Active Learning and Assessment

Symposium on the Use and Assessment of
Active Learning in Mathematics

August 3, 2016

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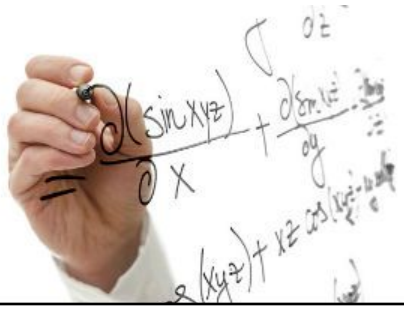
Agenda

- Issues in STEM education
- Active Learning – what is it? And why use it?
- CTL approach to promoting Active Learning
- Forms of assessment of Active Learning
- Scholarship of Teaching & Learning (SoTL)

Issues in STEM Education

What do we know?

- Decrease in STEM degrees conferred
- Increase in STEM employment opportunities
- Increase in need and value of STEM degree holders
- STEM pedagogies: In need of improvement



What is Active Learning?

- "Anything that involves students in **doing things** and **thinking about the things they are doing**" (Bonwell & Eison, 1991, p. 2).
- "Anything course-related that all students in a class session are **called upon to do** other than simply watching, listening and taking notes" (Felder & Brent, 2009, p.2).

Bonwell, C. C., & Eison, J. A. (1991). *Active learning: Creating excitement in the classroom (ASHE–ERIC Higher Education Rep. No. 1).*Washington, DC: The George Washington University, School of Education and Human Development.

Felder, R.M. & Brent, R. (2009). Active learning: An introduction. *ASQ Higher Education Brief, 2*(4).

Characteristics of Active Learning

- Students do more than listen
- More emphasis on developing skills than transmitting information
- Higher-order skills are targeted
- Engages students in activities
- Places emphasis on exploration of students attitudes and values

Bonwell, C. C., & Eison, J. A. (1991). *Active learning: Creating excitement in the classroom (ASHE-ERIC Higher Education Rep. No. 1).*Washington, DC: The George Washington University, School of Education and Human Development.

Why use Active Learning?

Does Active Learning Work? A Review of the Research

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ABSTRACT

This study examines the evidence for the effectiveness of active learning. It defines the common forms of active learning most relevant for engineering faculty and critically examines the core element of each method. It is found that there is broad but uneven support for the core elements of active, collaborative, cooperative and problem-based learning. [QA1]

I. INTRODUCTION

Active learning has received considerable attention over the past several years. Often presented or perceived as a radical change from traditional instruction, the topic frequently polarizes faculty. Active learning has attracted strong advocates among faculty looking for alternatives to traditional teaching methods, while skeptical faculty regard active learning as another in a long line of educational fads.

For many faculty there remain questions about what active learning is and how it differs from traditional engineering education, since this is already "active" through homework assignments and laboratories. Adding to the confusion, engineering faculty do not always understand how the common forms of active learning differ from each other and most engineering faculty are not inclined to comb the educational literature for answers.

This study addresses each of these issues. First, it defines active learning and distinguishes the different types of active learning most frequently discussed in the engineering literature. A core element is identified for each of these separate methods in order to differentiate between them, as well as to aid in the subsequent analysis of their effectiveness. Second, the study provides an overview of relevant cautions for the reader trying to draw quick conclusions on the effectiveness of active learning from the educational literature. Finally, it assists engineering faculty by summarizing some of the most relevant literature in the field of active learning.

II. DEFINITIONS

It is not possible to provide universally accepted definitions for all of the vocabulary of active learning since different authors in the field have interpreted some terms differently. However, it is possible to provide some generally accepted definitions and to highlight distinctions in how common terms are used.

Active learning is generally defined as any instructional method that engages students in the learning process. In short, active learning requires students to do meaningful learning activities and think about what they are doing [1]. While this definition could include traditional activities such as homework, in practice active learning refers to activities that are introduced into the classroom. The core elements of active learning are student activity and engagement in the learning process. Active learning is often contrasted to the traditional lecture where students passively receive information from the instructor.

Collaborative learning can refer to any instructional method in which students work together in small groups toward a common goal [2]. As such, collaborative learning can be viewed as encompassing all group-based instructional methods, including cooperative learning [3–7]. In contrast, some authors distinguish between collaborative and cooperative learning as having distinct historical developments and different philosophical roots [8–10]. In other interpretations, the core element of collaborative learning is the emphasis on student interactions rather than on learning as a solitary activity.

