

ConcepTest design workshop

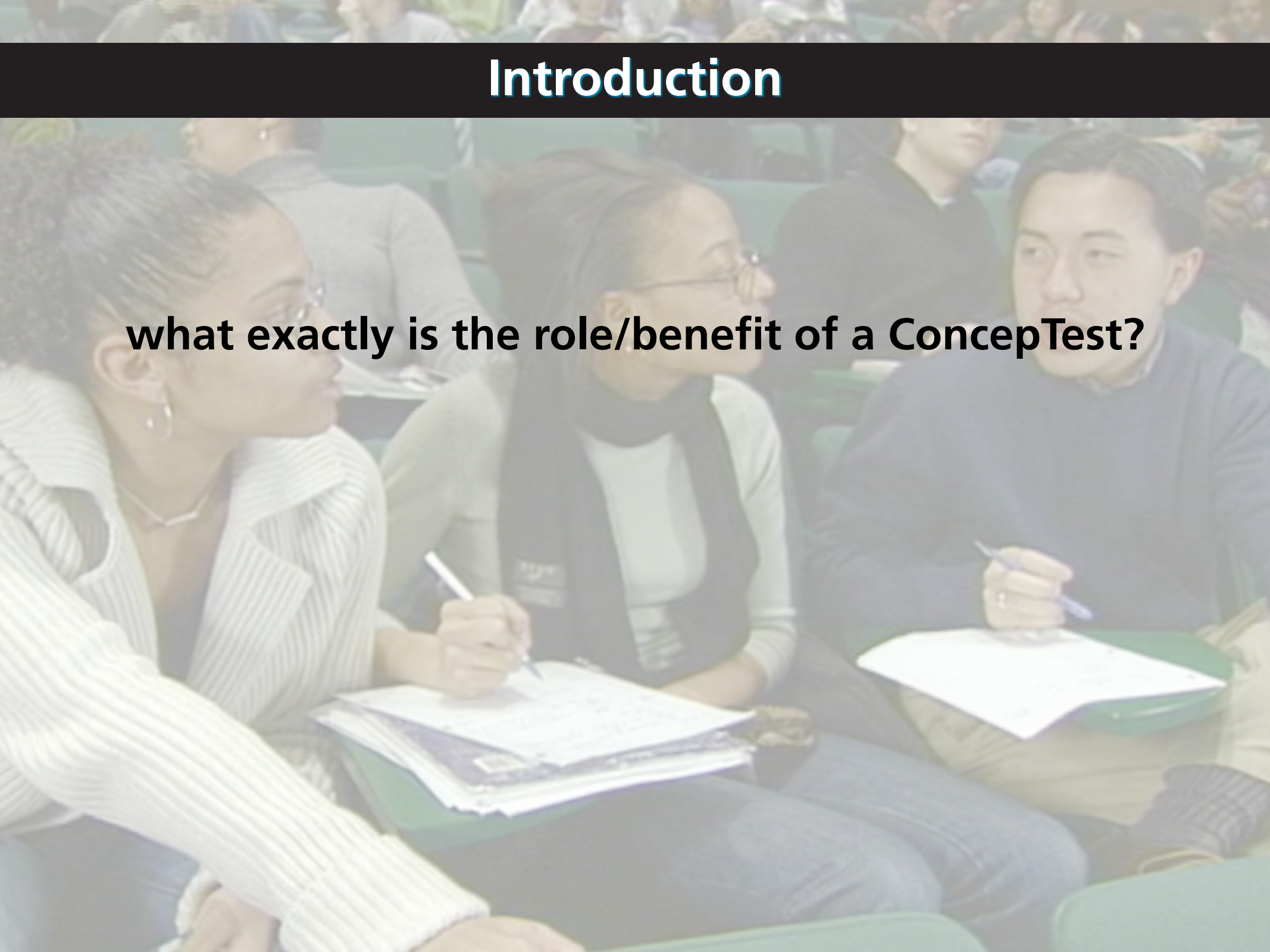


KTH Royal Institute of Technology visit
Harvard University
Cambridge, MA, February 11, 2011



Introduction

what exactly is the role/benefit of a ConcepTest?

A photograph of three students in a classroom setting, looking at each other and holding papers and pens, suggesting a collaborative learning activity. The students are seated at desks, and the background shows other students in a lecture hall.

Introduction

what exactly is the role/benefit of a ConcepTest?

students teaching students

Introduction

what exactly is the role/benefit of a ConcepTest?

students teaching students

but there's much more!

Introduction

Questioning provides:

- **a learning opportunity**
- **realization of gaps in knowledge**
- **reconsolidation opportunity**

Introduction

Retrieval Practice Produces More Learning than Elaborative Studying with Concept Mapping

Jeffrey D. Karpicke* and Janell R. Blunt

Educators rely heavily on learning activities that encourage elaborative studying, whereas activities that require students to practice retrieving and reconstructing knowledge are used less frequently. Here, we show that practicing retrieval produces greater gains in meaningful learning than elaborative studying with concept mapping. The advantage of retrieval practice generalized across texts identical to those commonly found in science education. The advantage of retrieval practice was observed with test questions that assessed comprehension and required students to make inferences. The advantage of retrieval practice occurred even when the criterial test involved creating concept maps. Our findings support the theory that retrieval practice enhances learning by retrieval-specific mechanisms rather than by elaborative study processes. Retrieval practice is an effective tool to promote conceptual learning about science.

Most thought on human learning is guided by a few tacit assumptions. One assumption is that learning happens primarily when people encode knowledge and experiences. A related assumption is that retrieval—the active, cue-driven process of reconstructing knowledge—only measures the products of a previous learning experience but does not itself produce learning. Just as we assume that the act of measuring a physical object would not change the size, shape, or weight of the object, so too people often assume that the act of measuring memory does not change memory (1, 2). Thus, most educational research and practice has focused on enhancing the processing that occurs when students encode knowledge—that is, getting knowledge “in memory.” Far less attention has been paid to the potential importance of retrieval to the process of learning. Indeed, recent National Research Council books

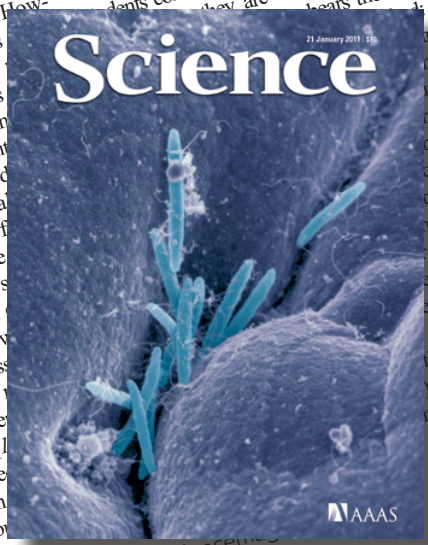
about how students learn in educational settings (3–5) contain no mention of retrieval processes. It is beyond question that activities that promote effective encoding, known as elaborative study tasks, are important for learning (6). However, research in cognitive science has challenged the assumption that retrieval is and uninfluential in the learning process. Not only does retrieval produce learning, retrieval event may actually represent a powerful learning activity than an encoding event. This research suggests a conceptual model and learning that is different from which encoding places knowledge in memory and retrieval simply accesses that knowledge. Because each act of retrieval is considered essential to the processing, the act of reconstructing knowledge is considered essential to the process.

