

Peer-Instruction: An active learning strategy to promote student conceptual understanding

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Sample question – vote individually

You toss an old 1-rupee coin and a new 1-rupee coin. Which is the most likely outcome:

- 1) Two heads
- 2) Two tails
- 3) One head and one tail
- 4) Each of 1, 2, 3 above is equally likely

Discuss with your neighbour, vote again

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- 4) Each of 1, 2, 3 above is equally likely

How many of you changed your answer?

What you just did was Peer Instruction!

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Examine more closely:

What exactly did you do? (you are the students in this case)

PAIR - Turn to your neighbor.

Write two specific actions that students (you) did. Don't simply say "we solved the problem"

SHARE – Discuss with entire class, facilitated by coordinator.

Come with a list of behaviours that a student does during the Peer-Instruction activity.

What you just did was Peer Instruction!

Examine more closely:

What do students do in Peer-Instruction ?

- Talk to each other
- Listen to their classmates
- Argue about the content
- Reason, solve steps of the problem
- Write or draw to solve the problem...

Dissecting Peer-Instruction method

What do students do? What are the benefits?

Talk, argue, listen (sometimes), reason, draw => Actively engaged

Learn from each other, teach each other (teach<=>learn)

Those who don't know willing to think, reason, answer

Those who do know also participate

Pre-existing thinking is elicited, confronted, resolved (*How many of you changed your answer?*)

What are benefits to instructor? To the class atmosphere?

Immediate feedback to instructor

Students realize that even others are struggling

Builds a friendly, yet scientific atmosphere

Improve communication

Recall - Requirements of active learning strategies

- Instructor creates carefully designed activities that require students to talk, write, reflect and express their thinking.
- Majority of students go beyond listening, copying of notes, execution of prescribed procedures.

Key elements of active learning strategies

- Students engage in problem-solving activities *during* class time.
- The problems posed are in a variety of contexts, often real-life.
- Specific student ideas are elicited and addressed.
- Students are asked to “figure things out for themselves.”
- Students are asked to express their reasoning explicitly.
- Students work collaboratively.
- Students receive rapid feedback on their work.
- Qualitative reasoning and conceptual thinking are emphasized.

Peer-Instruction is a classroom active learning strategy based on specific, well-designed questions.