Cooperative learning can be defined as a structured form of group work where students pursue common goals while being assessed individually [3, 11]. The most common model of cooperative learning found in the engineering literature is that of Johnson, Johnson and Smith [12, 13]. This model incorporates five specific tenets, which are individual accountability, mutual interdependence, face-to-face promotive interaction, appropriate practice of interpersonal skills, and regular self-assessment of team functioning. While different cooperative learning models exist [14, 15], the core element held in common is a focus on cooperative incentives rather than competition to promote learning.

Problem-based learning (PBL) is an instructional method where relevant problems are introduced at the beginning of the instruction cycle and used to provide the context and motivation for the learning that follows. It is always active and usually (but not necessarily) collaborative or cooperative using the above definitions. PBL typically involves significant amounts of self-directed learning on the part of the students.

III. COMMON PROBLEMS INTERPRETING THE LITERATURE ON ACTIVE LEARNING

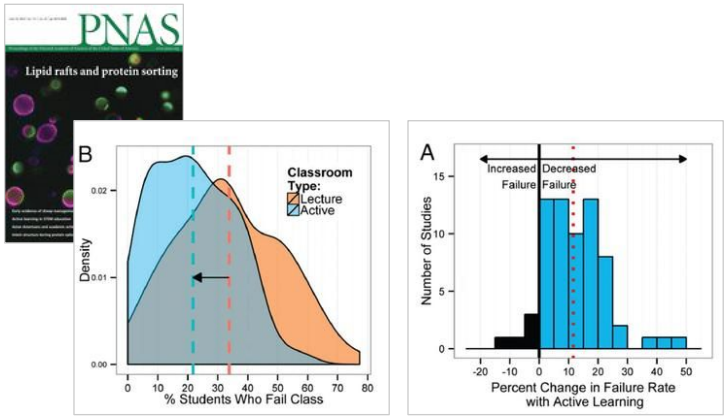
Before examining the literature to analyze the effectiveness of each approach, it is worth highlighting common problems that engineering faculty should appreciate before attempting to draw conclusions from the literature.

A Problem Defining What Is Being Studied

Confusion can result from reading the literature on the effectiveness of any instructional method unless the reader and author

July 2004 *Journal of Engineering Education* 1

Prince, M. (2004). Does Active Learning Work? A Review of the Research. *Journal of Engineering Education.* 93(3), 223-231.



Freeman, Scott; Eddy, Sarah L.; McDonough, Miles; Smith, Michelle K.; Okoroafor, Nnadozie; Jordt, Hannah; Wenderoth, Mary Pat; (2014). Active learning increases student performance in science, engineering, and mathematics. *Proc. Natl. Acad. Sci.*

Center for Teaching and Learning (CTL) Approach

- Supporting excellence and innovation in teaching
- Advancing a culture of teaching and learning

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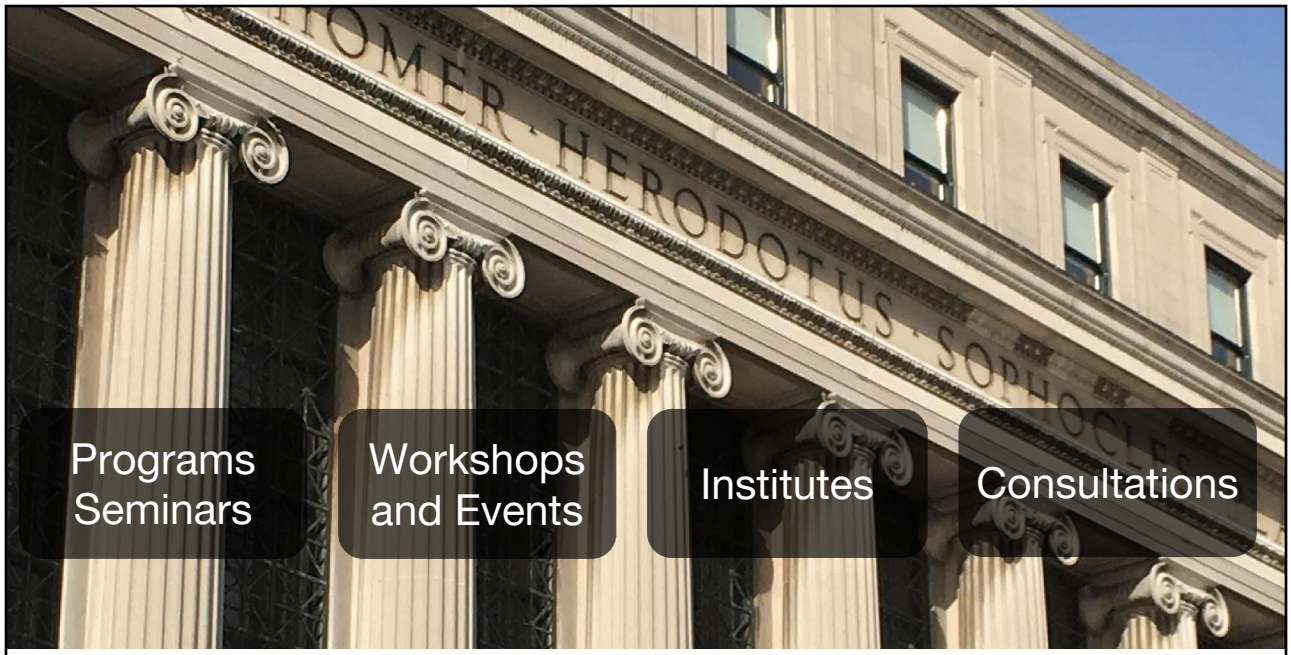