Most previous research on retrieval has been conducted in the laboratory. Conditions of memory research (1) used have often not reflected the conditions used when students learn in educational settings (13). Most previous

used assessments thought to measure meaningful learning, which refers to students' abilities to make inferences and exhibit deep understanding of concepts (14, 15). Perhaps the greatest impediment to broad application of retrieval practice, though, is that we do not know whether retrieval activities are more effective than other active, elaborative learning activities. Retrieval practice might produce levels of learning that are essentially the same as those produced by elaborative studying. Alternatively, if there are retrieval-specific mechanisms that promote learning, then retrieval practice may represent a way to promote student learning that goes beyond elaborative study activities used in science education.

The present experiments put retrieval practice to a test. Elaborative learning activities hold a central place in contemporary education. We examined the effectiveness of retrieval practice relative to elaborative studying with concept mapping (16–18). In concept mapping, students construct a diagram in which nodes are used to represent concepts, and links connecting the nodes represent relations among the concepts. Concept mapping is considered an active learning task, and it serves as an elaborative study activity when students construct concept maps in the presence of

Science



Introduction

To Really Learn, Quit Studying and Take a Test
(New York Times, Jan 21, 2011)



The New York Times

Learning Through Testing

Researchers asked college students to study a short science text using one of four study methods, then tested them a week later. The most effective study method combined two study sessions with retrieval practice, tests that asked the students to recall what they had read.

STUDY METHOD

One study session
Concept mapping
Retrieval practice
Repeated study

Direct questions
answered correctly

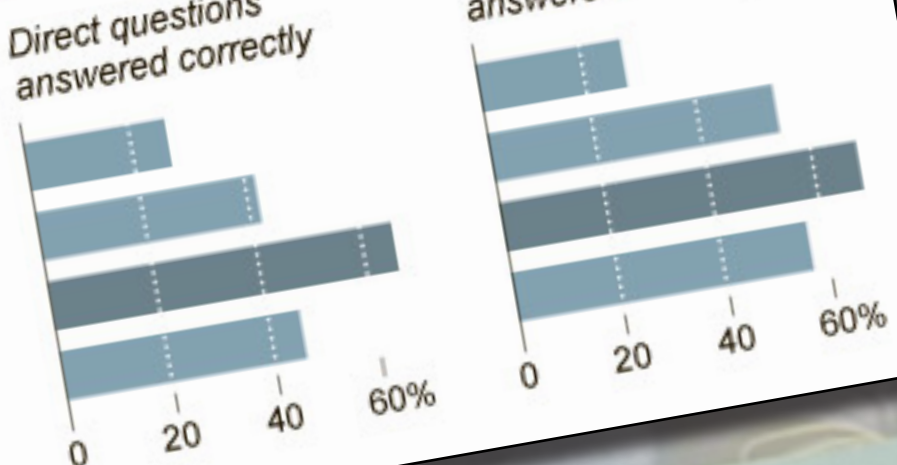
0 20 40 60%

Inference questions
answered correctly

0 20 40 60%

Source: Science

January 21, 2011



Introduction

“These other methods not only are popular, the researchers reported; they also seem to give students the illusion that they know material better than they do.

In the experiments, the students were asked to predict how much they would remember a week after using one of the methods to learn the material. Those who took the test after reading the passage predicted they would remember less than the other students predicted — but the results were just the opposite.”

Introduction

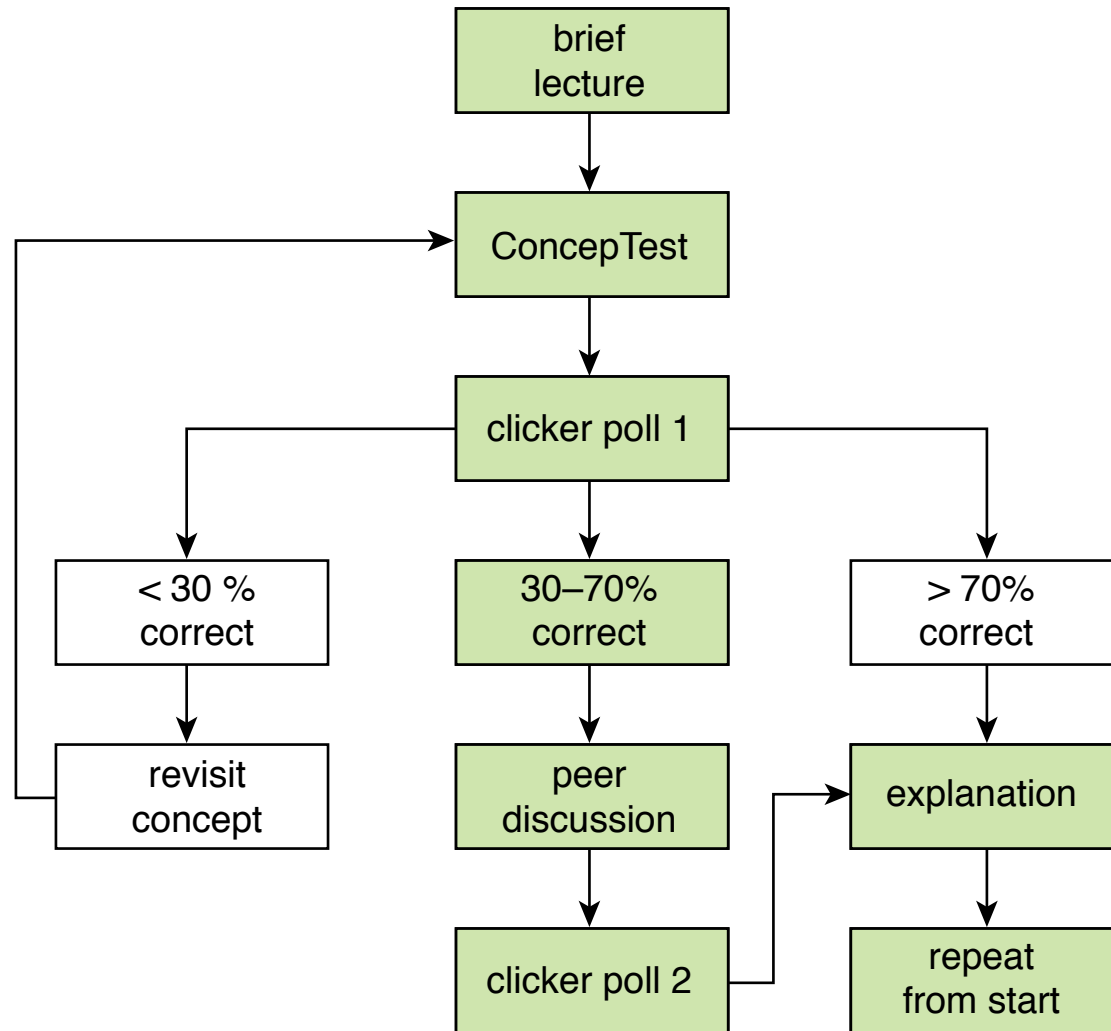
activation of memory causes reconsolidation

A photograph of a diverse group of students sitting in a lecture hall. They are looking towards the front of the room, some with pens in hand and papers on their desks, suggesting an active learning environment. The image is semi-transparent, with the text overlaid on it.