Anatomy of Peer-Instruction method

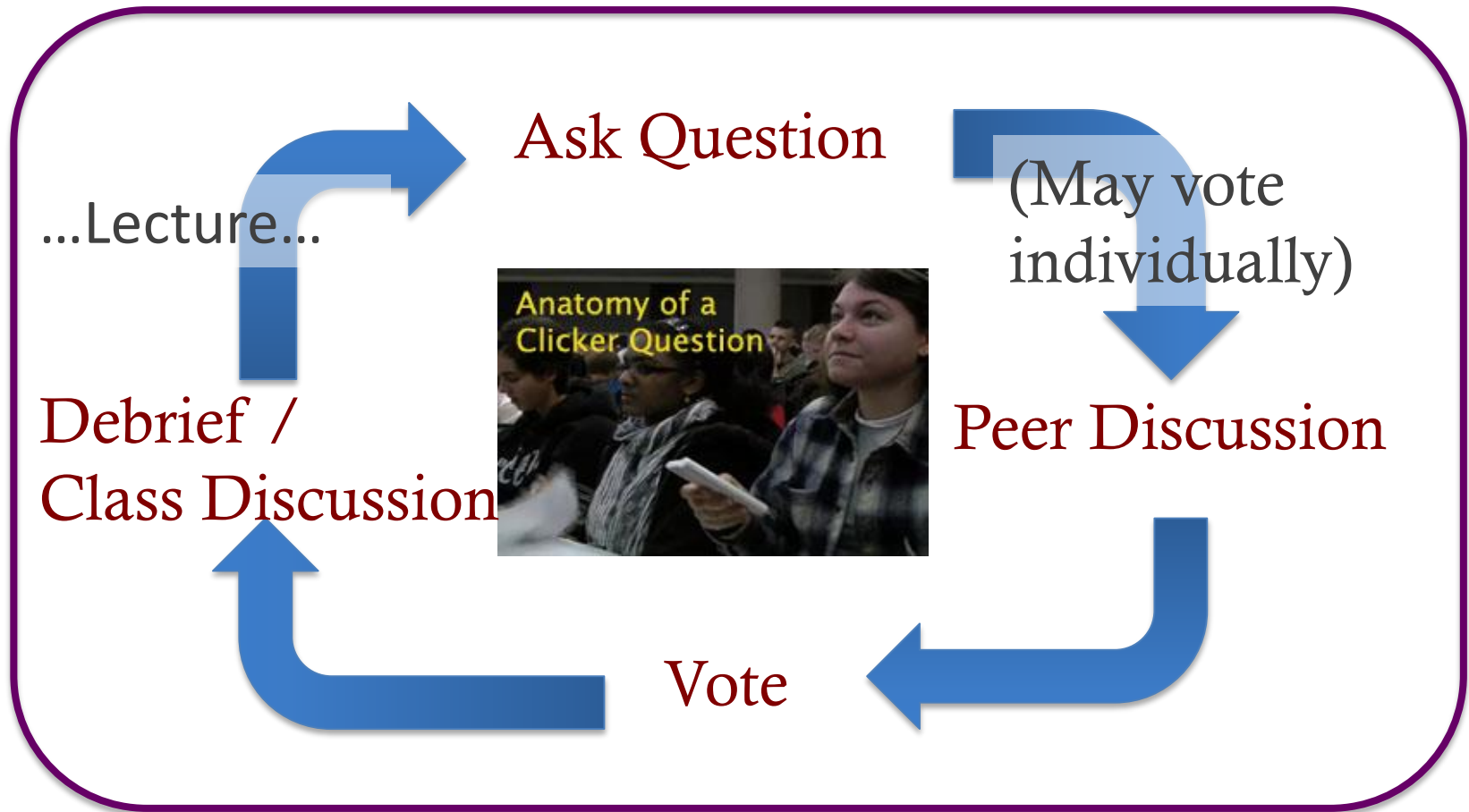


Figure attributed to: Stephanie Chasteen and the Science Education Initiative at the University of Colorado

See also: Peer Instruction, A User's Manual. Eric Mazur.

Implementing Peer-Instruction with clickers



But clickers are not Peer-Instruction



MIT TEAL classroom



From blog.peerinstruction.net

How to implement Peer-Instruction without clickers



How to implement Peer-Instruction in your class



Image from Monash University Peer Instruction in the Humanities Project
<http://tinyurl.com/kh7uo2o>



OR:

A4 sheet of paper

Fold it in four

Marker – A, B, C, D

PI one of the most widely researched* strategies

(* This is good because ...)

- Extent of research
 - 300+ research articles
 - Physics, biology, chemistry maths, CS, engineering, psychology, medicine & nursing ...
 - Many controlled studies using standardized tests
- Courses using peer instruction outperform traditional lecture courses on a common test
- Students can better answer a question on their own, after peer instruction discussion, (especially difficult questions) – study with 16 pairs of isomorphic questions *Smith et al, Science 2009*
- Research on student perception says: clickers help students show up for class, feel part of class community, make their voice heard, hold them accountable ...

Writing effective Peer-Instruction questions

Debate: Is a multiple-choice question good?

Coordinators: Make 2 groups - A and B.

Participants:

Those in group A should list points for why multiple choice questions can be “good.”

Those in group B should list points for why multiple choice questions are NOT “good.”

Coordinators: Send two main points in favour of what MCQs can be good and two points against it, through A-view chat.

What makes a peer-instruction question “good”?