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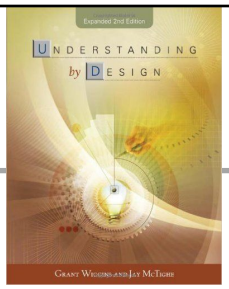
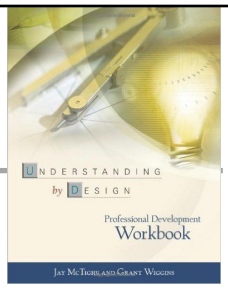
Backward Design





Framework Reference: Wiggins & McTighe.

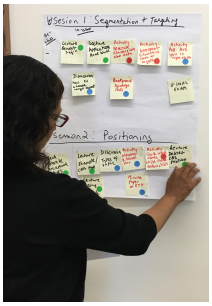
Activity: Think–Pair–Share

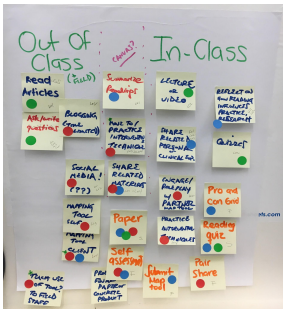
Teaching & Learning Context:
Who are your students? What are their learning needs?

Objectives: *What do you want your students to know, be able to do, and value?*

Assessment: *What evidence of student learning is acceptable?*

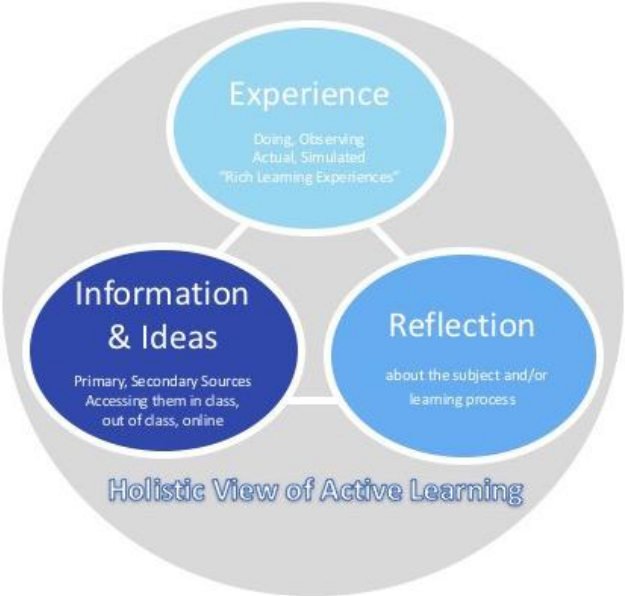
Learning experiences & instruction: *What active learning strategies and engaged pedagogies do you use in your courses?*





Active Learning Institute photographs (July 12–14, 2016).

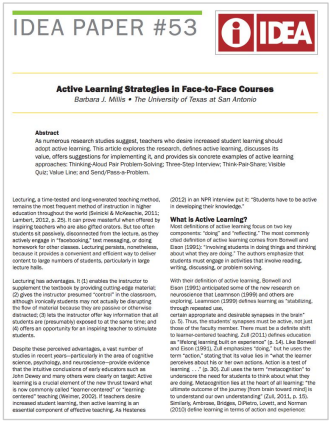
Holistic View of Active Learning



Fink, L.D. (2013). *Creating Significant Learning Experiences: An Integrated Approach to Designing College Courses.* 2nd Edition. San Francisco, CA: Jossey-Bass.

