Parimal and Pramod Chaudhari
Centre for Learning and Teaching

Indian Institute of
Technology Bombay

Writing Effective Course Learning Outcomes

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Workshop Overview

- **Part 1:** Writing Effective Course Learning Outcomes
  - Morning, Wednesday, 8 January 2020
- **Part 2:** Applying Research-based Instructional Strategies
  - Afternoon, Wednesday, 8 January 2020
- **Part 3:** Developing Course Assessment Plans
  - Morning, Thursday, 9 January 2020
- **Part 4:** Facilitating Student Use of Metacognitive Learning Strategies
  - Afternoon, Thursday, 9 January 2020

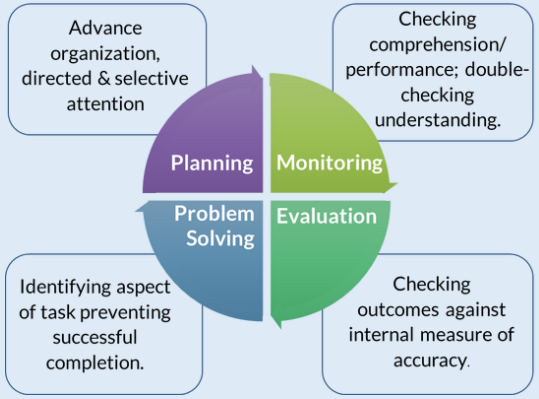
Workshop Overview

Writing Effective Learning Outcomes

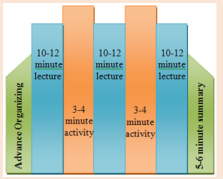
Designing Course Assessment Plans Aligned with Learning Outcomes

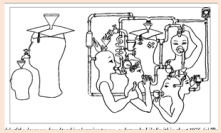
	Where the learner is going	Where the learner is	How to get there
Teacher	Clarifying, sharing and understanding learning intentions	Engineering effective discussions, tasks, and activities that elicit evidence of learning	Providing feedback that moves learners forward
Peer		Activating students as learning resources for one another	
Learner		Activating students as owners of their own learning	

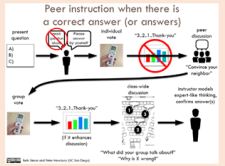
Facilitating Student Use of Metacognitive Learning Strategies

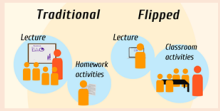


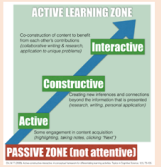
Designing Research-based Instructional Strategies Aligned with Learning Outcomes

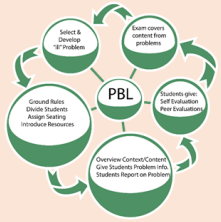


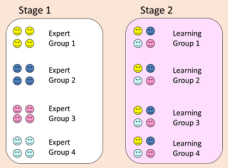








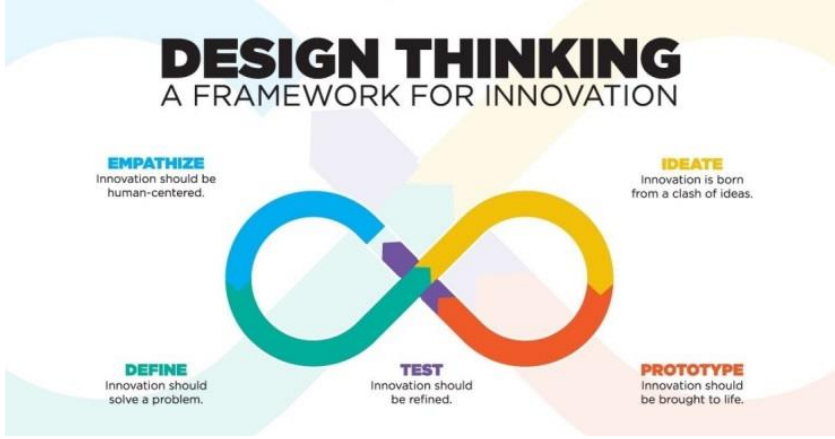




Workshop Ground Rules

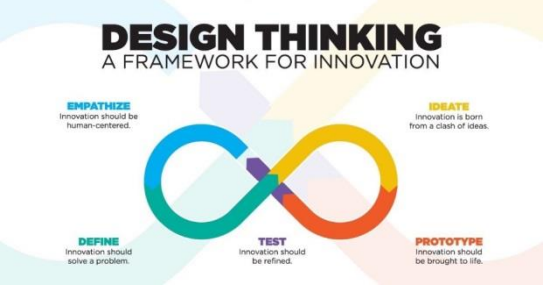
- **Ownership:** It is your workshop
- **Questions:** Ask when you have a question.
- **Slides:** The most recent copy of the slides will be available after the workshop
- Purposes of the Slides
  - Guide Workshop
  - Second Visual Source of Information
  - Resource after Workshop

Results from Research on Design



- Design begins with clear, explicit exposition of intent.
- Design continues with applicable knowledge, e.g., facts, principles, etc.
- Design continues by developing strategies, intermediate realizations, embodiments, etc. intended to achieve the intent by using relevant knowledge.
- Design involves multiple key decisions. The workshop is intended to equip you with evidence-based findings to support your course design decisions.

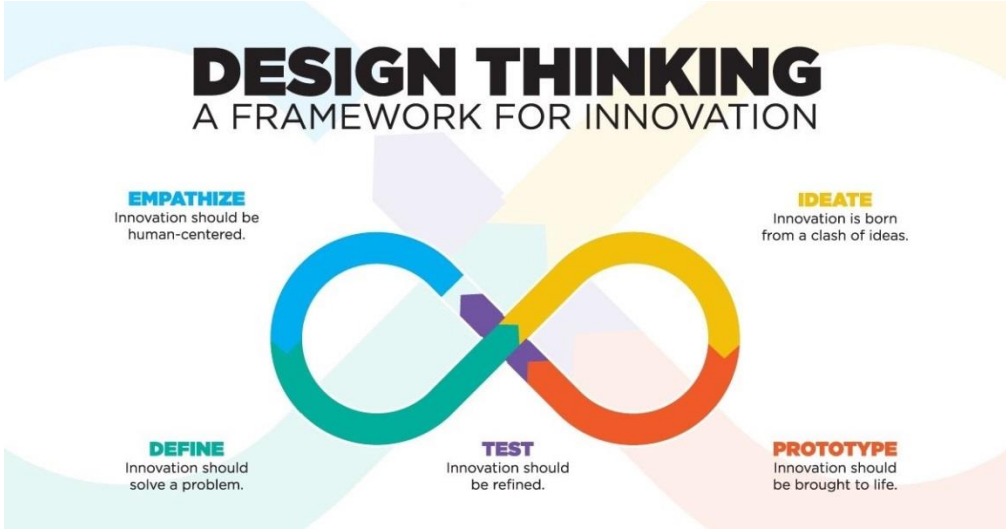
Applying Results from Research on Design



- Course design begins with clear, explicit exposition of intent, e.g., learning outcome.
- Course design continues with applicable knowledge, e.g., facts, principles, etc. from research on learning and teaching
- Course design continues by adapting and/or developing strategies, intermediate realizations, embodiments, etc. intended to achieve the intent by using relevant knowledge.
- Course design involves multiple key decisions. The workshop is intended to equip you with evidence-based findings to support your course design decisions.

PowerPoint vs. Blackboard

- Which is a better way to teach?
  - Writing class notes on a blackboard
  - Showing class notes via PowerPoint



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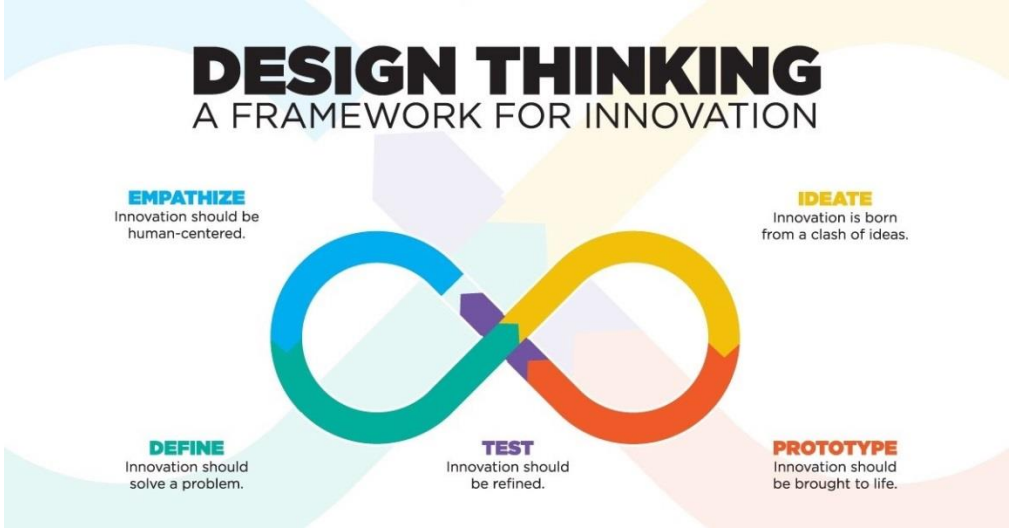
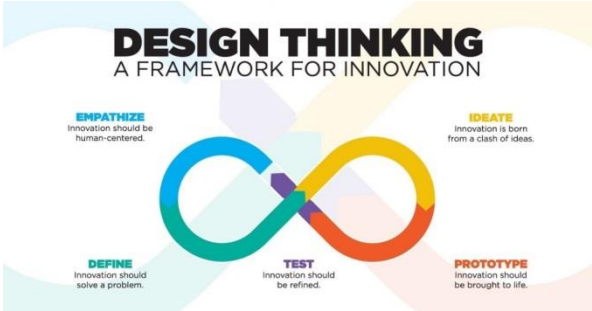


Note: Teaching is not an intent; it is an activity.

A design question is being posed without the intent being disclosed.

