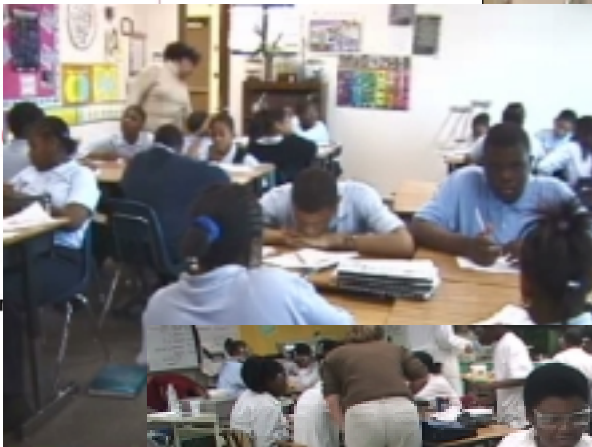
- Teachers were asked to do much.
- It worked only because of efforts of many!
- But
  - Takes professional development
  - Support from administrators
  - Working together!

QuickTime™ and a  
Sorenson Video decompressor  
are needed to see this picture.

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But it is worth it:  
Students learn!!!!



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- For more information
- [Krajcik@umich.edu](mailto:Krajcik@umich.edu)
- <http://www.hice.org>