Resources

CTL


IDEA PAPER #53

IDEA

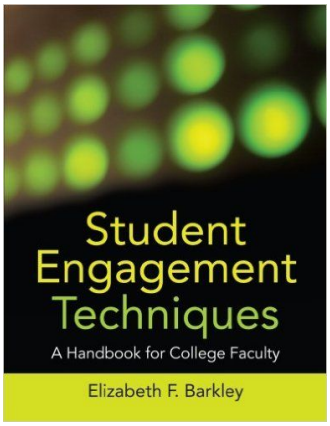
Active Learning Strategies in Face-to-Face Courses

Barbara J. Millis • The University of Texas at San Antonio

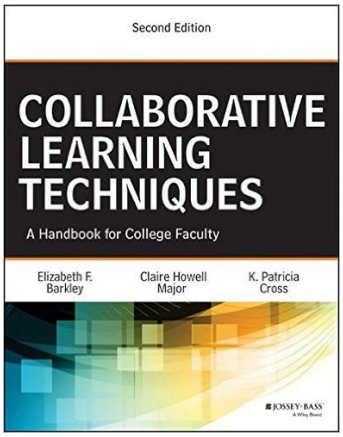
Abstract

As numerous research studies suggest, teachers who desire increased student learning should adopt active learning. This article explores the research, defines active learning, discusses its value, offers suggestions for implementing it, and provides six concrete examples of active learning approaches: Thinking-Aloud Pair Problem-Solving; Three-Step Interview; Think-Pair-Share; Visible Quiz; Value Line; and Send/Pass-a-Problem.

Millis, B. (2012). IDEA Paper #53. Active Learning Strategies in Face-to-Face Courses. The IDEA Center.



Barkley, E.F. (2009). *Student Engagement Techniques: A Handbook for College Faculty*. Jossey-Bass.

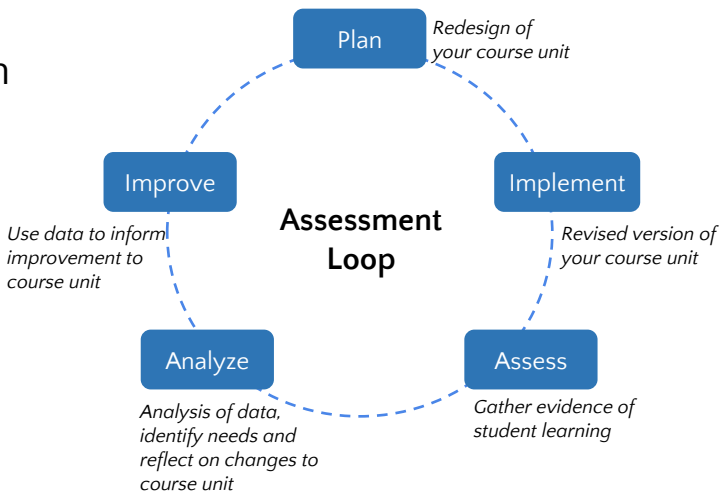


Barkley, E.F., Major, C., and Cross, K.P. (2014). *Collaborative Learning Techniques: A Handbook for College Faculty*. Jossey-Bass.

Assessment in the Active Classroom

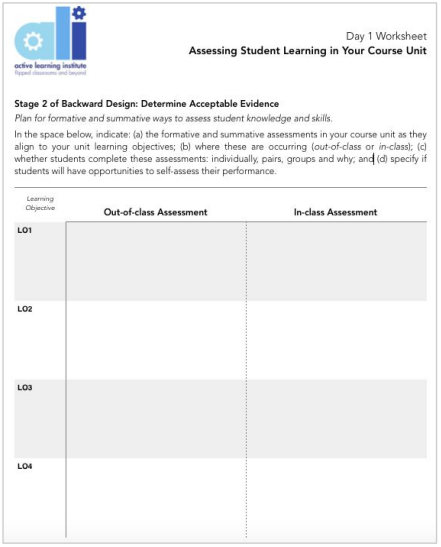
active learning institute
flipped classrooms and beyond

- To **provide feedback** on student learning for both students and instructor.
- To **measure** students' preparedness for the next course unit.
- To **direct** students' learning.



Assessment Strategy

1. How are you currently assessing student learning in your unit?
2. How can you articulate the **alignment** of assessment methods with learning objectives?
3. Where are students completing assessments: **in-class** and/or **outside of class**?
4. What **types** of methods are these?



Day 1 Worksheet
Assessing Student Learning in Your Course Unit

Stage 2 of Backward Design: Determine Acceptable Evidence

Plan for formative and summative ways to assess student knowledge and skills.