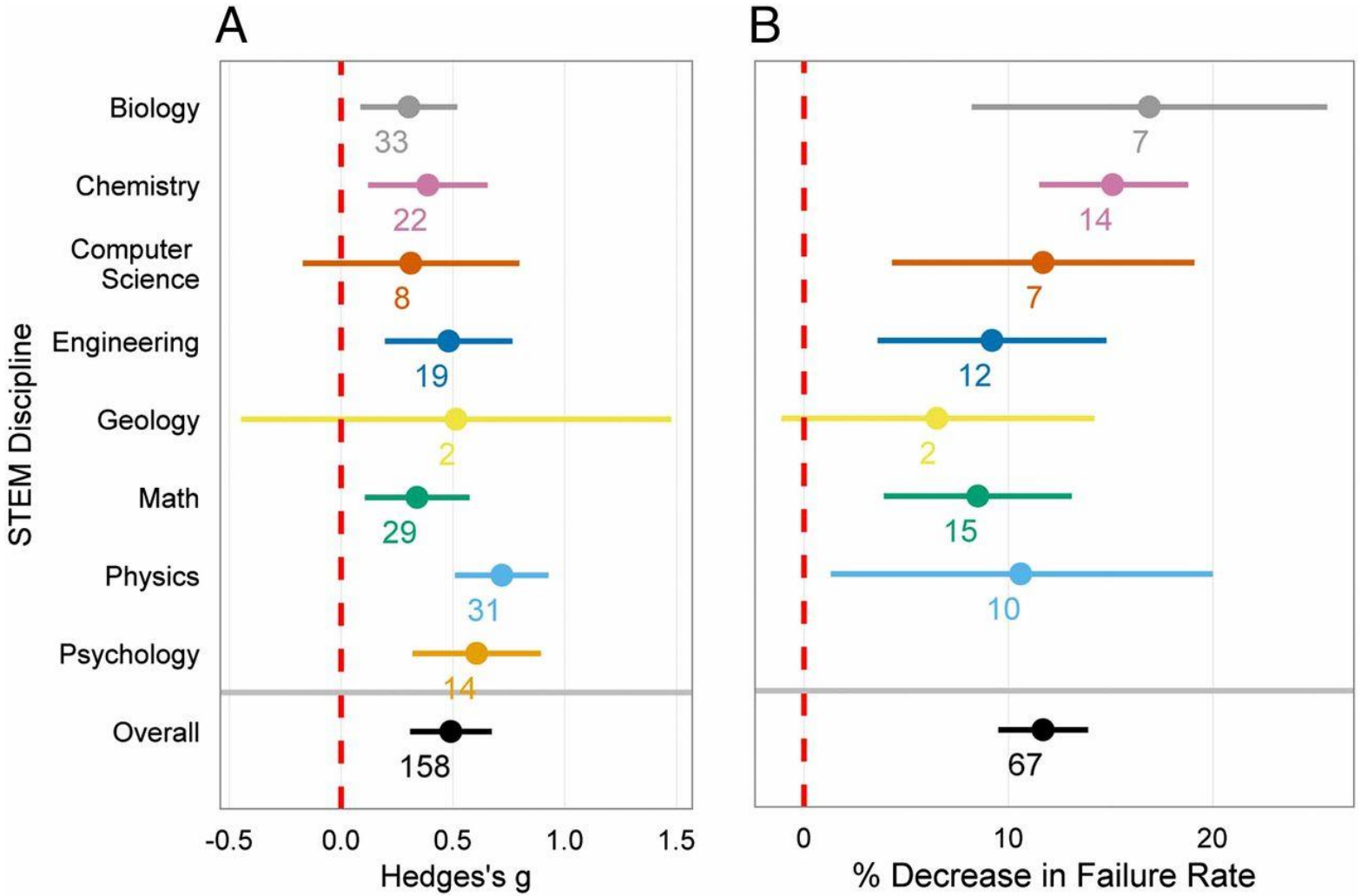
- Teaching designs an environment to enable learners to achieve intended goals. Without a statement of intended goals, questions of how to teach cannot be properly addressed.



- It is like asking whether a bridge should be built from wood, steel, plastic, etc., without including information about the span, the purpose, the loads, etc.

Why should you care about research-based course designs?

Effect Sizes by Discipline



Scott Freeman et al. PNAS 2014;111:8410-8415

Effect Size

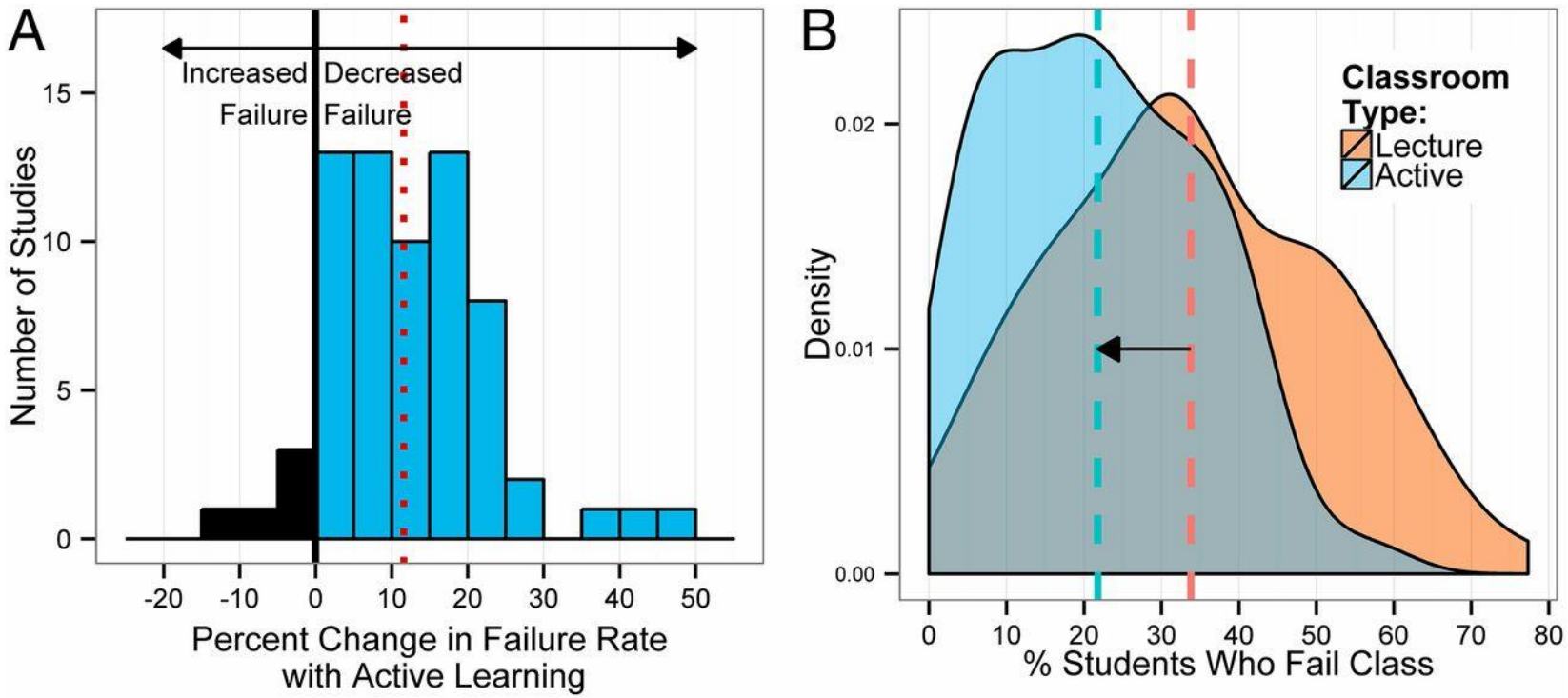
$$\text{Cohen's } d = \frac{M_1 - M_2}{SD_{pooled}} \qquad SD_{pooled} = \sqrt{\frac{\sum(X_1 - \overline{X}_1)^2 + \sum(X_2 - \overline{X}_2)^2}{n_1 + n_2 - 2}}$$

$$\text{Glass's } \Delta = \frac{M_1 - M_2}{SD_{control}}$$

$$\text{Hedges' } g = \frac{M_1 - M_2}{SD^*_{pooled}} \qquad SD^*_{pooled} = \sqrt{\frac{(n_1 - 1)SD_1^2 + (n_2 - 1)SD_2^2}{n_1 + n_2 - 2}}$$

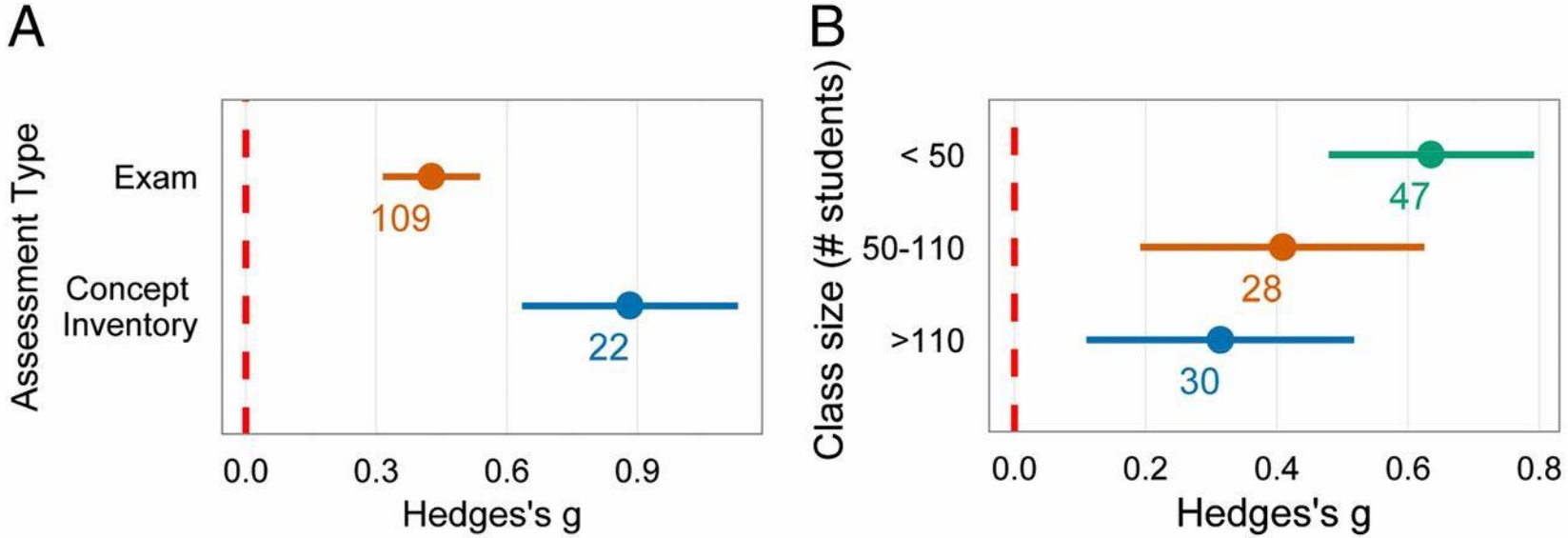
Effect Size Equations:
http://www.polyu.edu.hk/mm/effectsizefaqs/effect_size_equations2.html

Changes in Failure Rate



Scott Freeman et al. PNAS 2014;111:8410-8415

Heterogeneity analyses for data on examination scores, concept inventories, or other assessments



Scott Freeman et al. PNAS 2014;111:8410-8415

Why Use Research-based Course Designs?