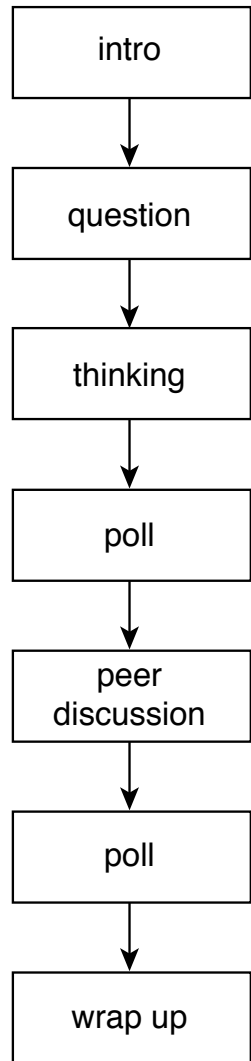
Outline

- **anatomy of a ConcepTest**
- **effective implementation**
- **creating ConcepTests**

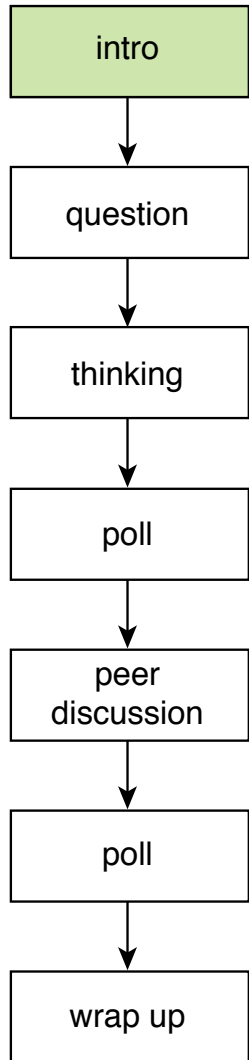
Anatomy of a ConcepTest



Anatomy of a ConcepTest

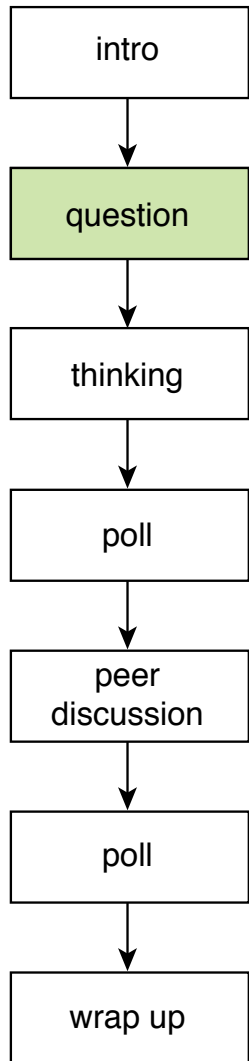


Anatomy of a ConcepTest



setting context

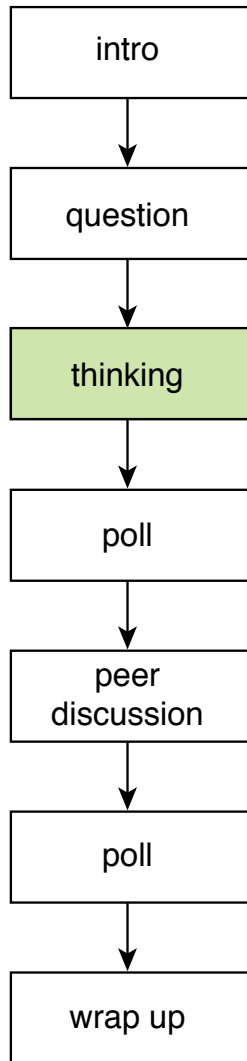
Anatomy of a ConcepTest



setting context

posing question

Anatomy of a ConcepTest

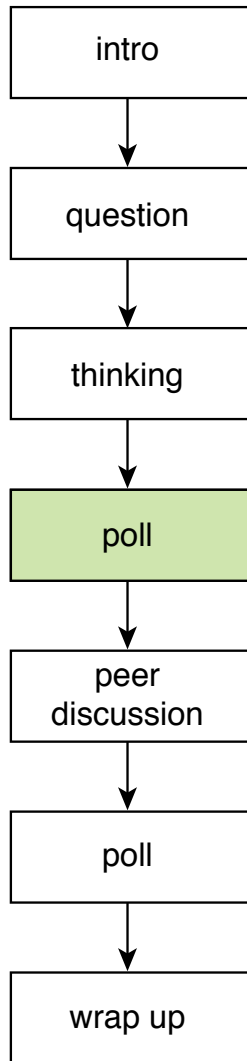


setting context

posing question

reflection

Anatomy of a ConcepTest



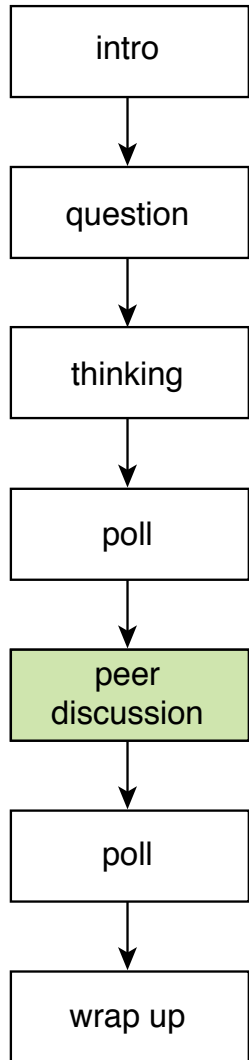
setting context

posing question

reflection

baseline data

Anatomy of a ConcepTest



setting context

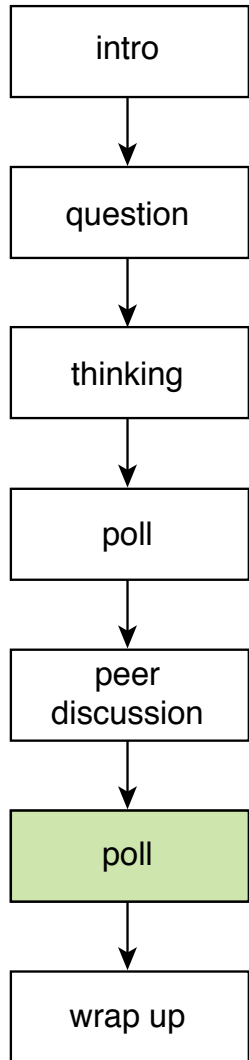
posing question

reflection

baseline data

peer instruction

Anatomy of a ConcepTest



setting context

posing question

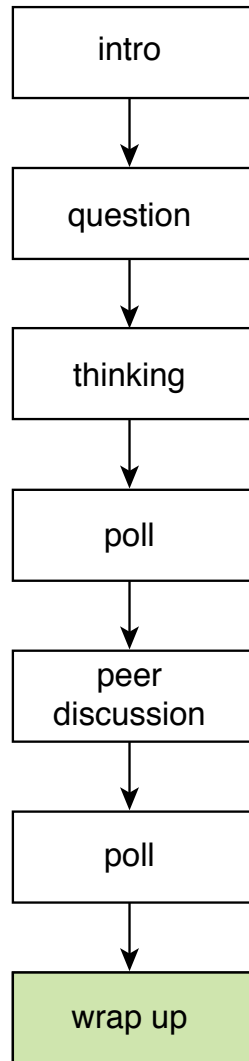
reflection

baseline data

peer instruction

gain data

Anatomy of a ConcepTest



setting context

posing question

reflection

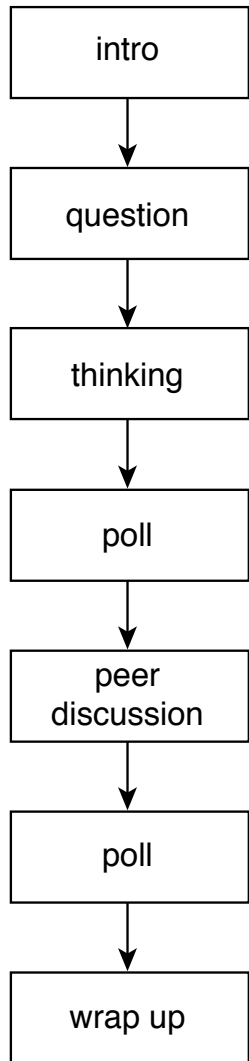
baseline data

peer instruction

gain data

closure

Anatomy of a ConcepTest



setting context 5 min (max)