In the space below, indicate: (a) the formative and summative assessments in your course unit as they align to your unit learning objectives; (b) where these are occurring (*out-of-class* or *in-class*); (c) whether students complete these assessments: individually, pairs, groups and why; and (d) specify if students will have opportunities to self-assess their performance.

Learning Objective	Out-of-class Assessment	In-class Assessment
LO1		
LO2		
LO3		
LO4		

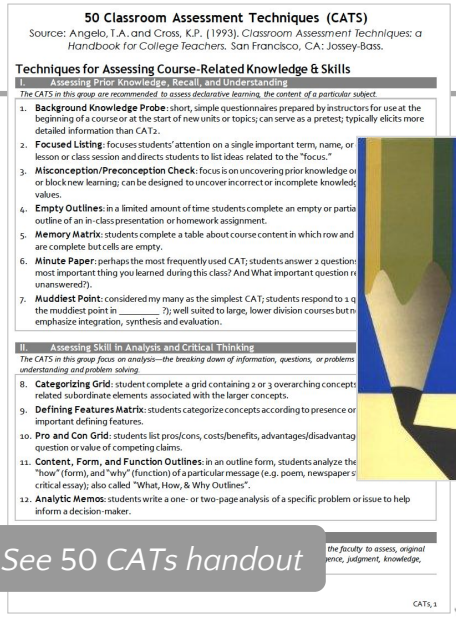
Types of Assessment

Formative	Summative
Low stake (no or low point value) Goal: Monitor student learning	*High stakes (high point value)* Goal: evaluate student learning
Examples: • Draw a concept map to represent understanding of a topic • Submit 1-2 sentences summarizing the main point of a lecture • Turn in a research proposal for early feedback • Solve sample problems in groups	*Examples:* • Midterm exam • Final project • A research paper

CATs

Classroom Assessment Techniques (CATs)

- Provide formative feedback on student learning
- Identify CAT(s) that are appropriate for your course unit.


50 Classroom Assessment Techniques (CATS)

Source: Angelo, T.A. and Cross, K.P. (1993). *Classroom Assessment Techniques: a Handbook for College Teachers.* San Francisco, CA: Jossey-Bass.

Techniques for Assessing Course-Related Knowledge & Skills

I. Assessing Prior Knowledge, Recall, and Understanding

The CATs in this group are recommended to assess declarative learning, the content of a particular subject.

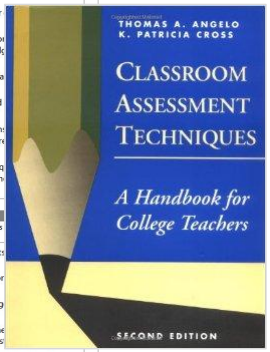
1. **Background Knowledge Probe**: short, simple questionnaires prepared by instructors for use at the beginning of a course or at the start of new units or topics; can serve as a pretest; typically elicits more detailed information than CAT2.
2. **Focused Listing**: focuses students' attention on a single important term, name, or
3. **Misconception/Preconception Check**: focus is on uncovering prior knowledge o
4. **Empty Outlines**: in a limited amount of time students complete an empty or partia
5. **Memory Matrix**: students complete a table about course content in which row and
6. **Minute Paper**: perhaps the most frequently used CAT; students answer 2 question
7. **Muddiest Point**: considered my many as the simplest CAT; students respond to 1 q

II. Assessing Skill in Analysis and Critical Thinking

The CATs in this group focus on analysis—the breaking down of information, questions, or problems understanding and problem solving.

8. **Categorizing Grid**: student complete a grid containing 2 or 3 overarching concepts
9. **Defining Features Matrix**: students categorize concepts according to presence or
10. **Pro and Con Grid**: students list pros/cons, costs/benefits, advantages/disadvantag
11. **Content, Form, and Function Outlines**: in an outline form, students analyze the
12. **Analytic Memos**: students write a one- or two-page analysis of a specific problem or issue to help inform a decision-maker.

CATs, 1

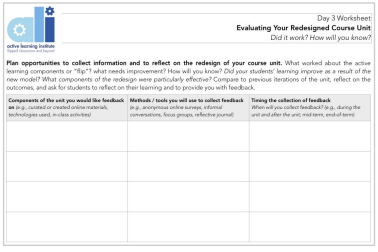


Angelo & Cross (1993)

See 50 CATs handout

Evaluating Your Active Learning Experience

- **Did it work? How will you know?**
  - Based on previous iterations of the unit, did your students' learning improve as a result of the new model?


Day 3 Worksheet:
Evaluating Your Redesigned Course Unit
Did it work? How will you know?