An effective peer-instruction question:

- Is usually conceptual (avoid long analytic computation)
- Elicits pre-existing thinking, students’ alternate conceptions
- Has believable distractors
- Asks students to predict results of experiment, or algorithm
- Makes students apply ideas in new context
- Relates different representations

- is not ambiguous
- is not leading
- is not ‘trivial’

Types of Peer-Instruction questions

Counting iterations

Below is the *for loop* for calculating the factorial of a number.
How many times is this set of code executed ?

```
for (i = 1; i <= N; i ++ ) {  
  nFactorial = nFactorial * i;  
}
```

- 1) 1 time
- 2) N times
- 3) N -1 times
- 4) N + 1 times

What does this code do?

```
main () {  
int vn=9; va[vn];  
    for (int i = 0; i < vn; i++) va[i] = i * (vn - 1 - i);  
    for (int i = 0; i < vn; i++) cout << va[i] << ",";  
    cout << endl;  
}
```

What does this code do?

- 1) Calculates values of array va[]
- 2) Prints the values of first vn elements of va
- 3) Initializes the array va and prints it
- 4) Finds maximum element in the array

Predict the outcome of a program

What is the output of the code shown below?

```
int main() {  
int a = 1; b = 2; c = 3;  
int *p, *q;  
  
p = &a; q = &b;  
c = *p; p = q;  
*p = 13;  
  
cout << a << b << c;  
}
```

- 1) a=1, b=2, c=3
- 2) a= 1, b=13, c=1
- 3) a=1, b=2, c=1

What will happen if were changed

Consider the function and main program shown below.

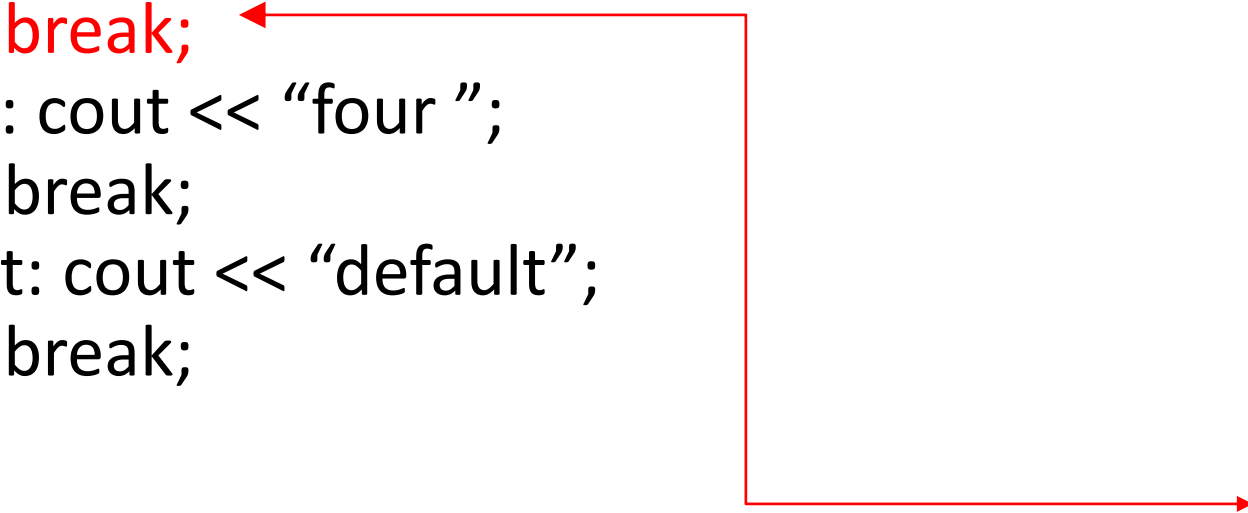
```
void fun (int x) { x = 5; }  
int main () {  
    int a = 3;  
    fun(a);  
    cout << a << endl;  
}
```

What will happen if we change the function call from `fun (int x)` to `fun (int& x)` ?