If the experiments [225 studies] analyzed here had been conducted as randomized controlled trials of medical interventions, they may have been **stopped for benefit**—meaning that enrolling patients in the control condition might be discontinued because the treatment [Active Learning] being tested was clearly more beneficial.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410-8415. doi: 10.1073/pnas.1319030111

Why Use Research-based Instructional Strategies?

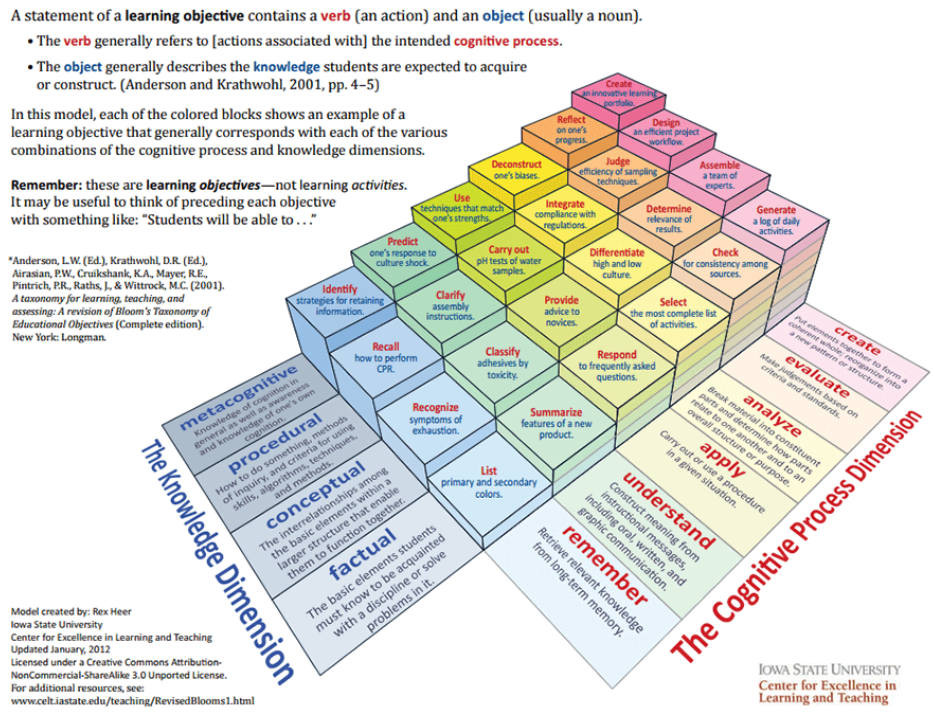
If the experiments [225 studies] analyzed here had been conducted as randomized controlled trials of medical interventions, they may have been **stopped for benefit**—meaning that enrolling patients in the control condition might be discontinued because the treatment [Active Learning] being tested was clearly more beneficial.

Meta-analysis of 225 studies that reported data on examination scores or failure rates when comparing student performance in undergraduate science, technology, engineering, and mathematics (STEM) courses under traditional lecturing versus active learning.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410-8415. doi: 10.1073/pnas.1319030111

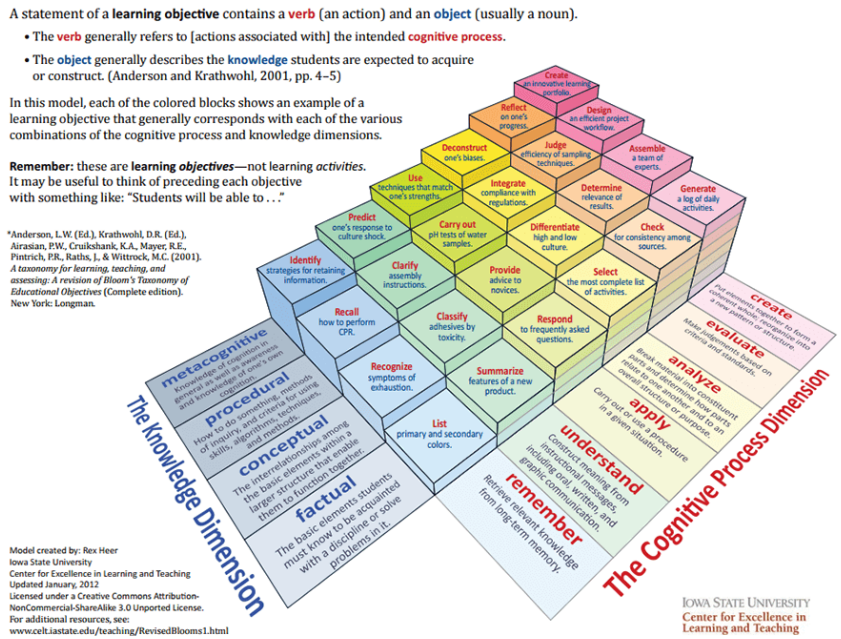
Exercise: Write a learning outcome

- Think of a course you have taught or will be teaching in the future
- Write a learning outcome for this course



Writing Effective Learning Outcomes

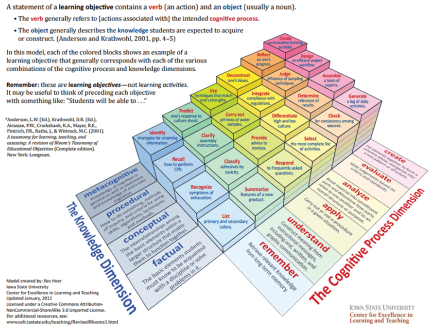
- Learning outcomes should answer the following questions:
  - “What should students know and be able to do as a consequence of instruction?”
  - “How will students be able to think?” or “At what cognitive level will the students perform?”



Learning Outcome Guidelines

Observable Verb	Content/Topic		Example
Calculate	Discrete-time system analysis		**Calculate** outputs of discrete-time systems in response to given inputs
Design	Finite impulse response (FIR) filters		**Design** a finite impulse response (FIR) filter to meet given specifications
Evaluate	Structural Analysis		**Evaluate** alternative structures for a bridge design with respect to given specifications
Apply	First and Second Laws of Thermodynamics		**Apply** the first and second laws of thermodynamics to analyze thermodynamic cycles

Learning Outcome Guidelines



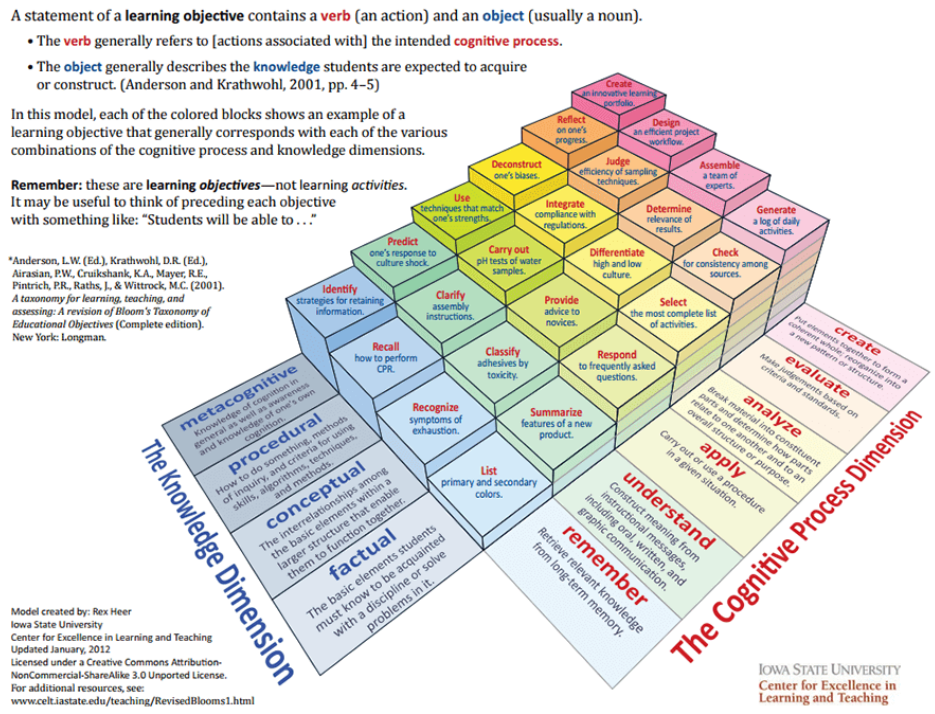
- An effective learning outcomes will:
  - **Cognitive Process Dimension:** Contain a **verb** describing an observable action
  - **Knowledge Dimension:** Contain a **noun** describe the content/topic to be employed
  - Focus on the student as the performer
    - What is a student expected to be able to do?
    - How is a student expected to be able to think?

Cognitive Process Dimension

Knowledge Dimension

Exercise: Write a learning outcome

- Think of a course you have taught or will be teaching in the future
- Write a learning outcome for this course
- Describe what you have changed.