posing question 1 min

reflection 1–2 min

baseline data

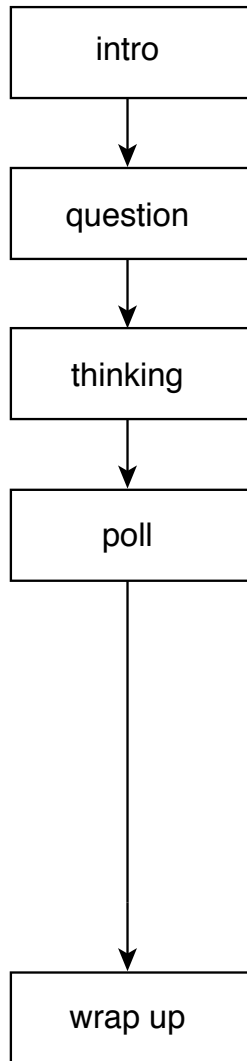
peer instruction 2–3 min

gain data

closure 5 min (max)

Anatomy of a ConcepTest

potential shortcuts

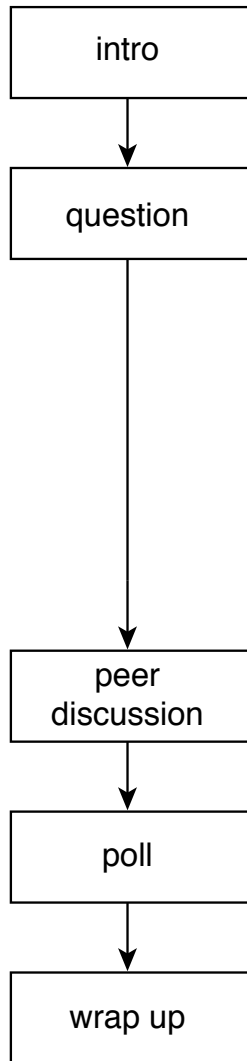


2–3 min saved, but...

takes the “Peer” out of “Peer Instruction”

Anatomy of a ConcepTest

potential shortcuts



1–2 min saved, but...

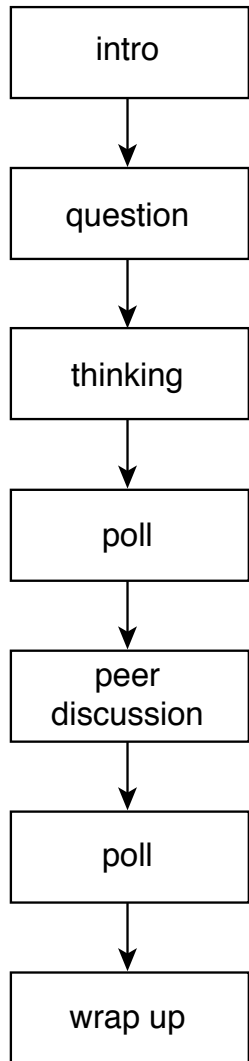
no opportunity to commit before discussion

Outline

- **anatomy of a ConcepTest**
- **effective implementation**
- **creating ConcepTests**

Effective implementation

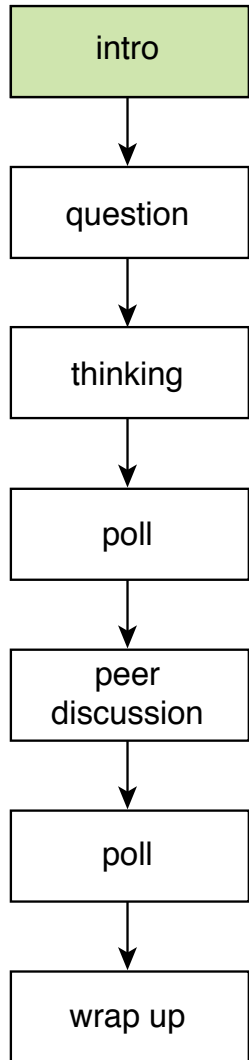
engendering “deep learning”



Effective implementation

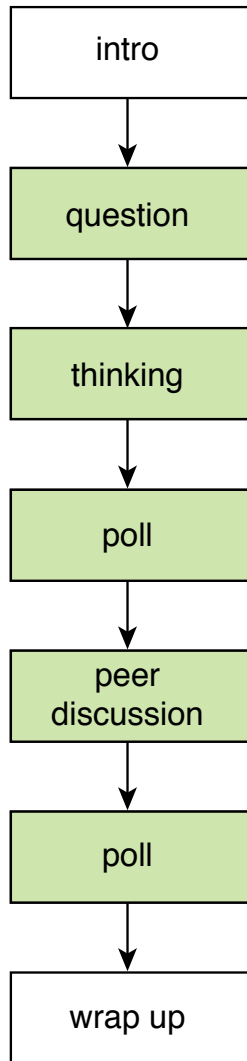
engendering “deep learning”

pre-class activity determines context



Effective implementation

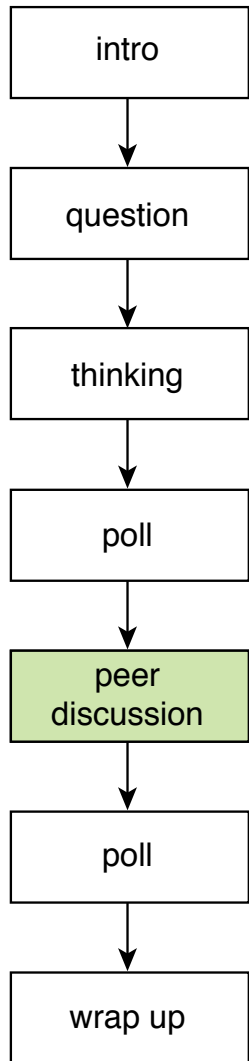
engendering “deep learning”