Plan opportunities to collect information and to reflect on the redesign of your course unit. What worked about the active learning components or "flip"? what needs improvement? How will you know? *Did your students' learning improve as a result of the new model? What components of the redesign were particularly effective?* Compare to previous iterations of the unit, reflect on the outcomes, and ask for students to reflect on their learning and to provide you with feedback.

Components of the unit you would like feedback on (e.g., curated or created online materials, technologies used, in-class activities)	Methods / tools you will use to collect feedback (e.g., anonymous online surveys, informal conversations, focus groups, reflective journal)	Timing the collection of feedback When will you collect feedback? (e.g., during the unit and after the unit; mid-term, end-of-term)

- Plan to evaluate by **reflecting on redesigned unit**
  - *Did you communicate ideas effectively?*
  - *Did you provide enough opportunities for students to practice?*
  - *Was it challenging enough?*
- Ask for **feedback from students** on what worked well and what could be improved – update your unit accordingly.

Assessment of Active Learning

- Indicators from the literature…
  - Academic success
  - Pre- and post-test comparison: Content and/or skills
  - Performance on tests measuring higher-order skills
  - Interpersonal relationships with peers and instructors
  - Satisfaction with college experience
  - Attitudes towards learning and subject area

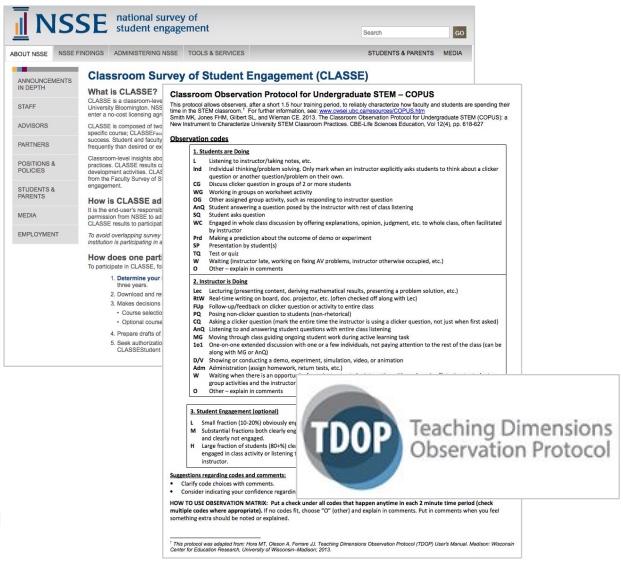
Measuring Active Learning

Scales / Questionnaires

- Classroom Survey of Student Engagement (CLASSE) (Ouimet & Smallwood, 2005)
- Motivation and Study Process Questionnaires

Observations

- Classroom Observation Protocol for Undergraduate STEM (COPUS; Smith, Jones, Gilbert, & Weiman, 2013)
- Teaching Dimensions Observation Protocol (TDOP)



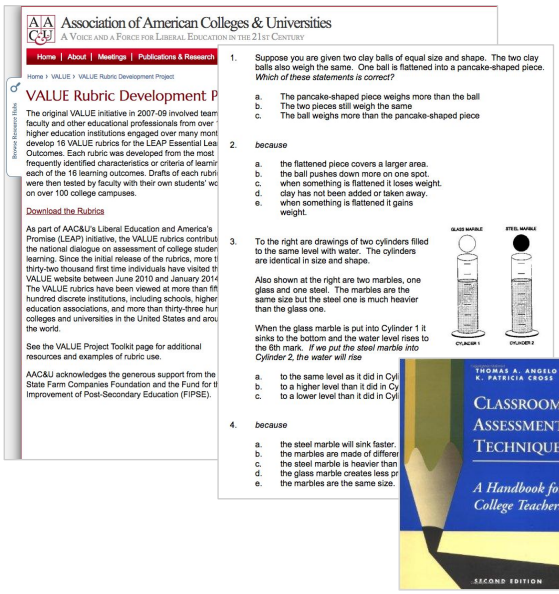
Measuring Active Learning

Tests

- Collegiate Learning Assessment Plus (CLA+)
- Classroom Test of Scientific Reasoning (Lawson, 1978)

Other / Inventories

- Classroom Assessment Techniques (CATS; Angelo & Cross, 1993)
- AAC&U VALUE Rubrics
- Teaching Practices Inventory (Wieman & Gilbert, 2014)



See handout for summary

Assessment Tools

Symposium (August 3, 2016)

