



# Center for Integrative Research on Cognition, Learning, and Instruction (CIRCLE)



## *Current Projects*

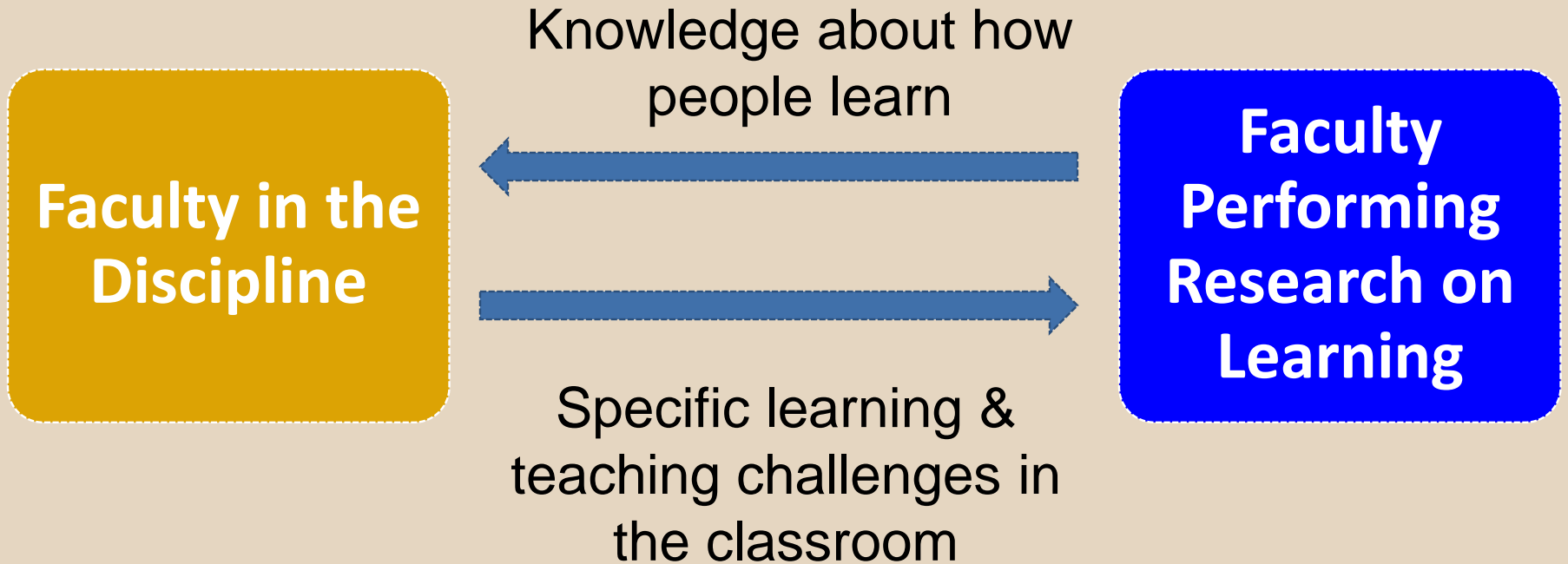
Mark McDaniel and Gina Frey  
Washington University in Saint Louis

# CIRCLE Mission



- Provide a **bridge** between WU faculty and researchers in cognitive and learning sciences to improve student learning.
  - Foster implementation of **innovations** in teaching
  - Support **research** to evaluate the effectiveness of these innovations
  - Disseminate the results of these **classroom-based** evaluations using experimental design methods

# Bridging The Gap



Collaboration to Improve Student Learning

# Types of CIRCLE Projects



- I. Active, Inquiry Learning, Problem-Based Approaches to Instruction
- II. Applying Cognitive Science (Memory Principles) to Improve Student Learning
- III. Teacher Development

## A. Identifying College Freshmen At-Risk For Migrating Out of Stem and How to Increase Retention



- Funded by Luce Foundation
- Consortium of 7 institutions
  - Private and public, large and small, research-intensive and PUI, different geographical regions
- Study focuses on General Chemistry
  - First university-level science course in most universities

## A. Identifying College Freshmen At-Risk For Migrating Out of Stem and How to Increase Retention



- Objective is to determine a student's learning approach
  - Using a Web-based learning-task program, which is independent of subject knowledge – developed at WU
- Compare a student's learning approach to course performance and see if a correlation exists

# Types of Student Learning Approaches



## Algorithmic (Exemplar)

- Memorizes information
- Follows procedures

## Conceptual-based (Rule-based)

- Connects concepts to problem solving
- Integrates ideas together

# Learning-Approach Study in General Chemistry



- Does the Web-based learning-task program work for a wide range of students?
  - Preliminary data from WU say “it works for psychology and general chemistry students”
- Does learning tendency relate to General Chemistry Performances?
  - Preliminary data from WU say “yes”
- Do active learning approaches benefit algorithmic learners?