- 1) No change in the output
- 2) Program will not compile
- 3) `a = 5` will be printed
- 4) `a = 3` will be printed

Debug

```
Int val = 5;
Switch (val) {
case 5: cout << "five ";
        break;
case 4: cout << "four ";
        break;
default: cout << "default";
         break;
}
```



What will happen if we forget to include 'break' statement?

- 1) Compiler error
- 2) It will print only *five*
- 3) It will print *five four*
- 4) It will print *five four default*

Activity – write your own question

Choose a topic in an Intro-to-programming course.

Write a peer-instruction question in that topic.

Make sure you include the choices too ~ 3 to 5.

Recall – An effective PI question :

- Elicits pre-existing thinking, students' misconceptions
- Has believable distractors
- Asks students to predict results of a program or algorithm
- Makes students apply ideas in new context
- Relates different representations

Avoid

- Long calculations
- Trivial questions

Activity – write your own question

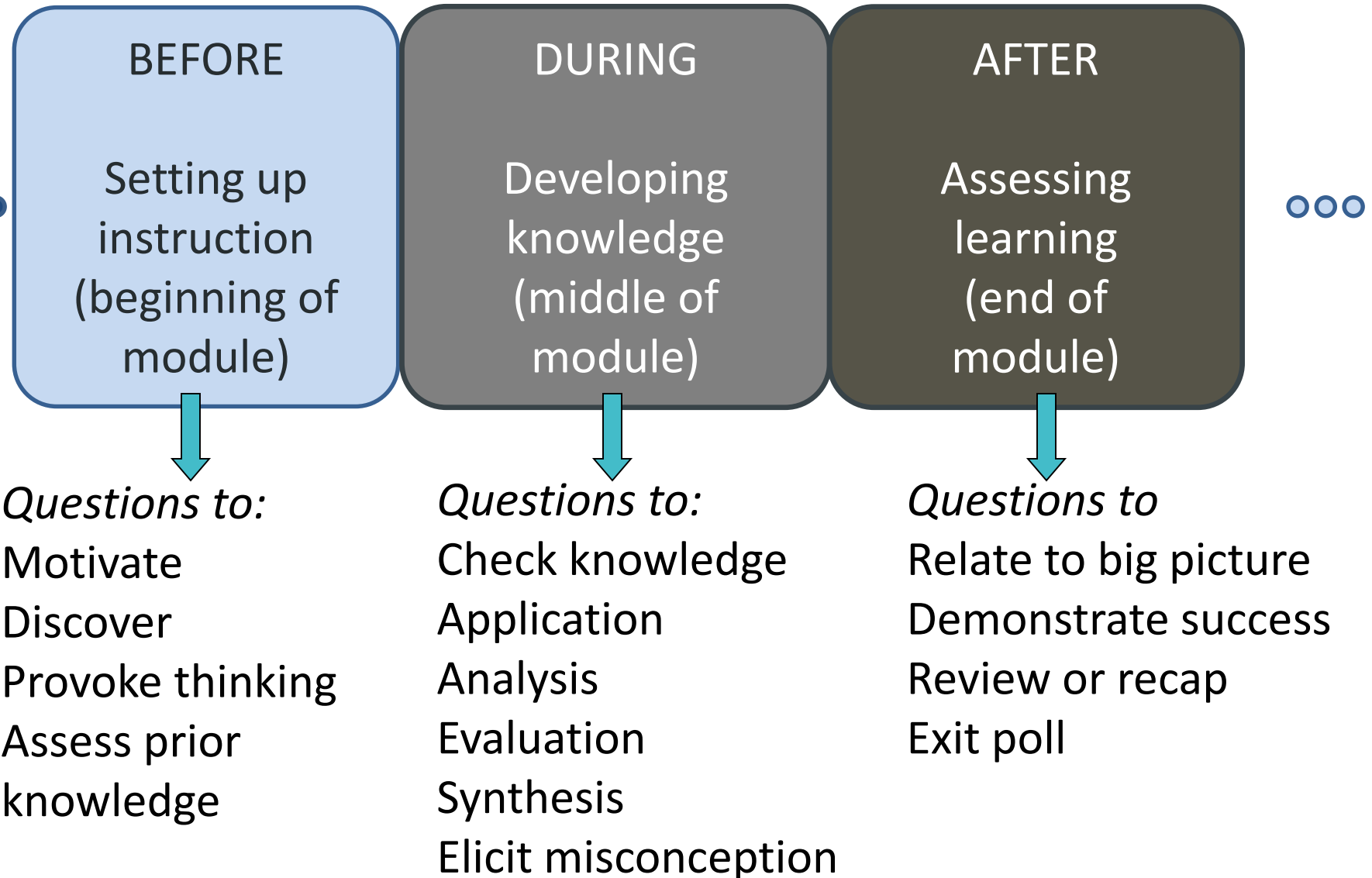
Choose a topic in an Intro-to-programming course.