Name of Tool	Type	Purpose and method	Considerations
CLASSE (Ouimet & Smallwood, 2005)	*Scale/ Questionnaire*	• Survey to students and faculty • Assesses student engagement in a course	• Asks students how frequently they engage in various practices • Asks faculty how important various practices are in facilitating student success • Responses are contrasted to determine educational practices that are occurring less frequently than expected
Questionnaire (Glynn, 2011)	*Scale/ Questionnaire*	• 5 item scale with 5 choices per scale • Assesses students' motivations to learn science in college and high schools	• Can help instructors determine students' motivation to learn science at an individual level, at a class level, or to examine change over time
Motivation Strategies for Learning Questionnaire (MSLQ; Pintrich & Degroot,1990)	*Scale/ Questionnaire*	• 44 Item Likert instrument with 7 choices • Designed to assess college students' motivational orientations and use of different learning strategies	• Guiding theory is that students' motivations are important mediators for instructional methods
Study Process questionnaire (Biggs, Kember, Leung, 2000)	*Scale/ Questionnaire*	• 20 item Likert measure with five choices per item • Evaluates college students' learning approaches	• Yields information about students' use of surface and deep approaches • Psychometrically strong
Classroom Observation Protocol for Undergraduate STEM (Smith, Jones, Gilbert, & Weiman, 2013)	*Observation*	• Protocol allows an observer to characterize how faculty and students are spending time in the classroom • Observers document classroom behaviors in two minute intervals	• Codes behaviors into what students are doing and what instructors are doing • Much less training needed (1-2 hours) than other observation instruments
Teaching Dimensions Observation Protocol (Hora, Oleson, Ferrare, 2013)	*Observation*	• Structured observation protocol designed to capture nuances of teaching behaviours in a descriptive manner • Codes made every two minutes	• Captures an expansive array of characteristics (46 possible codes) • Typically requires ~3 days of training
Name of Tool	**Type**	**Purpose and method**	**Considerations**

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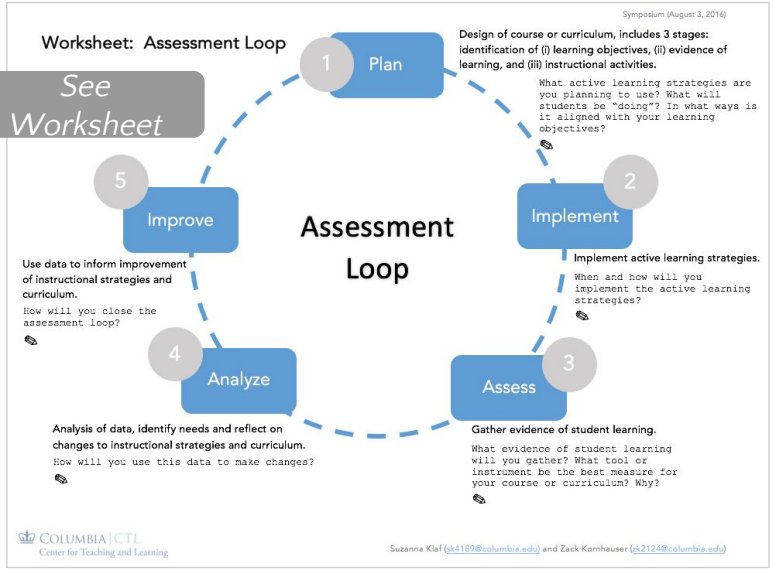
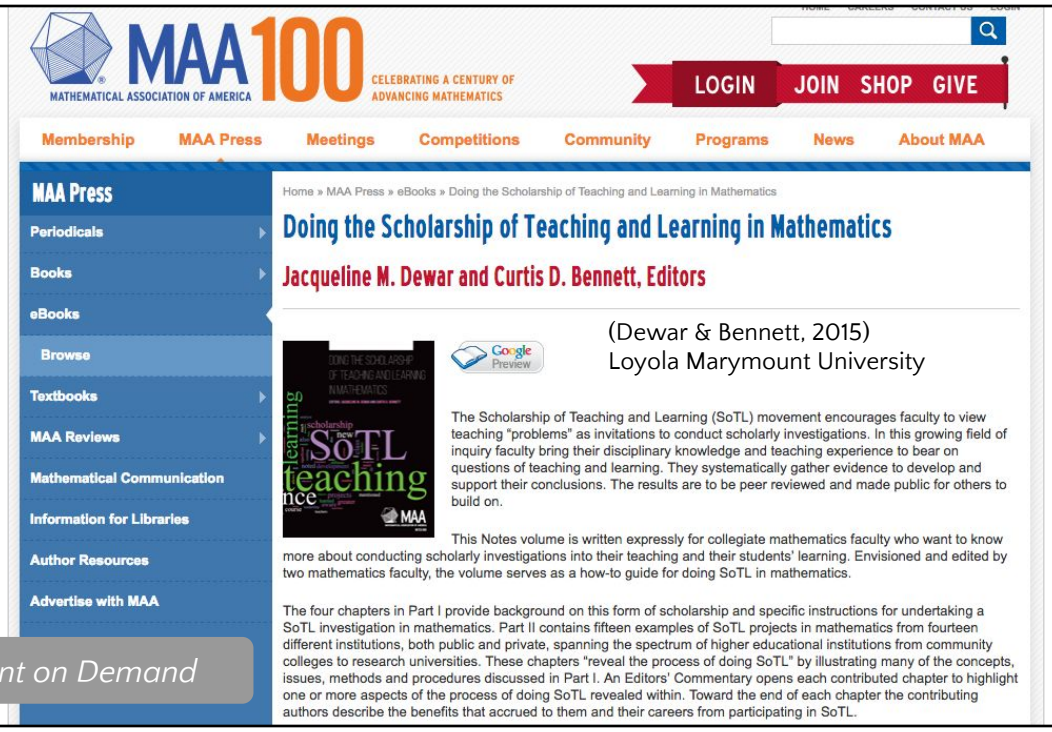
✏ Activity: Assessment Loop