## B. Active-Learning in Physics



- Hestenes, Physics professor at Arizona State, suspected that students in general physics were memorizing the formulas and not understanding the concepts
- Hestenes and colleagues developed the force-concept inventory in the early 1990s
  - Inventory tests conceptual understanding, not mathematical ability
- Inventory has been widely used and is highly validated.

## B. Assessment of Active-Learning in Physics (R. Trousil, M. Hynes)



- Initial funding by HHMI
- Introductory Physics sections
  - Standard lecture
  - Active problem solving, contextualized in everyday problems
- Administer Physics Concept Inventory (standardized exam) at beginning and end of semester
- Evaluate Problem sets with near and far transfer

## C. BioMedical Engineering Curriculum-Redesign Project

K. Thoroughman (Biomedical Eng.), B. Lutes (The Teaching Center)



- NSF proposal being submitted in January
- Engineering Virtual Studio in conjunction with Foundational Courses
  - Objective of studio is to provide students with enrichment material and exercises to see applications of concepts being studied in foundational courses
- CIRCLE's Role
  - Assist in designing assessment study for EVS and analysis of the educational impact
  - Assist in reporting the findings in the educational literature

## D. Process Oriented Guided Inquiry Learning (POGIL)



- IES funding pending
- Chemistry and Biology classes in 3 high schools—total of 20 classrooms
- Year 1: assess instructors' effectiveness by student improvement over the year
- Years 2 and 3: half instructors teach using POGIL materials; half with standard methods (with technology enrichment)
- Assessments: **Achievement**—exams; state standardized tests

**Scientific Reasoning  
Attitudes**

# Types of CIRCLE Projects



- I. Active, Inquiry Learning, Problem-Based Approaches to Instruction
- II. Applying Cognitive Science (Memory Principles) to Improve Student Learning**
- III. Teacher Development

## A. Business School

(Durai Sundaramoorthi, Mike Cahill, Jeri Little)



- Introductory Business Statistics (spring, 2012)
- Homework problem sets are grouped (massed) by problem type (compute independent sample t-tests; compute correlated sample t-tests)
- **Interleave problems** for half the course vs. standard practice for half the course
- Counterbalance halves across two sections
- In addition to course exams, administer a long-term retention test 3 months after course

## B. Occupational therapy/med school (Susan Fitzpatrick, Jeri Little)



- **Introductory Neuroscience (foundations course in OT)**
  - Challenge is that the course is terminology rich—lots of new terminology to learn
  - Many students do not know the terms even by mid-semester and do not seem to have familiarity with them in their subsequent clinically oriented courses
    - Likely interferes with comprehension and learning, especially during lectures
  - Frequent on-line quizzing of terminology initially to provide fluency in retrieval of meaning (Blackboard)
  - End of semester: Test for terms targeted and not targeted in quizzing;
  - End of summer: Test for long-term retention of terms

## C. Immunology (Dan Hanson)



- Project under Discussion
- Challenge is that the course is terminology rich—lots of new terminology to learn
  - Likely interferes with comprehension and learning, especially during lectures
- Frequent on-line quizzing of terminology initially to provide fluency in retrieval of meaning



# Types of CIRCLE Projects



- I. Active, Inquiry Learning, Problem-Based Approaches to Instruction
- II. Applying Cognitive Science (Memory Principles) to Improve Student Learning
- III. Teacher Development**

# A. Resident Teaching in OB/GYN (Tammy Sonn, WU medical school)



- Resident-teacher ratings in OB/GYN clinical rotations are among the worst in medical schools nation-wide
- Develop and implement residents-as-teachers professional-development program
- Designing a study which includes
  - Pre-test on a simulated teaching activity
  - Series of workshops on teaching
  - Post-test on a simulated teaching activity
  - Analyze student evaluations

# National Consortium of Universities for STEM Future Faculty WUSTAR Projects (Biology, The Teaching Center); Evaluation by CIRCLE



- NSF funding submitted in January (Part of consortium)
- WUSTAR Projects
  - Graduate Students conducting “teaching as research” projects
- Pilot program spring 2012
  - 4 WUSTAR Projects – biology
- Working with The Teaching Center
  - Refine pedagogical innovation and develop evaluation study
  - Weekly group meetings with The Teaching Center to discuss projects
  - The Teaching Center to evaluate WUSTAR program
- Working with CIRCLE to assist graduate students in learning to evaluate individual WUSTAR projects

# WU Conference: *Integrating Cognitive Science with Innovative Teaching in STEM Disciplines*



- Being held September 27-28, 2012 at Washington University in St. Louis
- Funded by the James S. McDonnell Foundation
- Bringing together experts in two adjoining fields:
  - STEM discipline experts (biology, chemistry, engineering, and physics)
    - ✦ Developing innovations in fostering student learning in STEM
    - ✦ Conducting classroom evaluations of these innovations in experiments and quasi-experiments
  - Cognitive-science experts
    - ✦ Conducting research in the laboratory with authentic educational materials
    - ✦ Conducting research in classroom contexts
    - ✦ Seeking to derive general principles of effective instruction and student learning.