Who’s Asking the Questions in Math Class?
Strategies for Inspiring and Cultivating Students’ Curiosity

Tim Hudson, PhD
Chief Learning Officer
timh@dreambox.com
@DocHudsonMath

Mission
The Mission of the Parkway School District is to ensure all students are capable, curious, and confident learners who understand & respond to the challenges of an ever-changing world.

Questions from the Community
- Can curiosity be measured? If so, how?
- Can we really guarantee all students are curious learners?
- Can you make someone a curious learner? If so, how?
- Can you cause someone to be a non-curious learner? If so, how?
- Is there a difference between a curious person and a curious learner?
- Under what conditions is curiosity best cultivated?
- Others?

Problems to Solve
My students aren’t curious in math. They just wait for me to show them what to do.
Who’s Asking the Questions in Math Class?
Strategies for Inspiring and Cultivating Students’ Curiosity

Plan “Backwards”
1. Identify desired results
2. Determine acceptable evidence
3. Plan learning experiences & instruction

Plan Backwards for Curiosity
1. What does a curious learner look like?
2. What is acceptable evidence of curiosity?
3. What classroom practices cultivate curious learners?

Math Program Design
1. Define Goals & Clarify Outcomes
2. Design Reports with Meaningful Feedback
3. Develop Assessments & Grading System
4. Ensure Print & Digital Resource Alignment
Who's Asking the Questions in Math Class?
Strategies for Inspiring and Cultivating Students' Curiosity

Tim Hudson, Chief Learning Officer, DreamBox Learning
timh@dreambox.com  @DocHudsonMath

Defining Curiosity Outcomes

<table>
<thead>
<tr>
<th>Curiosity</th>
<th>Lack of Curiosity</th>
</tr>
</thead>
</table>

This study, a child is said to be curious when he (a) reacts positively to new, strange, incongruous, or mysterious elements in his environment, (b) exhibits a need to know more about himself and his environment, (c) sees his surroundings seeking new experiences, and (d) persists in examining and exploring stimuli in order to know more about them.

WALLACE W. MAY AND ETHEL W. MAY

THE MEASUREMENT OF A SCIENTIFIC ATTITUDE—CURIOSITY

R.J. Flagg and A.A. Helman

NCTM Annual, April 27, 2018, Washington DC
Who’s Asking the Questions in Math Class?  
Strategies for Inspiring and Cultivating Students’ Curiosity

Learning Outcomes: A-M-T

Do you want students to be able to...

Do our students know we want all of these outcomes?

If they’re excited by PhotoMath…

NCTM Annual, April 27, 2018, Washington DC
Who’s Asking the Questions in Math Class?
Strategies for Inspiring and Cultivating Students’ Curiosity

Tim Hudson, Chief Learning Officer, DreamBox Learning

timh@dreambox.com  @DocHudsonMath

Do our students know we want them to be curious?
Who’s Asking the Questions in Math Class?
Strategies for Inspiring and Cultivating Students’ Curiosity

If it’s an outcome we want, we MUST assess it and report progress to students and parents.

Otherwise, we can’t know if students achieved it. And why even bother to pretend we teach it?

Math Program Design

- Define Goals & Clarify Outcomes
- Design Reports with Meaningful Feedback
- Develop Assessments & Grading System
- Ensure Print & Digital Resource Alignment

B Track
Honors & A Track

not grab a pencil or calculator to solve 13 x 12?

grab a pencil or calculator for 3,998 + 4,247?

know which measure is best for the situation?

know their 12 x 12 “facts?”

know 8 + 7?

compute mean, median, and mode?

If it’s an outcome we want, we MUST assess it and report progress to students and parents.

Otherwise, we can’t know if students achieved it. And why even bother to pretend we teach it?

How to Measure Anything, D.W. Hubbard

1. If it matters at all, it is detectable or observable
2. If it is detectable, it can be detected as an amount (or a range of possible amounts)
3. If it can be detected as a range of possible amounts, it is measurable
1. Learning: From Speculation to Science
2. How Experts Differ from Novices
3. Learning and Transfer
4. How Children Learn
5. Mind and Brain

For any outcome you want for your students, you can build a Novice-Expert rubric for it.