question transfers concepts to new context

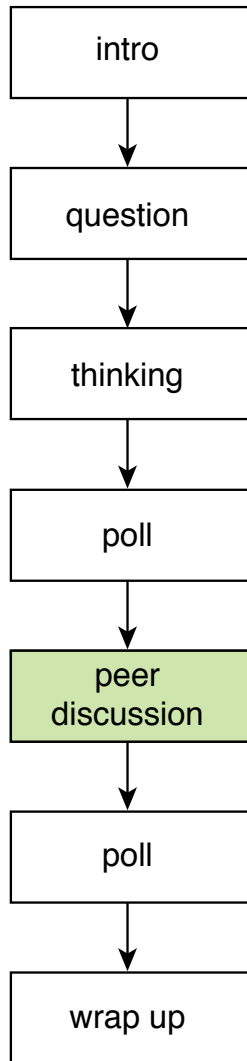
Effective implementation

importance of peer discussion



Effective implementation

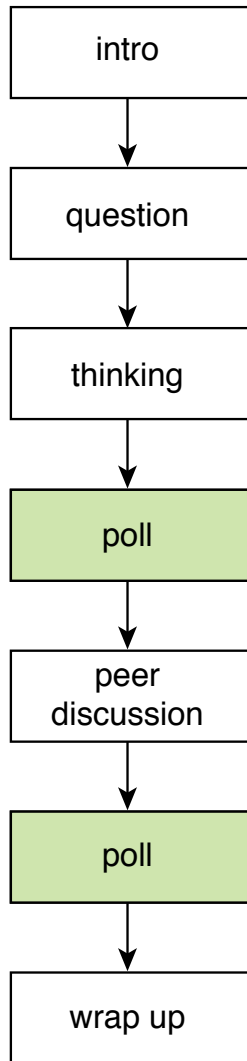
importance of peer discussion



vary activity

Effective implementation

importance of peer discussion



vary activity, measure poll-repoll gain

Effective implementation

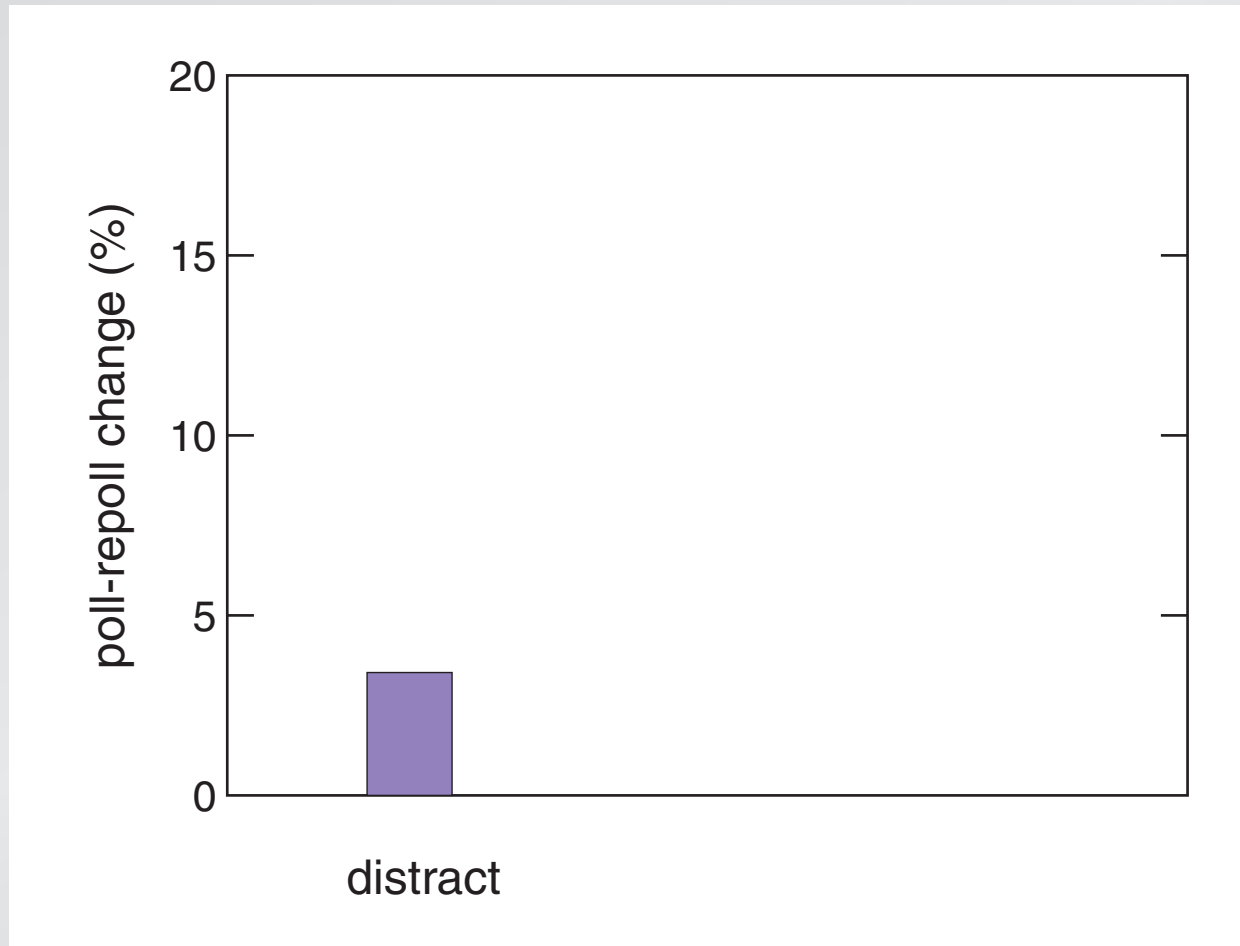
importance of peer discussion

compare poll-repoll gain for 3 activities:

- distract
- reflect
- discuss

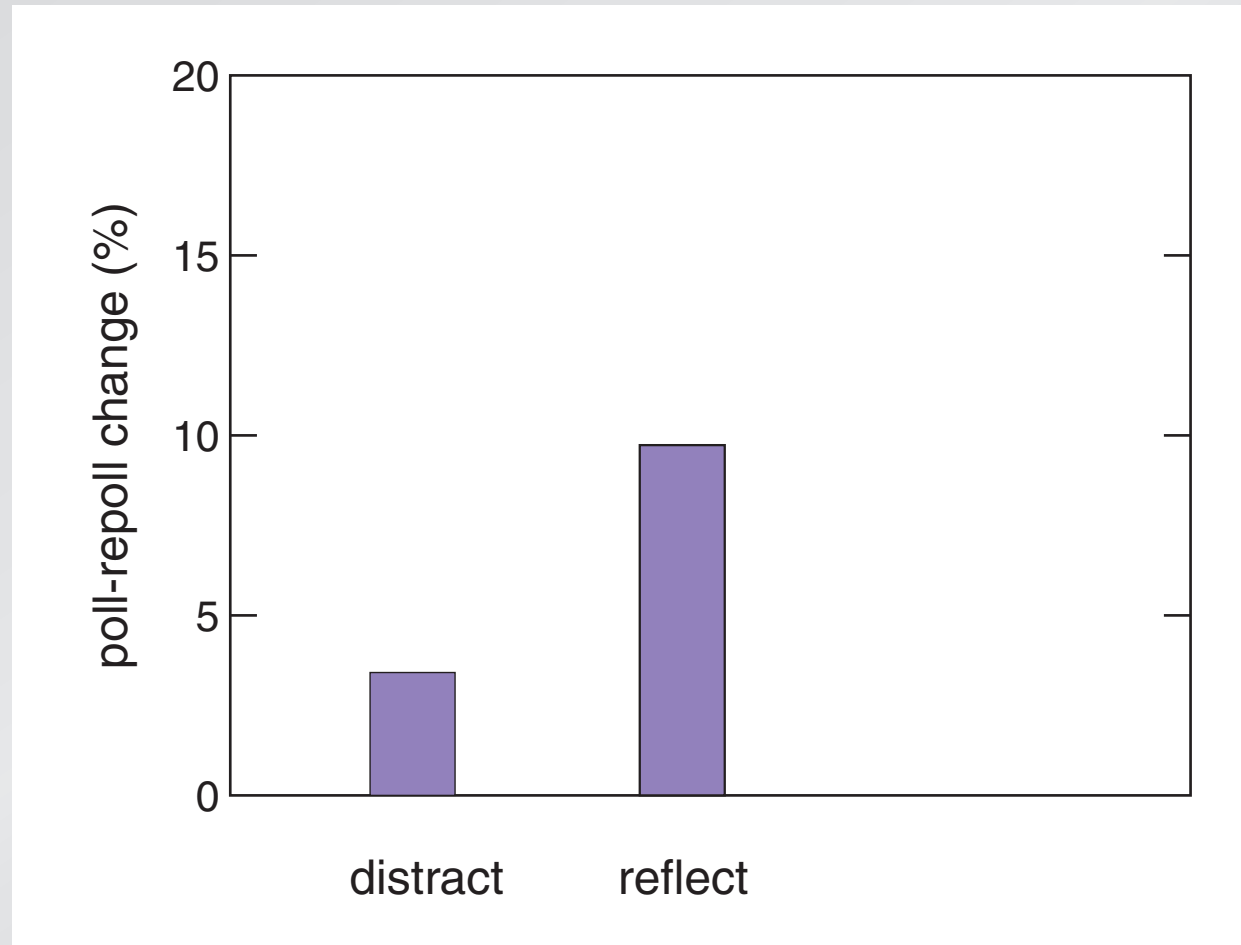
Effective implementation

importance of peer discussion



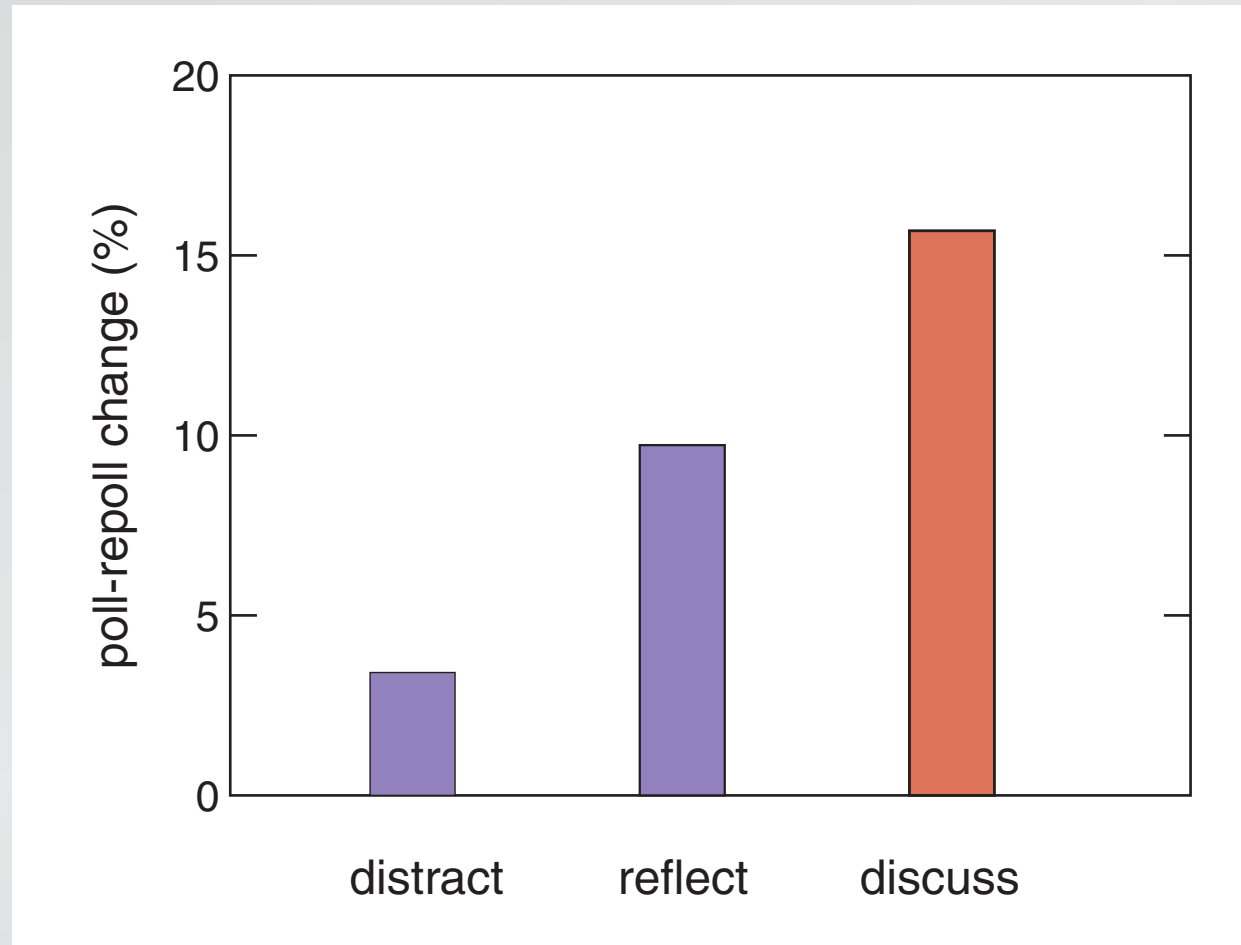
Effective implementation

importance of peer discussion



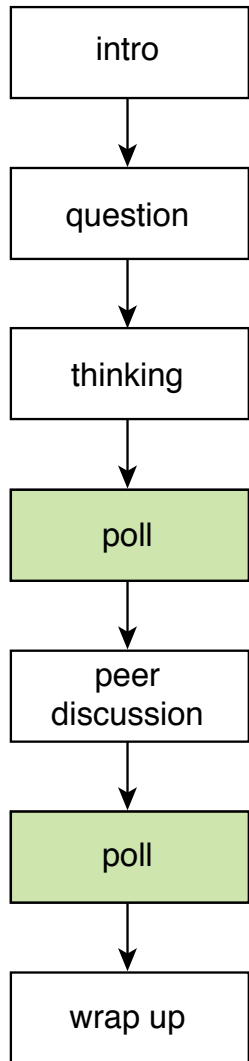
Effective implementation

importance of peer discussion



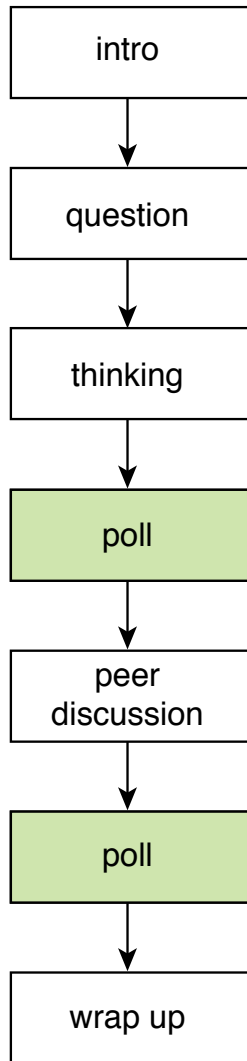
Effective implementation

technology important?



Effective implementation

technology important?



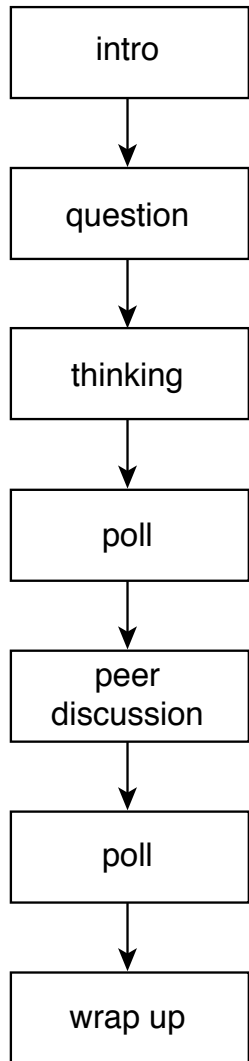
normalized FCI gain:

flashcards: 0.47

clickers: 0.44

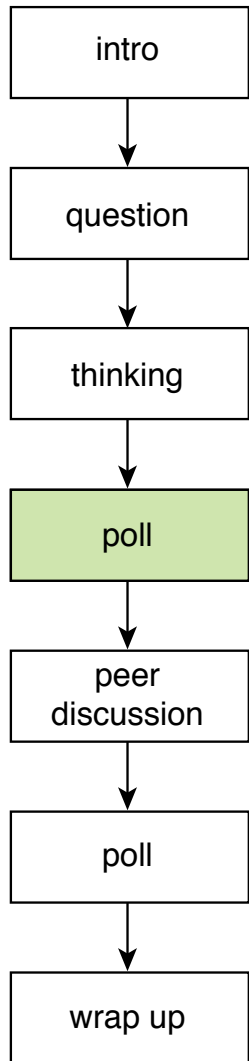
Effective implementation

show histograms?