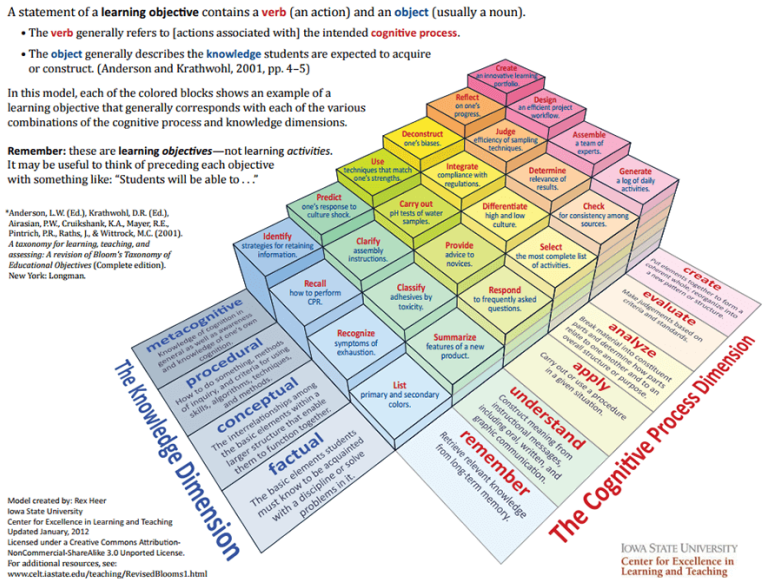


Syllabus vs. Learning Outcomes

Syllabus	Learning Outcomes
Describes topics/content to be delivered/covered	Describes expected learning in observable terms
Noun-oriented	Verb and noun-oriented
Instruction-focused	Learning-focused
Lists content	Describes what students will be expected to do with the content

Learning Outcomes: Number One Challenge

- Faculty members when they initially write learning outcome, want to use verbs such as
  - Understand or “demonstrate understanding”
  - Know or “demonstrate knowledge”
  - Appreciate or “demonstrate appreciation”
  - …
- What is the problem?



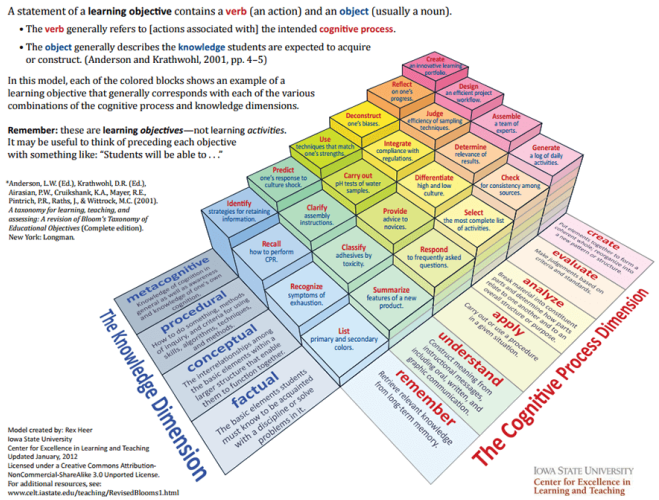
Learning Outcomes: Number One Challenge

- Verbs such as understand do not describe an observable outcome. As a result, learning outcomes that rely on verbs such as understand cannot be assessed, practice, improved, etc.
- Students and faculty members often have different interpretations of understand. As a result, expectations are not clearly communicated.
- Learning outcomes that rely on verbs such as understand do not convey opportunities for practice or improvement, either by the student or the faculty member.

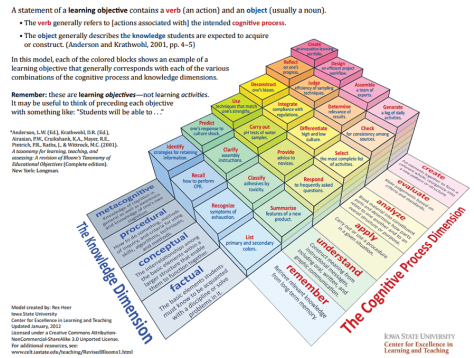
Learning Outcomes: Number One Challenge

What does it mean to “understand”?

- Think about a room with 40 people. Half of the people understand what you want them to understand, half do not.
- What activities will you ask them to do to distinguish the two groups of people?
- You can then use these activities to write your learning outcomes.



What do we want our students to be able to do with the [BLANK] knowledge that they acquire?



We certainly expect them to be able to:

- ***Predict*** the responses of a [BLANK] system if it is disturbed.
- ***Explain*** the responses that occur in systems that have been disturbed.
- ***Solve*** quantitative problems (calculate something).

And, we expect them to be able to do this with systems and disturbances that they have not encountered in lecture or the textbook. That is, we expect them to be able to ***apply*** what they know about [BLANK] to **novel** situations.

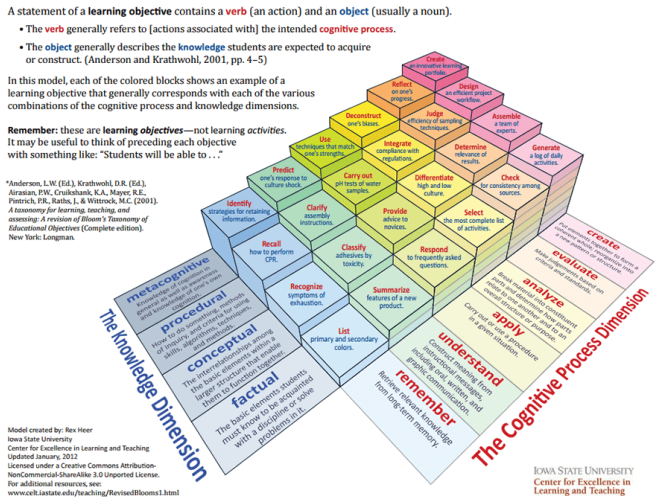
When they can do this, we say they "understand" [BLANK].

Michael, J. (2001). In Pursuit of Meaningful Learning. *Advances in Physiology Education, 25*, 145–158

Learning Outcomes: Number One Challenge

What does a learner do to improve “understanding”?

- If you were learning a new subject, what would you do to understand the subject better?
- You can then use these activities to write your learning outcomes.



Learning Outcomes: Number One Challenge

What does a teacher do to improve “understanding”?

- If you were teaching a new subject, what would you do to help your students understand the subject better?
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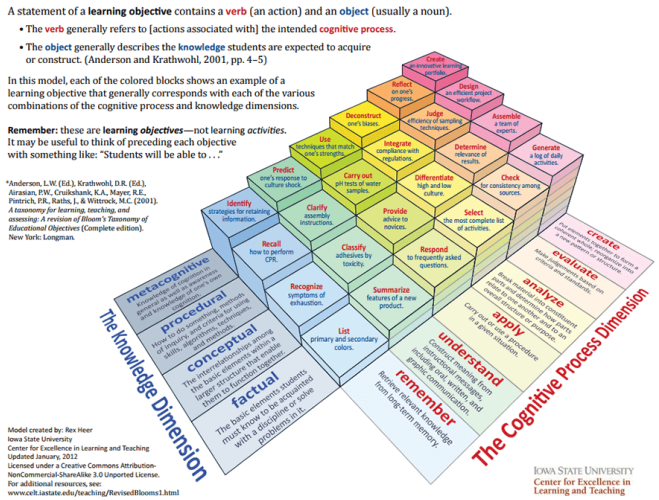


Learning Outcomes:
Number Two Challenge

- What is the number 2 challenge?
  - Technology (or terminology) is needed to describe and address the number 2 challenge.
  - The technology is called **taxonomies of learning outcomes**.

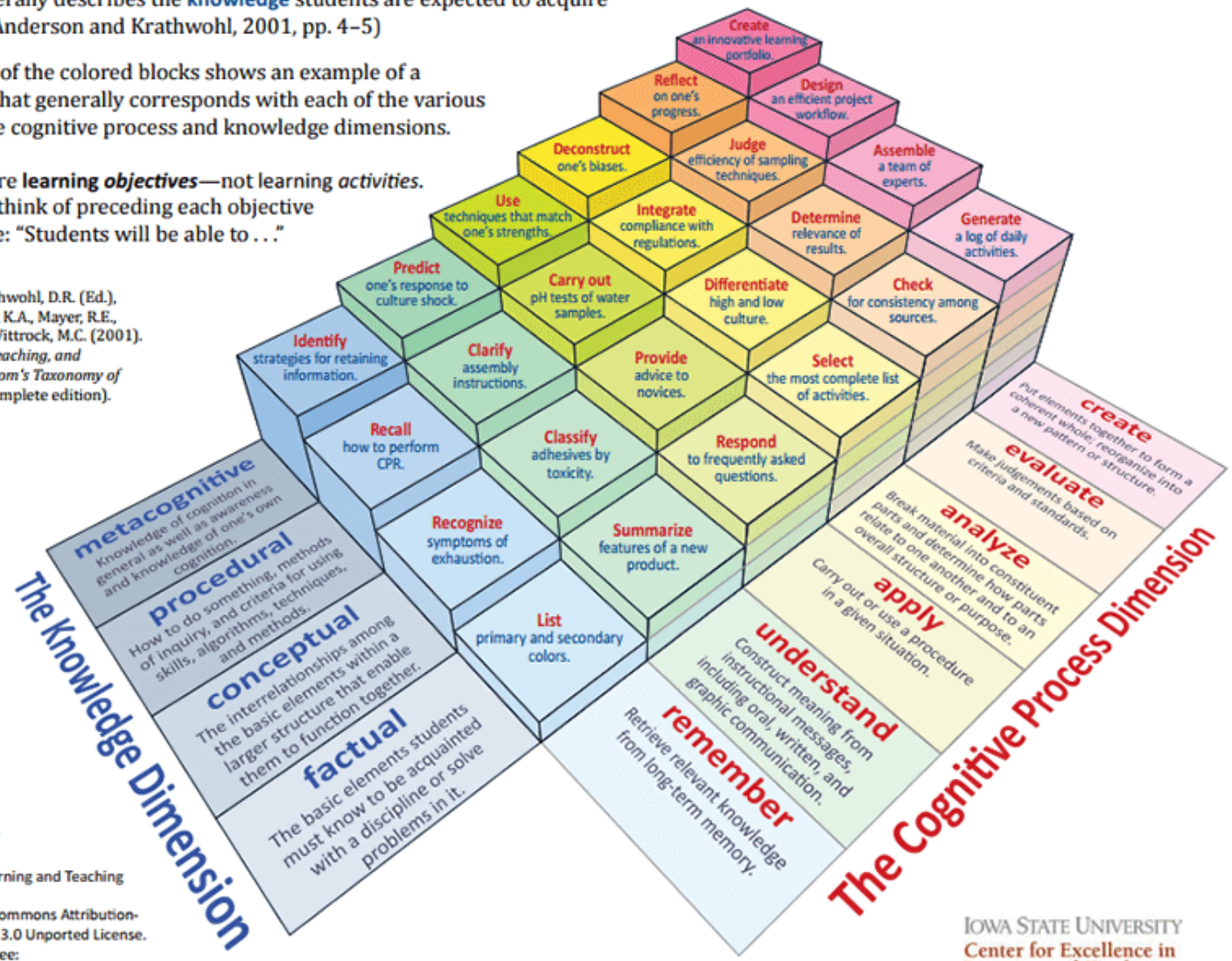
A statement of a **learning objective** contains a **verb** (an action) and an **object** (usually a noun).