What Term-Long Rubrics Communicate

A Rubric for Thought

NCTM Annual, April 27, 2018, Washington DC
**Who’s Asking the Questions in Math Class?**
Strategies for Inspiring and Cultivating Students’ Curiosity

---

**Inquiry Rubric**

<table>
<thead>
<tr>
<th>Expert</th>
<th>Practitioner</th>
<th>Developing</th>
<th>Novice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can formulate questions and seek answers independently, generates tests, and refines hypotheses according to well-formulated criteria; uses evidence powerfully and persuasively; foresees and responds to counterarguments.</td>
<td>Looks for and uses questions to guide investigation; uses criteria to generate hypotheses; uses evidence effectively, but may fail to fully address counterarguments.</td>
<td>Fails to look for questions to guide investigation; generates hypotheses rashly; fails to use evidence to substantiate claims.</td>
<td></td>
</tr>
</tbody>
</table>

---

**Transfer: Measures of Central Tendency**

<table>
<thead>
<tr>
<th>Expert</th>
<th>Proficient</th>
<th>Developing</th>
<th>Novice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply new and unfamiliar statistical measures (or invent new ones) to make predictions and draw conclusions.</td>
<td>Justify the most appropriate statistical measures of center to make predictions and draw conclusions.</td>
<td>Compute mean, median, mode, and range given a data set.</td>
<td></td>
</tr>
</tbody>
</table>

---

**Problem Solving Rubric**

<table>
<thead>
<tr>
<th>Expert</th>
<th>Practitioner</th>
<th>Developing</th>
<th>Novice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is constantly looking for and posing relevant questions.</td>
<td>Understands there is more than one way to attack a problem</td>
<td>Accepts problems on their own terms (e.g., rarely restates them to make them more meaningful);</td>
<td>Avoids difficult problems &amp; rarely questions ideas</td>
</tr>
<tr>
<td>Experiments with a variety of solutions and perspectives</td>
<td>Surveys own understanding to determine progress toward solution</td>
<td>Often generates only one or two obvious solutions</td>
<td>Looks for convenient solutions</td>
</tr>
</tbody>
</table>

---

**Teaching What Matters Most by Strong, Silver, and Perini. © 2001, p. 58**

---

**Transfer: Measures of Center Tendency (MO State Standard)**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Expert</th>
<th>Proficient</th>
<th>Developing</th>
<th>Novice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Represent (Creating Mathematical Models)</td>
<td>Represent quantities that both increase and decrease (e.g., area as a function of height).</td>
<td>Represent a function as a graph.</td>
<td>Represent the domain and range of a given function.</td>
<td></td>
</tr>
<tr>
<td>2. Identify (Choosing Mathematical Models)</td>
<td>Identify the relationship between two quantities in a table.</td>
<td>Identify the relationship between two quantities in a graph.</td>
<td>Identify the relationship between two quantities in a situation.</td>
<td></td>
</tr>
</tbody>
</table>

---

**Problem Solving Rubric (rev. 10/11)**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Expert</th>
<th>Proficient</th>
<th>Developing</th>
<th>Novice</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2A</td>
<td>Flag a table or graph, identify a variable, and find a pattern.</td>
<td>Given a table, graph, or equation, generate and justify the type of function.</td>
<td>Given a table, graph, or equation, generate and justify the type of function.</td>
<td></td>
</tr>
<tr>
<td>A1C</td>
<td>Determine the domain and range of a given function.</td>
<td>Determine the domain and range of a given function.</td>
<td>Determine the domain and range of a given function.</td>
<td></td>
</tr>
<tr>
<td>A1D</td>
<td>Translate an equation into a graph.</td>
<td>Translate an equation into a graph.</td>
<td>Translate an equation into a graph.</td>
<td></td>
</tr>
</tbody>
</table>

---

**Teaching What Matters Most by Strong, Silver, and Perini. © 2001, p. 58**

---

**Problem Solving Rubric**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Expert</th>
<th>Proficient</th>
<th>Developing</th>
<th>Novice</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2A</td>
<td>Flag a table or graph, identify a variable, and find a pattern.</td>
<td>Given a table, graph, or equation, generate and justify the type of function.</td>
<td>Given a table, graph, or equation, generate and justify the type of function.</td>
<td></td>
</tr>
<tr>
<td>A1C</td>
<td>Determine the domain and range of a given function.</td>
<td>Determine the domain and range of a given function.</td>
<td>Determine the domain and range of a given function.</td>
<td></td>
</tr>
<tr>
<td>A1D</td>
<td>Translate an equation into a graph.</td>
<td>Translate an equation into a graph.</td>
<td>Translate an equation into a graph.</td>
<td></td>
</tr>
</tbody>
</table>