Effective implementation

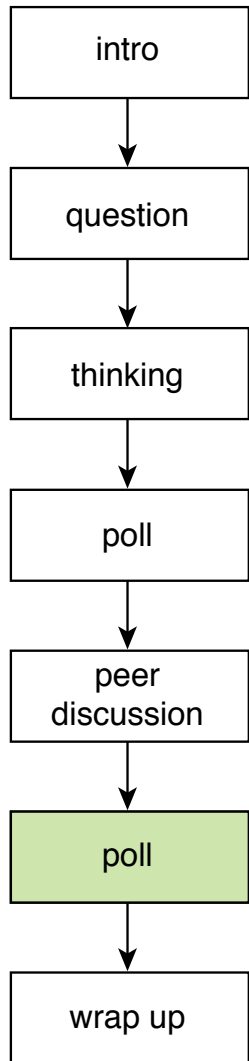
show histograms?



no — biases discussion

Effective implementation

show histograms?

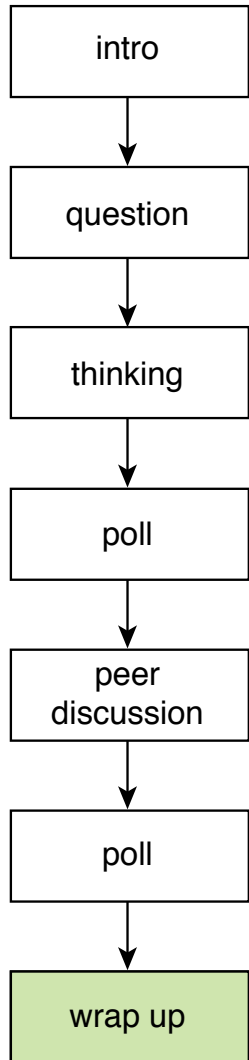


no — biases discussion

yes — helps bring closure

Effective implementation

show histograms?



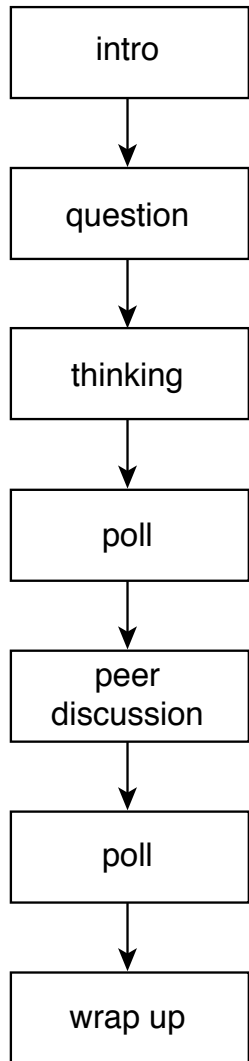
no — biases discussion

yes — helps bring closure

provide *your* answer

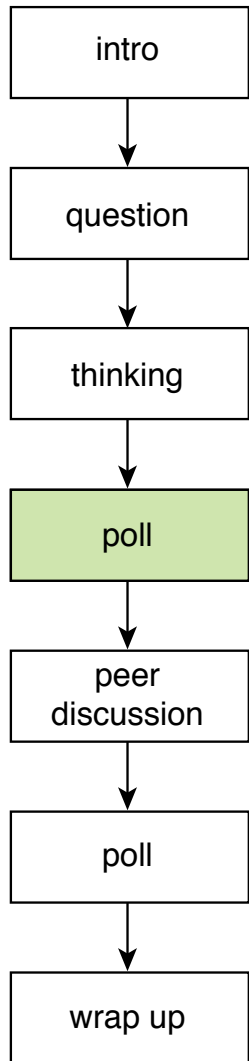
Effective implementation

have individual students defend choices?



Effective implementation

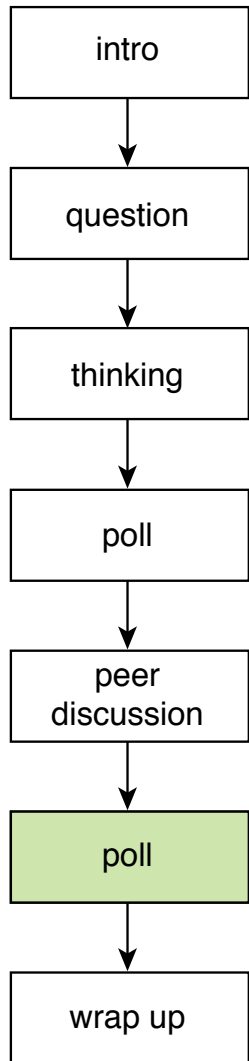
have individual students defend choices?



provides additional insights for discussion

Effective implementation

have individual students defend choices?

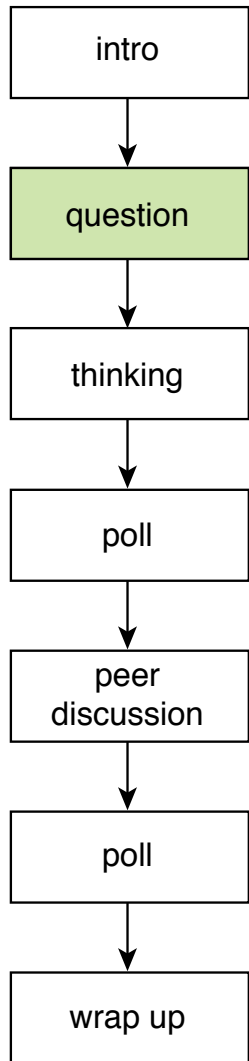


involves students in wrap up

Outline

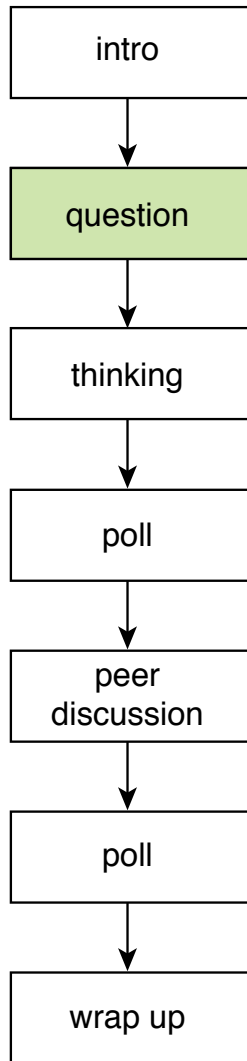
- **anatomy of a ConcepTest**
- **effective implementation**
- **creating ConcepTests**

Creating ConcepTests



what constitutes an effective ConcepTest?