- How do you know if the active learning strategies you used were effective?
- What changes might you make to the learning experience and your instruction?



Current trends in the literature…

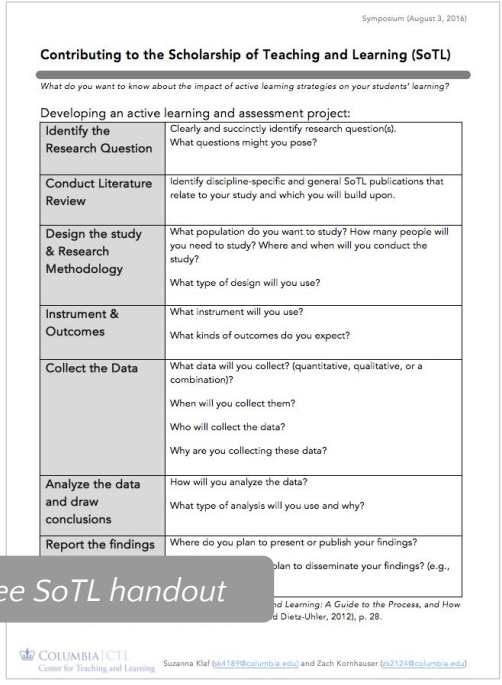
- Focus on flipping the classroom
  - Even for large classes (Rodriguez, 2016; Eichler & Peeples, 2016)
- Getting faculty to adopt active learning classrooms
  - Issues with faculty adopting active learning classrooms (Van Horne & Murniati, 2016)
  - Using a mentorship model for faculty to adopt active learning classrooms (Grimes & White, 2015)
- Using active learning to address the achievement gap (Cooper, 2015)
- "Alternative" ways of promoting active learning in the class
  - Students modeling molecular models with their bodies (Voltzow, 2016)
  - Promoting active learning through students answering online questions outside of class (Gibson, 2015)
  - Using storytelling to engage students genetics in a genetics course (Moitra, 2014)



Print on Demand

Activity: Scholarship of Teaching and Learning (SoTL)

- How might you contribute to the scholarship?
- What question(s) might you pose?



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Contributing to the Scholarship of Teaching and Learning (SoTL)

What do you want to know about the impact of active learning strategies on your students' learning?

Developing an active learning and assessment project:

Identify the Research Question	Clearly and succinctly identify research question(s). What questions might you pose?
Conduct Literature Review	Identify discipline-specific and general SoTL publications that relate to your study and which you will build upon.
Design the study & Research Methodology	What population do you want to study? How many people will you need to study? Where and when will you conduct the study? What type of design will you use?
Instrument & Outcomes	What instrument will you use? What kinds of outcomes do you expect?
Collect the Data	What data will you collect? (quantitative, qualitative, or a combination)? When will you collect them? Who will collect the data? Why are you collecting these data?
Analyze the data and draw conclusions	How will you analyze the data? What type of analysis will you use and why?
Report the findings	Where do you plan to present or publish your findings?

nd Learning: A Guide to the Process, and How
d Dietz-Uhler, 2012), p. 28.

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See SoTL handout

CIRTL

http://www.cirtl.net/

Mathieu, Pfund, and Gillian-Daniel (2009)

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