---

**Teaching What Matters Most by Strong, Silver, and Perini. © 2001, p. 58**

---

**Problem Solving Rubric**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Expert</th>
<th>Proficient</th>
<th>Developing</th>
<th>Novice</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2A</td>
<td>Flag a table or graph, identify a variable, and find a pattern.</td>
<td>Given a table, graph, or equation, generate and justify the type of function.</td>
<td>Given a table, graph, or equation, generate and justify the type of function.</td>
<td></td>
</tr>
<tr>
<td>A1C</td>
<td>Determine the domain and range of a given function.</td>
<td>Determine the domain and range of a given function.</td>
<td>Determine the domain and range of a given function.</td>
<td></td>
</tr>
<tr>
<td>A1D</td>
<td>Translate an equation into a graph.</td>
<td>Translate an equation into a graph.</td>
<td>Translate an equation into a graph.</td>
<td></td>
</tr>
</tbody>
</table>

---

**Teaching What Matters Most by Strong, Silver, and Perini. © 2001, p. 58**

---

**Tim Hudson, Chief Learning Officer, DreamBox Learning**

timh@dreambox.com  @DocHudsonMath
**Who’s Asking the Questions in Math Class?**
Strategies for Inspiring and Cultivating Students’ Curiosity

Tim Hudson, Chief Learning Officer, DreamBox Learning
timh@dreambox.com  @DocHudsonMath

---

**Transfer: Curious Learners (Questioning)**

<table>
<thead>
<tr>
<th>Expert</th>
<th>Proficient</th>
<th>Developing</th>
<th>Novice</th>
</tr>
</thead>
<tbody>
<tr>
<td>I continually ask insightful questions both inside and outside of class that extend the conversation and learning into new areas.</td>
<td>I ask questions before, during, and after class that are relevant to the current conversation and lesson. I’m not complacent with just simple answers.</td>
<td>I ask unrelated questions or just ask for facts. I ask questions only when prompted, and only think about problems someone else tells me about.</td>
<td>I ask few, if any, questions either before or after being presented with information.</td>
</tr>
</tbody>
</table>

---

**Transfer: Curious Learners (Skepticism)**

<table>
<thead>
<tr>
<th>Expert</th>
<th>Proficient</th>
<th>Developing</th>
<th>Novice</th>
</tr>
</thead>
<tbody>
<tr>
<td>When presented with questions, I question the underlying assumptions and perspective of the questioner to find deeper meaning.</td>
<td>When I am presented with a problem or new information, I ask questions to determine its meaning and begin reasoning to assess validity and credibility.</td>
<td>I often trust what I hear or read, but if something sounds really weird, I ask questions to learn more.</td>
<td>I immediately accept what is presented. I want an easy answer or method, so I can mindlessly use it forever.</td>
</tr>
</tbody>
</table>

---

**Transfer: Curious Learners (Mindset)**

<table>
<thead>
<tr>
<th>Expert</th>
<th>Proficient</th>
<th>Developing</th>
<th>Novice</th>
</tr>
</thead>
<tbody>
<tr>
<td>I’d rather try something on my own first, because even through failure I’ll learn something that I couldn’t understand and learn any other way.</td>
<td>When I’m presented with a challenge, I usually keep at it until I solve it. I don’t care if I’m wrong, fail, or make a mistake. These experiences only improve my understanding.</td>
<td>If I’m not successful after one or two tries, I stop trying. I might try again if someone else encourages me.</td>
<td>If I’m not familiar with something, I don’t try. I avoid mistakes or doing things wrong.</td>
</tr>
</tbody>
</table>

---

**Curiosity Progress Report**

<table>
<thead>
<tr>
<th>6-week</th>
<th>12-week</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebra 1</td>
<td>Novice</td>
<td>Novice</td>
</tr>
<tr>
<td>Modern American History</td>
<td>Novice</td>
<td>Expert</td>
</tr>
<tr>
<td>Biology</td>
<td>Expert</td>
<td>Proficient</td>
</tr>
<tr>
<td>Orchestra</td>
<td>Proficient</td>
<td>Proficient</td>
</tr>
<tr>
<td>Physical Education</td>
<td>Novice</td>
<td>Novice</td>
</tr>
<tr>
<td>Honors English 1</td>
<td>Proficient</td>
<td>Proficient</td>
</tr>
<tr>
<td>Introduction to Business</td>
<td>Expert</td>
<td>Expert</td>
</tr>
</tbody>
</table>
Who’s Asking the Questions in Math Class?
Strategies for Inspiring and Cultivating Students’ Curiosity

Tim Hudson, Chief Learning Officer, DreamBox Learning
timh@dreambox.com  @DocHudsonMath

Change the assessment and reporting system and you change the conversation with students, teachers, and parents.