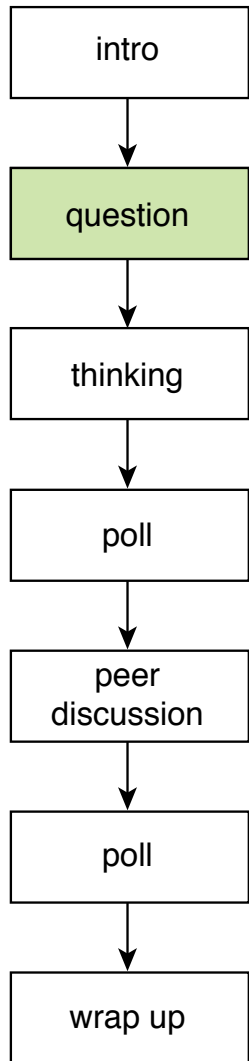
Creating ConcepTests



An effective ConcepTest...

- is driven by student needs
- tests understanding, not memorization
- pushes students (but not too much)

Creating ConcepTests

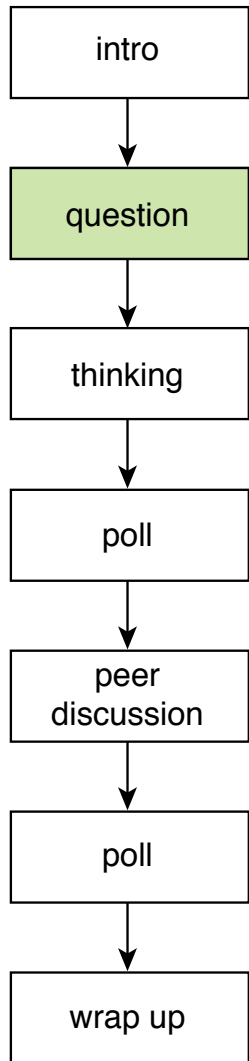


Sources of ConcepTests:

- **literature/web (you'd be surprised!)**
- **pre-class assignments**
- **other assignments**

Creating ConcepTests

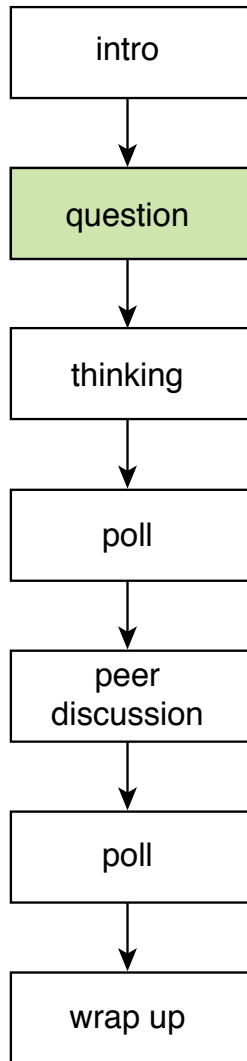
some of your questions



“Could they be too easy?”

Creating ConcepTests

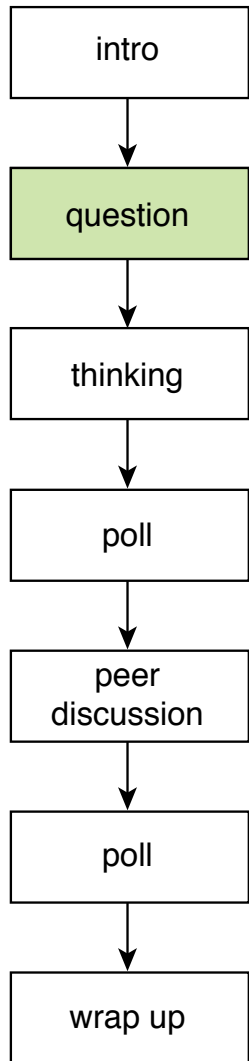
some of your questions



“Is it important to have multiple answer choices? Or is true/false OK?”

Creating ConcepTests

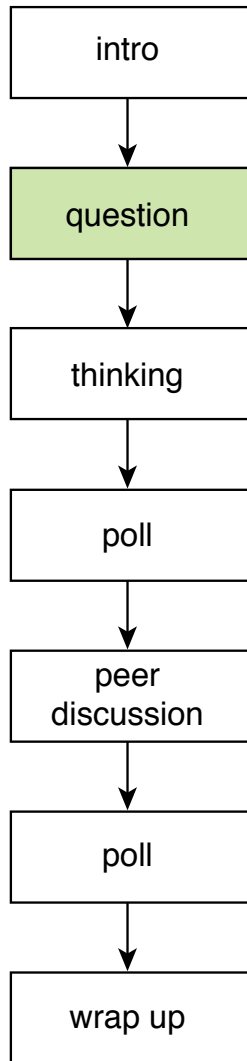
some of your questions



“When do ConcepTests not work well?”

Creating ConcepTests

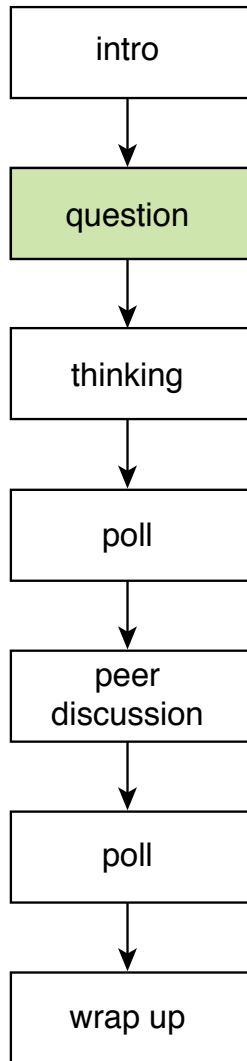
some of your questions



“Is it important to have multiple answer choices? Or is true/false OK?”

Creating ConcepTests

before trying out **YOUR** ConcepTests, need...



1. context

2. question

3. closure

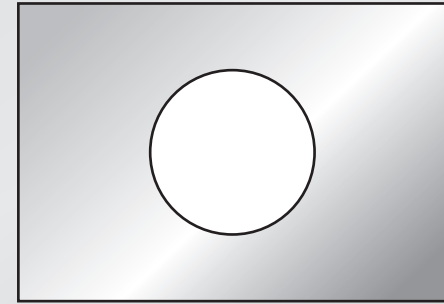
Creating ConceptTests

When metals heat up, they expand because all atoms get farther away from each other.



Creating ConceptTests

Consider a rectangular metal plate with a circular hole in it.



When the plate is uniformly heated, the diameter of the hole

1. increases.
2. stays the same.
3. decreases.

QUESTION



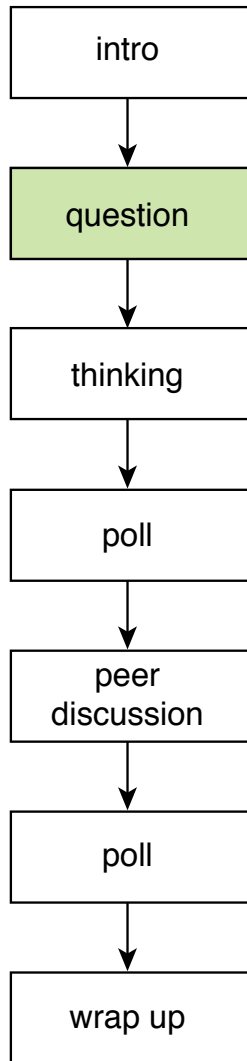
Creating ConceptTests

consider the atoms at the rim of the hole



Creating ConcepTests

before trying out **YOUR** ConcepTests, need...



1. context

2. question

3. closure

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for more information and a copy of this presentation:

<http://mazur.harvard.edu>

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