Building Student Understanding through Effective Questioning

Presented by
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To question well is to teach well. In the skillful use of questions, more than anything else, lies the fine art of teaching.

Earnst Sachs
What are the purposes of teachers’ classroom questions?

* To develop interest and motivate students to become actively involved in lessons
* To evaluate students’ preparation and check on homework or seatwork completion
* To develop critical thinking skills and inquiring attitudes
* To review and summarize previous lessons
* To nurture insights by exposing new relationships
1. **Apply mathematics to problems** arising in everyday life, society and the workplace.

2. Use problem solving model that incorporates **analyzing** given information, **formulating** a plan or strategy, **determining** a solution, **justifying** the solution and **evaluating** the problem solving process.

3. **Select tools** such as real objects, manipulative, paper pencil and technology or techniques such as mental math, estimation and number sense to problems.

4. **Communicate mathematical ideas, reasoning** and their implications using symbols, diagrams, graphs and language.

5. **Create and use representations** to recognize, record and communicate mathematical ideas.

6. **Analyze** mathematical relationships to connect and communicate mathematical ideas.

7. **Display, explain or justify mathematical ideas or arguments** using **precise mathematical language** in written and oral communications.
What are the results of good questioning during teaching?

- Helps students to participate actively in lessons
- Provides an opportunity for students to express their ideas and thoughts
- Allows students to hear divergent opinions from peers.
- Draws attention and highlights important points in the lesson
- Helps develop confidence and feelings of success in students, leading them beyond the conventional patterns of thinking
Research shows classroom teachers spend anywhere from 35% to 50% of their instructional time conducting questioning sessions.

Kathleen Cotton. “Classroom Questioning.” North West Regional Educational Laboratory.
What is the BEST question you have asked in your classroom?
The Art of Questioning in Mathematics
NCTM Professional Standards
The Art of Questioning in Mathematics

NCTM Professional Standards

Help students work together to make sense of mathematics

Help students rely more on themselves to determine whether something is mathematically correct

Help students learn to reason mathematically

Help students learn to conjecture, invent, and solve problems

Help students to connect mathematics, its ideas, and its applications
What Types of Questions do we ask?

1. Factual questions are used to get information from the students and often test rote memory. Example: “What is ____?”

2. Clarification questions intend to provide clarity to both students and teachers. Such questions have important clueing effects and help students to revisit their earlier statements with alternative perspectives. Example: “What do you mean by ..?” “Can you give me an example?” “Can you rephrase what you have just said?”
3. Broadening / Extension questions can be useful in opening up further possibilities. Such questions can be used to assess additional knowledge of the students.

Example: “Do you know any other situation where this can be applied?”

4. Justifying questions probe for assumptions and explore reasons for particular answers. These questions require significant comprehension and reasoning skills on the part of the students.

Example: “You mentioned ___. What are your reasons?”
5. Hypothetical questions are used to explore students’ understanding of complex situations beyond the scope of a particular encounter by creating hypothetical scenarios.
Example: "Suppose this happened. How would you revise or rearrange ___?"

6. Questions about questions probe for reasons for the question that students ask other students or teachers.
Example: “You asked ___. Why did you ask that particular question? What are you thinking of?”
### Video: Types of Questions

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<th>Factual</th>
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<td>Clarification</td>
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During questioning

<table>
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<th>Use less of:</th>
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**Remembering**: can the student recall or remember the information?

**Understanding**: can the student explain ideas or concepts?

**Applying**: can the student use the information in a new way?

**Analyzing**: can the student distinguish between the different parts?

**Evaluating**: can the student justify a stand or decision?

**Creating**: can the student create new product or point of view?
While questions which elicit lower level thinking are an important part of teaching, they are useless unless they build toward questions which help kids develop higher order thinking skills.

Benjamin Bloom
Mr. Garza has three kinds of animals on his farm. He has 6 dogs. He has twice as many cows as dogs. He has 3 times as many sheep as cows. How many sheep does Mr. Garza have on his farm?
Wait Time

Some call it laziness.
I call it deep thought.

Garfield
What are the Benefits of Silence?

For the students
- More meaningful answers
- Improved accuracy
- Improved length
- Fewer ‘no answers’

For the teachers
- Higher order questions
- Precise formulation of questions
- Varied and flexible questions
- Convey teachers’ attentiveness
What can we ask when students fail to answer any question?

- Is the question clear to you?
- Do you want me to rephrase the question?
- Which part of the question did you not understand?
- Is the question too difficult for you?
What should teachers do when a student's response is incorrect?

- Provide the opportunity for revisions by not responding immediately, thus allowing the student time to come up with another answer.
- Ask subsequent questions in a manner that contains clues to the first question leading the student to the correct answer.
What should teachers do when a student's response is incorrect?

- Re-frame the question so that the wrong answer becomes correct.
- Treat the wrong answer as plausible but in need of further elaboration and consideration.
- Declare perplexity over the response, i.e. "Tell us more."
**Question Cycle**

1. Ask the question
2. Period of silence
3. (No response)
4. Simplify the question
5. Students answer
6. Period of silence
7. Discuss the answer
A prudent question is one-half of wisdom.

Francis Bacon
1. Revoicing
   “So you’re saying that it’s an odd number?

2. Restate someone else’s reasoning
   “Can you repeat what Joe just said in your own words?”

3. Apply their own reasoning to someone else’s reasoning.
   “Do you agree or disagree? Why?”

4. Prompt students for further participation
   “Would someone like to add on?”

5. Use Wait Time
   “Take your time. We’ll wait”

Classroom Discussions: Using Math Talk to Help Students Learn
Chapin, O’Connor, Anderson
Strategically timing when to ask specific questions

**Before** beginning a new unit: discover and honor what students already know and to create excitement about what is coming next.

**During** learning: encourage students to engage with one another, which can lead to more questions

**End** of a class period: help students synthesize what they have learned

*The Curious Classroom: Answers About Questions*

*Catherine Rubin*
Teaching Children Mathematics

Focus Issue: The Value of “WHY?”

Bees have 4 wings, and flies have 2 wings. There are some bees and some flies in a room. There are 24 wings in all. How many bees and flies could there be?

Do you have all the combinations? How do you know?
I count by 2s
There are 5 bees and 2 flies.

No, because there could be more flies or more bees.
(a) flies and bees

flies wings
8 8
6 flies 9 bees
12 + 12 = 24

Reduce flies by 2, and add 1 bee

(b)

5 bees 2 flies

\[
\begin{align*}
4 & \quad y & \quad 2 \\
10 & \downarrow & \downarrow
\end{align*}
\]

Yes

| 6 bees | 0 flies |
| 5 bees | 2 flies |
| 4 bees | 4 flies |
| 3 bees | 6 flies |
| 2 bees | 8 flies |
| 1 bee | 10 flies |
Maricella buys 75 tickets at a carnival. She keeps 35 tickets for herself and gives the remaining tickets to her 2 sisters. If each of Maricella’s sisters gets the same number of tickets, how many tickets does each sister get?
Open Questions

The answer is 5. What is the question?

Why is 0 a special number?
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1860 edition of Barnard’s
American Journal of Instruction