- The **verb** generally refers to [actions associated with] the intended **cognitive process**.
- The **object** generally describes the **knowledge** students are expected to acquire or construct. (Anderson and Krathwohl, 2001, pp. 4–5)

In this model, each of the colored blocks shows an example of a learning objective that generally corresponds with each of the various combinations of the cognitive process and knowledge dimensions.

Remember: these are **learning *objectives***—not learning *activities*. It may be useful to think of preceding each objective with something like: "Students will be able to . . ."

*Anderson, L.W. (Ed.), Krathwohl, D.R. (Ed.), Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., & Wittrock, M.C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives* (Complete edition). New York: Longman.



Model created by: Rex Heer
Iowa State University
Center for Excellence in Learning and Teaching
Updated January, 2012

For additional resources, see:
www.celt.iastate.edu/teaching/RevisedBlooms1.html

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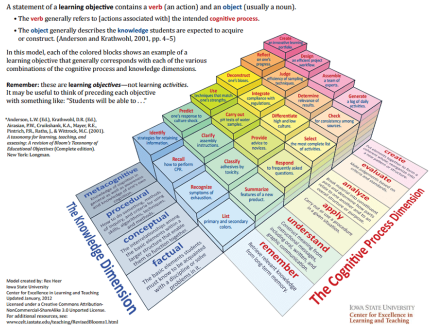
Center for Excellence in Learning and Teaching

Learning Outcome Guidelines



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Cognitive Process Dimension

Knowledge Dimension

Cognitive Process Dimension

Create: Putting elements together to form a novel, coherent whole or make an original product - Generating, Planning, Producing

Evaluate: Making judgments based on criteria and standards - Checking, Critiquing

Analyze: Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose - Differentiating, Organizing, Attributing

Cognitive Process Dimension

Apply: Carrying out or using a procedure in a given situation [usually somewhat novel] - Executing, Implementing, Solving

Understand: Determining the meaning of instructional messages, including oral, written, and graphic communication - Interpreting, Exemplifying, Classifying, Summarizing, Inferring, Comparing, Explaining

Remember: Retrieving relevant knowledge from long-term memory - Recognizing, Recalling

Cognitive Process Dimension

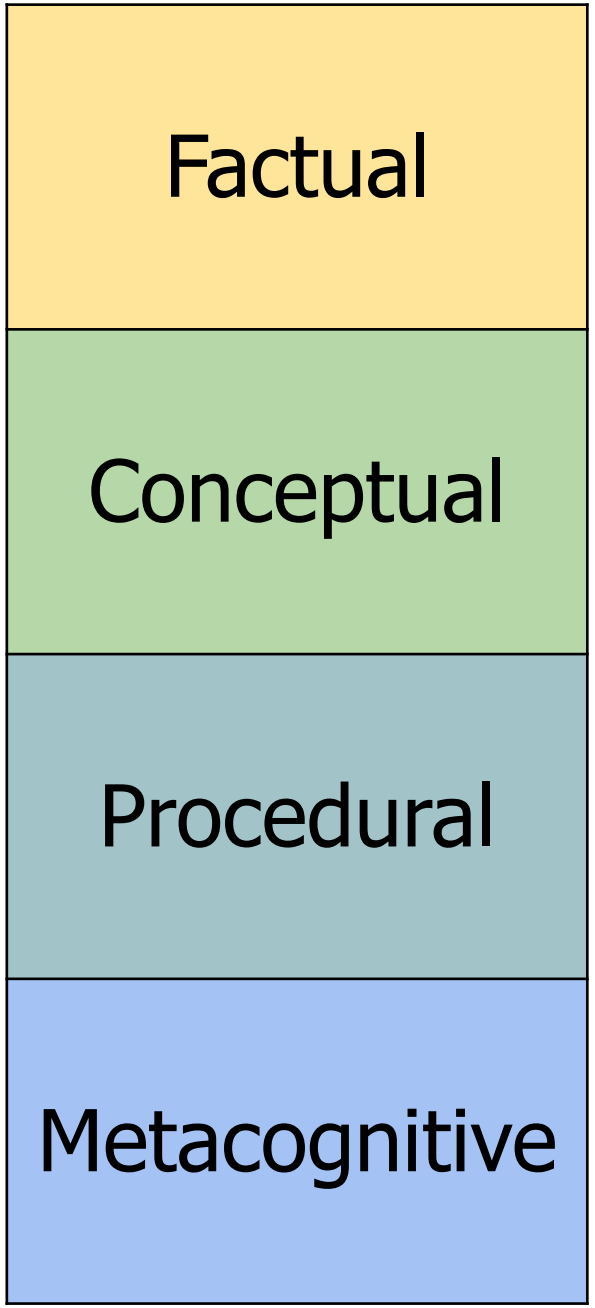
Write down appropriate verbs for each cognitive process dimension in the Revised Bloom's Taxonomy:

- Remember: ?
- Understand: ?
- Apply: ?
- Analyze: ?
- Evaluate: ?
- Create: ?

Knowledge Dimension

Factual: The basic elements that students must know to be acquainted with a discipline or solve problems in it - Knowledge of: terminology, specific details and elements

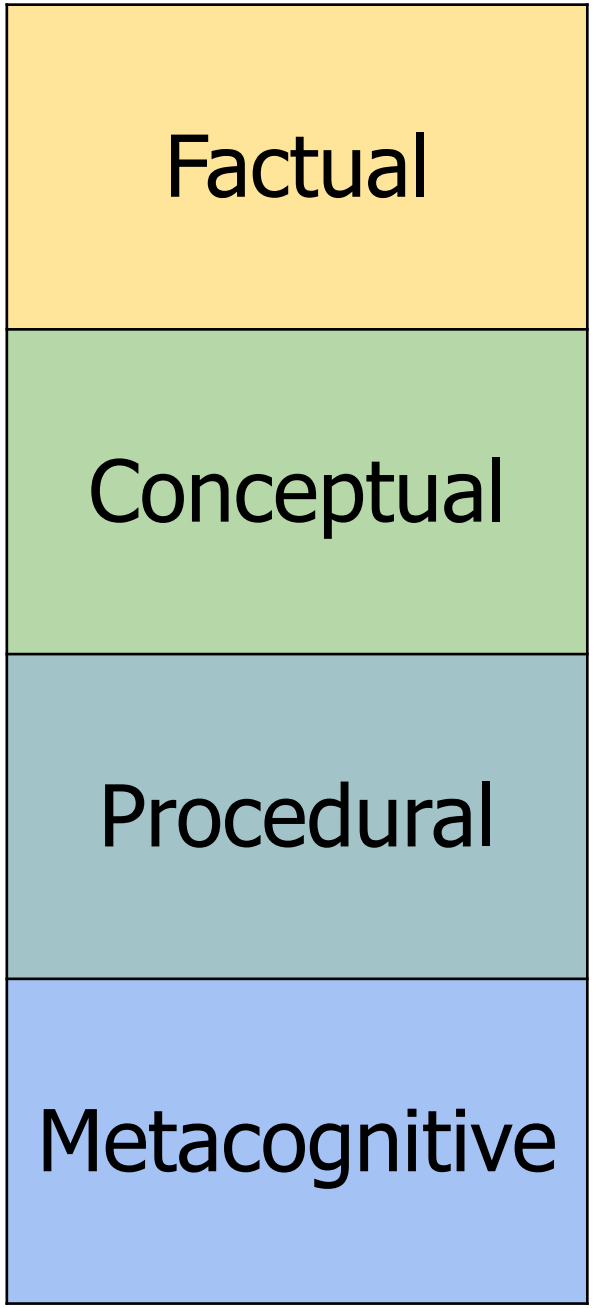
Conceptual: The interrelationships among the basic elements within a larger structure that enable them to function together - Knowledge of: classifications and categories, principles and generalizations, theories, models, and structures



Knowledge Dimension

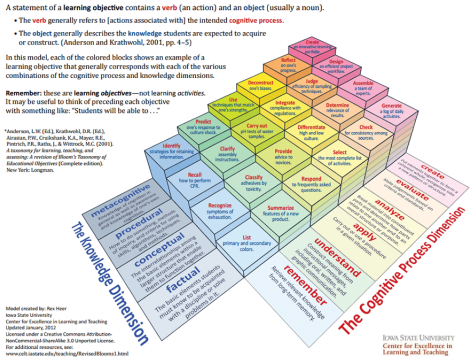
Procedural: How to do something; methods of inquiry, criteria for using skills, algorithms, techniques, and methods - Knowledge of: subject-specific skills and algorithms, subject-specific techniques and methods, criteria for when to use appropriate procedures

Metacognitive: Knowledge of cognition in general as well as awareness and knowledge of one's own cognition - Strategic knowledge, Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge, Self-knowledge



Learning Outcomes: Number Two Challenge

- What is the number 2 challenge?
  - Most people who initially try to write learning outcomes write lower level learning outcomes and are unhappy with the level of learning described by their learning outcomes.
  - They often do not have or apply the terminology for expressing higher order learning



Minute Paper

Write brief answers to the following questions:

- What is most valuable or helpful about writing a learning outcomes?
- What is the “muddiest or most confusing point” about writing a learning outcomes?