Math Program Design
- Define Goals & Clarify Outcomes
- Design Reports with Meaningful Feedback
- Develop Assessments & Grading System
- Ensure Print & Digital Resource Alignment

Assessing Questions
East High School has been recording the number of 12th graders who drop out of school before earning a diploma. The principal of East High School has asked you to help her reduce the number of students who drop out of school. She gives you the data table:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Seniors who Dropped Out</td>
<td>21</td>
<td>24</td>
<td>25</td>
<td>48</td>
<td>24</td>
<td>27</td>
<td>26</td>
<td>28</td>
<td>32</td>
<td>30</td>
</tr>
</tbody>
</table>

1. Write two questions you would ask the principal at East High School about these dropout data.

Questioning Data
Who's Asking the Questions in Math Class?  
Strategies for Inspiring and Cultivating Students’ Curiosity

Math Program Design
- Define Goals & Clarify Outcomes
- Design Reports with Meaningful Feedback
- Develop Assessments & Grading System
- Ensure Print & Digital Resource Alignment

Plan “Backwards” for Greatness
1. Identify desired results
2. Determine acceptable evidence
3. Plan learning experiences & instruction

in-struc-tion  
noun
1. the act or practice of instructing or teaching; education.
2. knowledge or information imparted.
3. an item of such knowledge or information.
4. Usually, instructions; orders or directions. The instructions are on the back of the box.
5. furnishing with authoritative directions.
6. a command given to a computer to carry out a particular operation.

Daniel Schwartz on 'telling too soon'

NCTM Annual, April 27, 2018, Washington DC
“It is little short of a miracle that modern methods of instruction have not completely strangled the holy curiosity of inquiry.”

– Albert Einstein

“Getting into the brain is like getting into an exclusive nightclub where only the glamorous few are selected. Once inside, another gatekeeper, stress, determines what makes the cut to enter the upper VIP lounge in the prefrontal cortex - that valuable 13% of cerebral architecture where our highest cognition and emotional reflection takes place.”

www.psychologytoday.com

“The system that determines what gets in – what the brain attends to – is the Reticular Activating System (RAS). When not under high stress alert, the RAS is particularly receptive to novelty and change that arouse curiosity. That is the key to the gate - the brain seeks input about the new, the unexpected, the colorful, musical, moving, aromatic sensations that are available when perceived or imagined threat is not blocking the way.”

www.psychologytoday.com

“The brain actually learns based on a system of predictions and feedback as neuroplasticity strengthens neural networks used to make correct predictions and corrects memory networks used to make incorrect predictions. (This is why feedback is important so those faulty circuits can be replaced with accurate information.)”

www.psychologytoday.com
Who’s Asking the Questions in Math Class?
Strategies for Inspiring and Cultivating Students’ Curiosity

Have children make PREDICTIONS.
- written down
- shared with a partner
- held up on individual white boards at any point
- don’t break the curiosity with a "yes" or "no"
- respond with a nod of acknowledgment or a "thank you" so other students continue to predict.

What is a “Learning Experience?”

Dewey, 1916
“Thinking is the method of an educative experience.”

Genuine Situation
Genuine Problem Develops
Seek information, Make observations
Solutions OCCUR to her
Opportunity to Test Ideas

Classroom Learning Experience

4 Kids 3 Subs 8 Kids 7 Subs
5 Kids 4 Subs 5 Kids 3 Subs
Who’s Asking the Questions in Math Class?
Strategies for Inspiring and Cultivating Students’ Curiosity

Tim Hudson, Chief Learning Officer, DreamBox Learning
timh@dreambox.com  @DocHudsonMath

Learning is not accomplished by putting thoughts into a mind, but rather by empowering a mind to generate thoughts.

Digital Learning Experience

Audience Engagement Audit
Contrived Problem Dullis Though
Mathematical Problem
Genuine Problem Stimulates Though

—

Thank you
Tim Hudson, PhD
Chief Learning Officer
timh@dreambox.com  @DocHudsonMath