Write a peer-instruction question in which:

- You show part of a program.
- Then ask students to predict the output of the program
- Include 3-5 choices for the output

When to use Peer-instruction questions

Questions within the learning cycle



Adapted from From from "iClicker" by Stephanie Chasteen and the Science Education Initiative at the University of Colorado

Challenges and Best Practices

Challenges you might face

REPORTED CHALLENGES	RECOMMENDED STRATEGIES
The class is too quiet.	Be patient – students' reluctance to discuss improves after 3-4 iterations Do solo vote, allow enough time
The class is too noisy.	That's ok, this is good noise. Most students are seen to be on task.
Some students just may not participate.	Explain why you are doing this, use challenging & interesting questions, ... let them be
Students may not know how to reason.	This is not quite true provided questions are designed well
The class will get chaotic. How do I get students back?	Use a cue such as a bell

Best Practices

On Writing Questions

- Recommended – questions requiring conceptual reasoning (verbal, logical, diagrammatic)
- Avoid – questions involving number crunching (but can use PI to precede a numerical problem, for ex ...)
- Recommend – Mix it up.
 - WHY: different pedagogical goals : bringing out a misconception, predicting an outcome, recall point from last class
 - WHAT: different types of questions: survey, representations, reasoning, Y/N
 - WHEN: at a variety of points during class (beginning / middle / end)
- Avoid - questions that can be answered by memorization (unless that's your goal, then use sparingly).

Best Practices

On Facilitating Peer-Instruction

- DON'T SKIP ON PEER DISCUSSION (if single vote, only after group talk)
- FOCUS ON REASONING NOT ON RIGHT ANSWER.
 - Withhold judgment. Do not give 'rapid rewards' (nodding in assent)
 - Discuss reasons for *right* and *wrong* answers
 - Ask multiple students to give answers.
- TIME. Recommended 2-5 minutes per question.
- FREQUENCY. Recommended – a “few” per class, 2-4.
- CREDIT. **Do not** assign heavy credit for right / wrong answers. Some instructors (with clickers) assign a “whiff” of credit for participation.
- I like to circulate, listen to student reasoning, give individual attention

Important good practice – Applicable for all active learning strategies

GET STUDENT BUY-IN.

Create it by explaining why you are doing this.

Better still demonstrate why you are doing this.

Plenty of resources

- Peer-instruction How-tos, workshop slides, videos, research ...
Carl Wieman Science Education Institute
<http://www.cwsei.ubc.ca/resources/clickers.htm>
and host of links from within
- Instructors in many disciplines have posted peer-instruction questions for their courses – physics, CS, Statistics – use Google (search with varied nomenclature – PI, clickers, PRS)

BUT ...

- We need to create a library of questions for our courses, report experiences in our context.
Please participate!