Is Your Learning Outcome Effective?

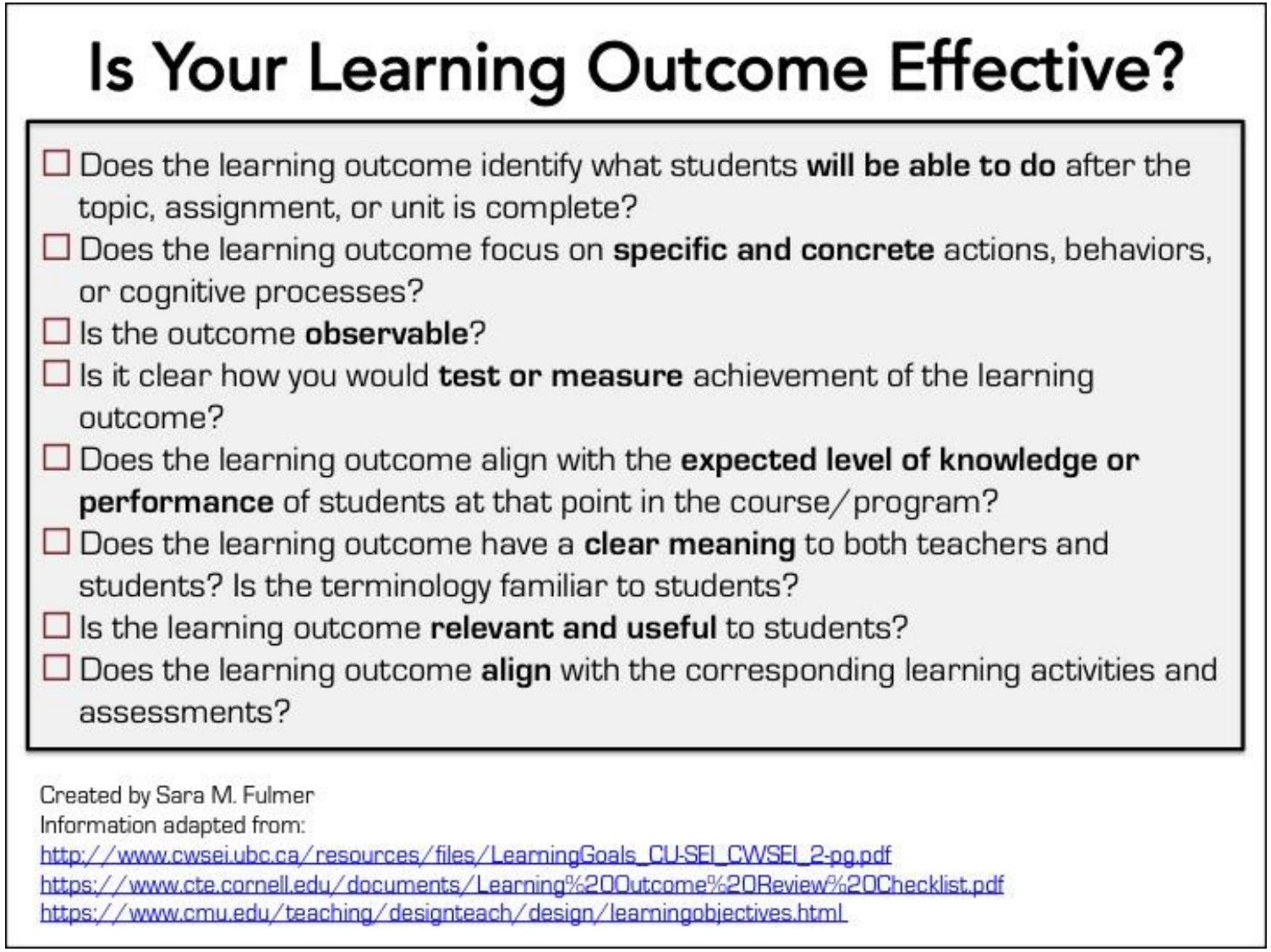
- ☐ Does the learning outcome identify what students **will be able to do** after the topic, assignment, or unit is complete?
- ☐ Does the learning outcome focus on **specific and concrete** actions, behaviors, or cognitive processes?
- ☐ Is the outcome **observable**?
- ☐ Is it clear how you would **test or measure** achievement of the learning outcome?
- ☐ Does the learning outcome align with the **expected level of knowledge or performance** of students at that point in the course/program?
- ☐ Does the learning outcome have a **clear meaning** to both teachers and students? Is the terminology familiar to students?
- ☐ Is the learning outcome **relevant and useful** to students?
- ☐ Does the learning outcome **align** with the corresponding learning activities and assessments?

Created by Sara M. Fulmer
Information adapted from:
http://www.cwsei.ubc.ca/resources/files/LearningGoals_CU-SEI_CWSEI_2-pg.pdf
https://www.cte.cornell.edu/documents/Learning%20Outcome%20Review%20Checklist.pdf
https://www.cmu.edu/teaching/designteach/design/learningobjectives.html

Checklist for Effective Learning Outcomes

Resources

- Creating and Using Effective Learning Goals, Carl Wieman Science Education Institute, http://www.cwsei.ubc.ca/resources/files/LearningGoals_CU-SEI_CWSEI_2-pg.pdf
- Setting Learning Outcomes, Cornell University Center for Teaching Innovation, https://teaching.cornell.edu/teaching-resources/designing-your-course/setting-learning-outcomes
- Articulate Your Learning Objectives, Eberly Center, Carnegie Mellon University, https://www.cmu.edu/teaching/designteach/design/learningobjectives.html



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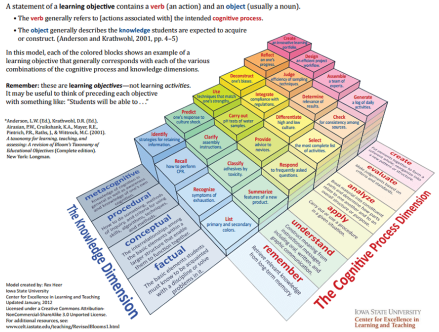
- ☐ Does the learning outcome align with the **expected level of knowledge or performance** of students at that point in the course/program?
- ☐ Does the learning outcome have a **clear meaning** to both teachers and students? Is the terminology familiar to students?
- ☐ Is the learning outcome **relevant and useful** to students?
- ☐ Does the learning outcome **align** with the corresponding learning activities and assessments?

Created by Sara M. Fulmer
Information adapted from:
http://www.cwsei.ubc.ca/resources/files/LearningGoals_CU-SEI_CWSEI_2-pg.pdf
https://www.cte.cornell.edu/documents/Learning%20Outcome%20Review%20Checklist.pdf
https://www.cmu.edu/teaching/designteach/design/learningobjectives.html

What is the Value of Course-Specific Learning Goals? (for students)



How do you think your students would benefit if you developed and consistently used course-specific learning outcomes?

- Individually write down your thoughts.

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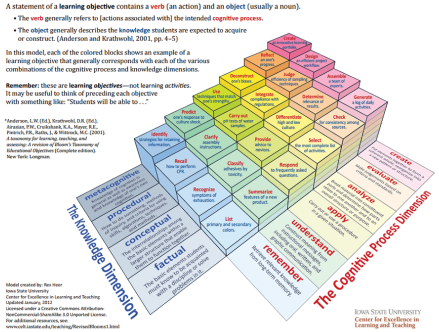

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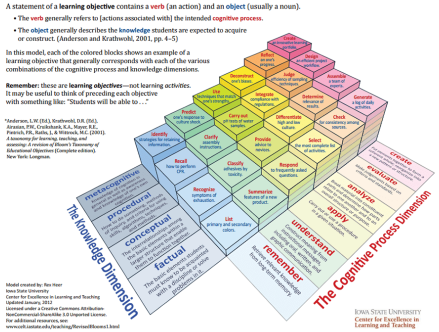
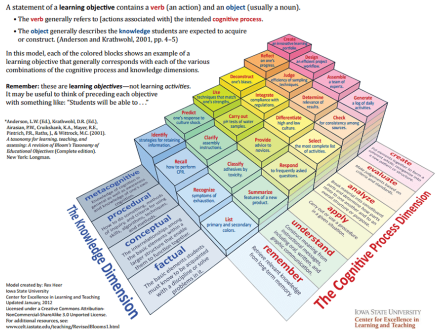


- Clarity of expectations for learning
- Relate assessments to expectations for learning
- Self-evaluation
- Students can stay on the plan for study
- Students know what to study for for the exam

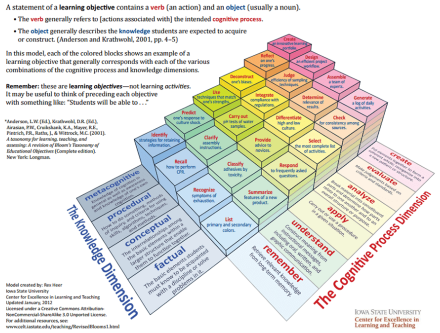
What is the Value of Course-Specific Learning Goals? (for students)



- "students overwhelmingly found value in the use of detailed, course-specific learning goals"
- "students found that the learning goals helped them determine what they needed to know"
- "students expressed relief and gratitude at being given clear direction as to how to focus their efforts, most notably in the lectures, and also in organizing their studying, reviewing, and preparing for exams"

Simon, B., & Taylor, J. (2009). What is the value of course-specific learning goals? *Journal of College Science Teaching, 39*(2), 52-57.

What is the Value of Course-Specific Learning Goals? (for students)



- "Students in more 'constructively aligned courses' were more likely to adopt deep learning approaches and less likely to use surface learning approaches in their study of a particular course."

Simon, B., & Taylor, J. (2009). What is the value of course-specific learning goals? *Journal of College Science Teaching, 39*(2), 52-57.

Students who adopt a surface approach... ‘scrape the surface' of the material being studied, without carrying out any deep processing of the material.

They tend to:

- Concentrate purely on assessment requirements
- Accept information and ideas passively
- Memorize facts and procedures routinely
- Ignore guiding principles or patterns
- Fail to reflect on underlying purpose or strategy.

Surface, Deep, & Strategic Learning Approaches: http://www2.rgu.ac.uk/celt/pgcerttlt/how/how5a.htm

Students who adopt a deep approach make a serious attempt to turn other people's ideas into their own personalised structure of knowledge.

They tend to:

- Endeavour to understand material for themselves
- Interact vigorously and critically with content
- Relate ideas to previous knowledge and experience
- Use organising principles to integrate ideas
- Relate evidence to conclusions
- Examine the logic of arguments

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See the video by Stephen Chew on levels of processing:

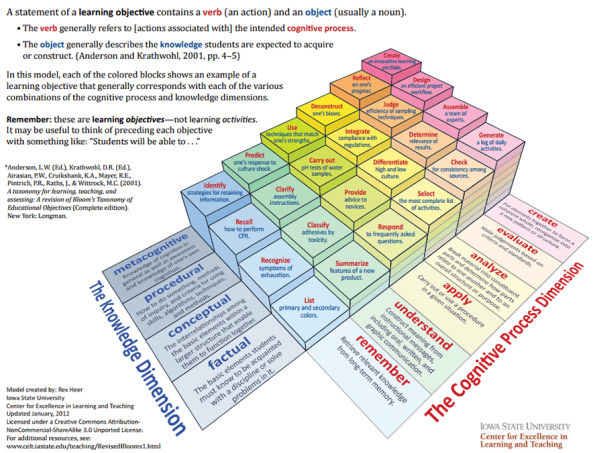
Cognitive Principles for Optimizing Learning

The third video operationalizes the concept of level of processing into four principles that students can use to develop effective study strategies.

https://www.samford.edu/departments/academic-success-center/how-to-study

Surface, Deep, & Strategic Learning Approaches: http://www2.rgu.ac.uk/celt/pgcerttlt/how/how5a.htm

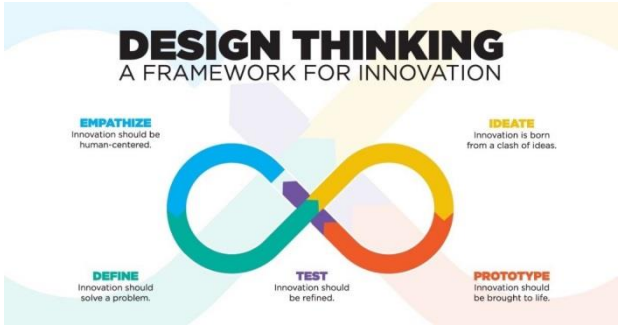
Share learning outcomes with your students



- Share Bloom's Revised Taxonomy with your students
- Share specific learning outcomes for each lecture
  - Help them see how to use learning outcomes to prepare for lecture
- Share specific learning outcomes for each upcoming exam
  - Help them see how to use learning outcomes to prepare for lecture
- Provide students feedback on progress with respect to learning outcomes

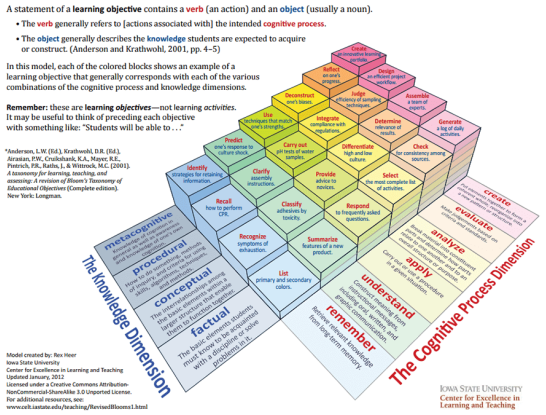
GUEST POST: Should I share my learning outcomes with students? http://www.learningscientists.org/blog/2017/10/4-1

Share Your Learning Outcomes with Your Students



Two-minute Exercise

Generate 5 ways you might share your learning outcomes with your students

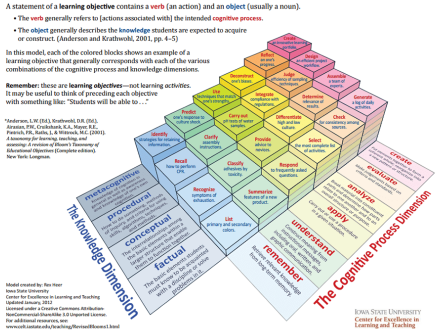


Student Resistance

"If you have tried anything innovative in class, you know that students hate not knowing the rules."

Felder, R. M. (1987). On creating creative engineers. *Engineering Education, 77*(4), 222-227.

What is the Value of Course-Specific Learning Goals? (for teachers)



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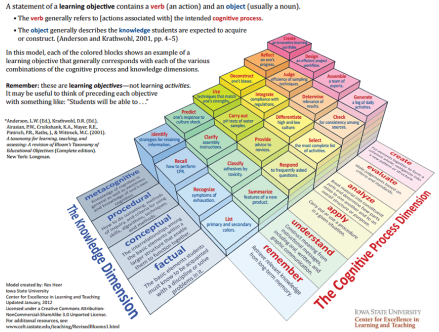

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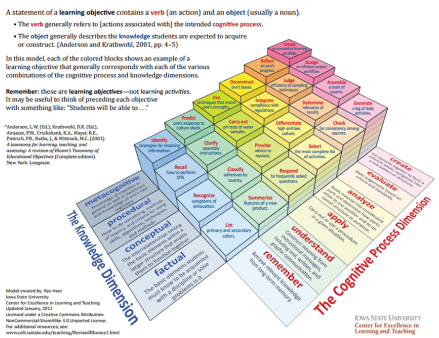
What is the Value of Course-Specific Learning Goals? (for teachers)

- ?



Benefits of Learning Outcomes for Teachers

Effective course design	• By keeping learning outcomes front and center, teachers can develop courses in which all aspects of the course, including learning activities and assessments, support what they want students to learn *(a)*.
Effective assessment of learning	• Clear expectations make it easier to evaluate students' progress and ensure that assessments are targeting the appropriate level of knowledge or skill *(a, b)*.
Better time management	• Well-defined learning outcomes simplify difficult decisions about what content to include and what to omit when preparing lessons and assessments *(b, c)*.
Improved communication	• Teachers can use learning outcomes to have explicit and constructive dialogues with students about the course and their learning, and with colleagues about the expectations of courses *(b)*.
Improved teaching experience	• Teachers who use learning objectives report less anxiety, more confidence interacting with students, and use more diverse teaching and assessment approaches *(b, c)*.

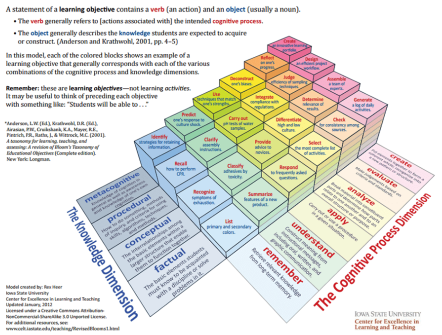
[a] Wang, X., Su, Y., Cheung, S., Wong, E., & Kwong, T. (2013). An exploration of Biggs' constructive alignment in course design and its impact on students' learning approaches. *Assessment and Evaluation in Higher Education, 38*, 477-491.

[b] Simon, B., & Taylor, J. (2009). What is the value of course-specific learning goals? *Journal of College Science Teaching, 39*, 52-57.

[c] Reynolds, H. L., & Kearns, K. D. (2017). A planning tool for incorporating backward design, active learning, and authentic assessment in the college classroom. *College Teaching, 65*, 17-27.

Created by Sara M. Fulmer

What is the Value of Course-Specific Learning Goals? (for teachers)



Resources

- Simon, B., & Taylor, J. (2009). What is the value of course-specific learning goals? *Journal of College Science Teaching, 39*(2), 52-57.

- Reynolds, H. L., & Kearns, K. D. (2017). A planning tool for incorporating backward design, active learning, and authentic assessment in the college classroom. Journal of College Teaching, 65(1). https://doi.org/10.1080/87567555.2016.1222575

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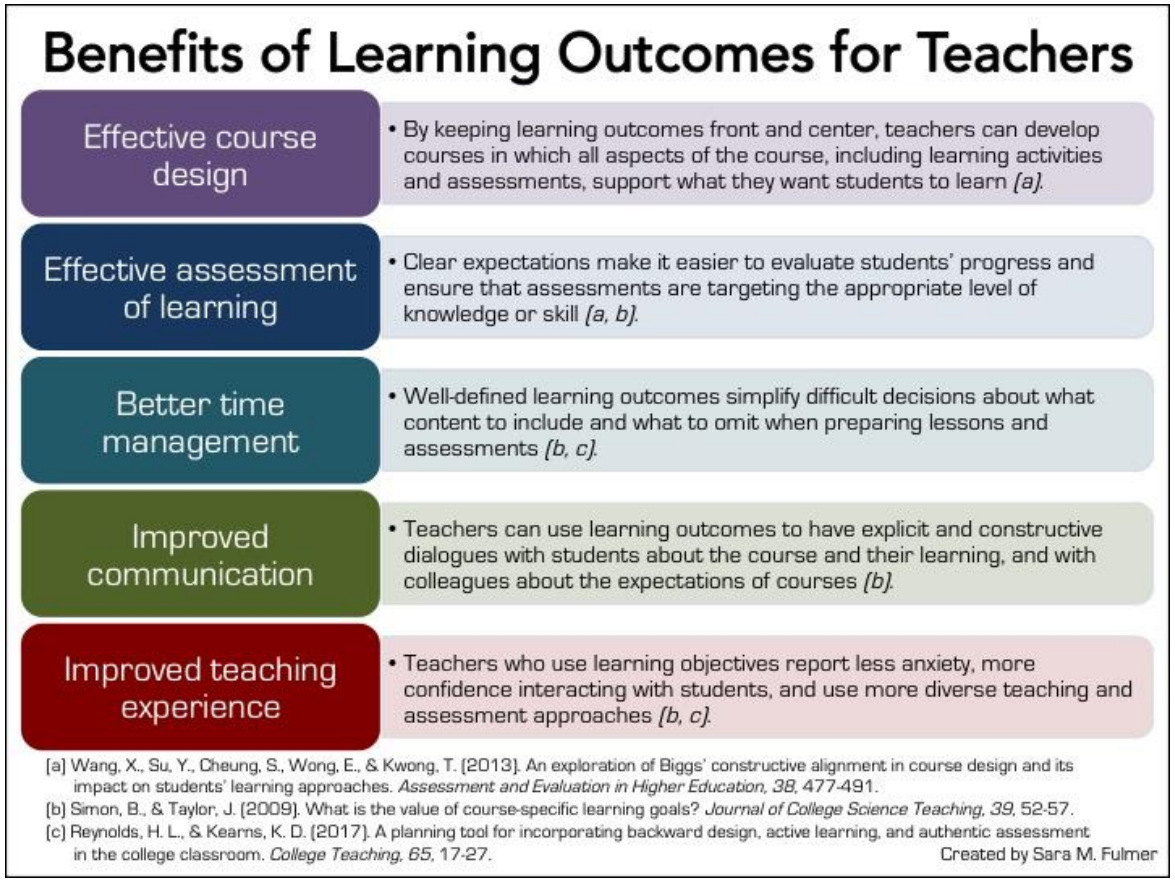
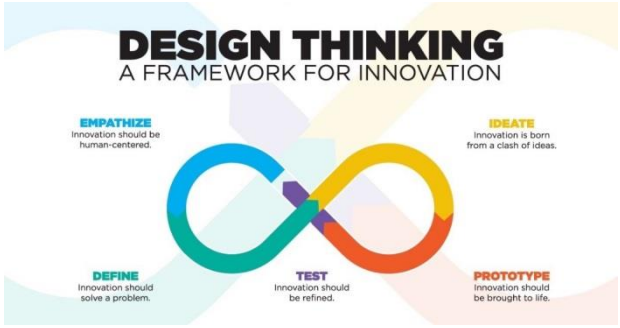
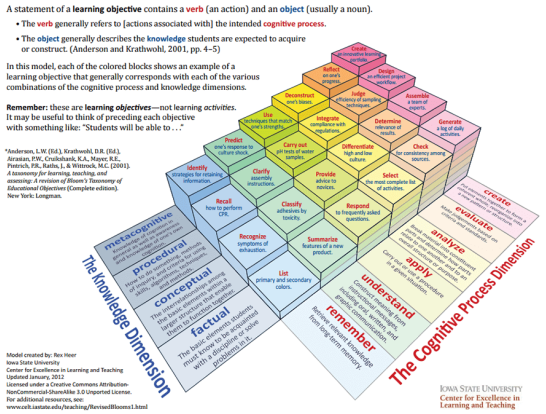


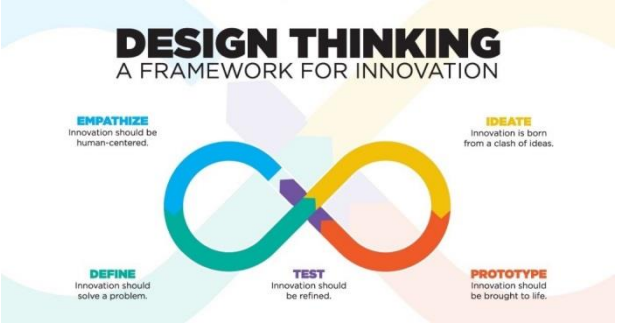
Using Learning Outcomes Effectively

- Share learning outcomes with your students
- Use learning outcomes in preparing lectures
- Use learning outcomes in composing exams
- Rely less on covering a topic list

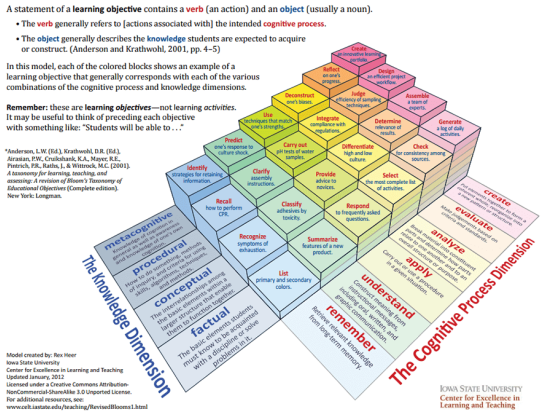




Use Learning Outcomes in Preparing Lectures



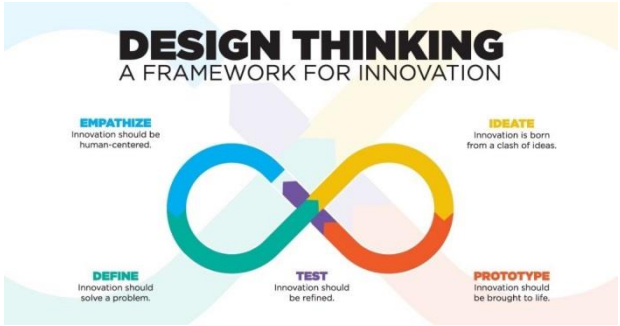
- Build a schedule showing when you address the learning outcomes in the academic term.
- Start each lecture with the course learning outcomes to be address in the lecture
- Select one or more learning outcomes for a lecture
  - What do students need to know for achieving the learning outcome?
  - What can students easily learn on their own?
  - Where do students most need your input and feedback?



One Organization Scheme

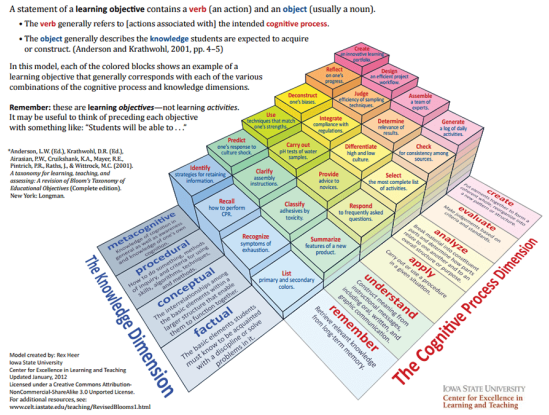
	Lecture 1	Lecture 2	…	Exam 1	Exam 2
LO #1					
LO #2					
LO #3					
LO #4					
…					

Share Your Learning Outcomes with Your Students

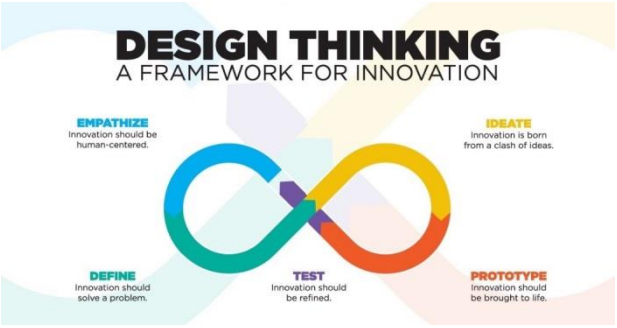


Two-minute Exercise

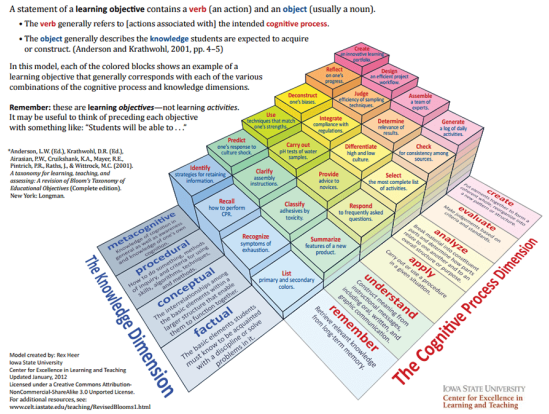
Generate 5 ways you might use your learning outcomes in setting your exams



Use Learning Outcomes in Preparing Exams



- Write down the learning outcomes that will be evaluated with the exam
- Share the list of learning outcomes with the students a week or so in advance
- Generate multiple potential problems for each learning outcome



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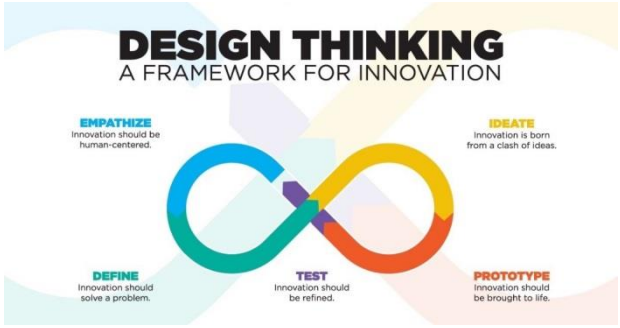
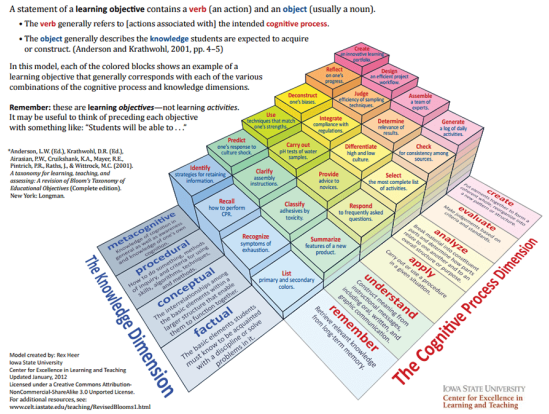


- Limit the number of higher-order learning outcomes per exam
- Select from the potential problems the final problems
- Should you use problems that evaluate multiple learning outcomes?
  - Physics chapter example



Minute Paper

If I were doing another session on learning outcomes, what instructional practices should I:

- Continue to do
- Start doing
- Stop doing