Welcome!
Please pick a sheet and start playing while you wait!
Teaching Math through Inquiry

ANN WALTERS * MATH COORDINATOR
* @SEEANNG033 *
Agenda for the Workshop

Best way to learn about inquiry.... Is through inquiry!

1) What is inquiry?
2) Math tasks
3) Purposeful Questioning
4) Collaborative learning
5) Reflection

Take risks! Have fun!
Benefits of Inquiry Based Learning

- IBL increases students' achievement in math and sciences (European Commission, 2007).
- IBL supports learning with understanding, which leads to greater transference of skills (Walker, 2007).
- IBL promotes higher order thinking skills, development of core competencies, and wide range of complementary skills (PRIMAS, 2013).
- IBL may be effective in increasing girls interest, participation and self-confidence in math and science (European Commission, 2007).
What is Inquiry Based Learning (IBL)?
## Transmission vs. Inquiry approach

<table>
<thead>
<tr>
<th>Predominance of old orientation (non inquiry-oriented)</th>
<th>Predominance of new orientation (inquiry-oriented)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teacher role:</strong></td>
<td></td>
</tr>
<tr>
<td>As dispenser of knowledge:</td>
<td>As coach and facilitator:</td>
</tr>
<tr>
<td>Transmits information</td>
<td>Helps students process information</td>
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<tr>
<td>Communicates with individuals</td>
<td>Communicates with groups</td>
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<tr>
<td>Directs students actions</td>
<td>Coaches students actions</td>
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<tr>
<td>Explains conceptual relationships</td>
<td>Facilitates students thinking</td>
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<tr>
<td>Teachers knowledge is static</td>
<td>Models the learning process</td>
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<tr>
<td>Directed use of textbook, etc.</td>
<td>Flexible use of materials</td>
</tr>
<tr>
<td><strong>Student role:</strong></td>
<td></td>
</tr>
<tr>
<td>As passive receiver:</td>
<td>As self-directed learner:</td>
</tr>
<tr>
<td>Records teacher’s information</td>
<td>Processes information</td>
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<tr>
<td>Memorizes information</td>
<td>Interprets, explains, hypothesizes</td>
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<tr>
<td>Follows teacher directions</td>
<td>Designs own activities</td>
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<tr>
<td>Defers to teacher as authority</td>
<td>Shares authority for answers</td>
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<tr>
<td><strong>Student work:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Teacher-prescribed activities:</strong></td>
<td><strong>Student-directed learning:</strong></td>
</tr>
<tr>
<td>Completes worksheets</td>
<td>Directs own learning</td>
</tr>
<tr>
<td>All students complete same tasks</td>
<td>Tasks vary among students</td>
</tr>
<tr>
<td>Teacher directs tasks</td>
<td>Design and direct own tasks</td>
</tr>
<tr>
<td>Absence of items on right</td>
<td>Emphasizes reasoning, solving problems, building from existing cognitive structures, and explaining complex problems</td>
</tr>
</tbody>
</table>

Anderson (2002, p. 5)
**Inquiry is....**

A process!

An inductive, collaborative, student-centered approach!

A way of teaching and learning that more accurately mimics the real-world!

Involves the 8 standards for mathematical practice!
What does TMI look like in a classroom?

Three parts to the lesson:

A. **Teacher presents a task**: a problem, a situation, a prompt or a question.

B. **Small group work**: students engage in a collaborative activity in their attempt to unravel the task.

C. **Group share**: students present their work, providing explanations, questioning ideas, and justifying conclusions.

Four Features to keep in mind: math tasks, purposeful questioning, collaborative learning, student agency.
Math Tasks
Inquiry-based tasks

1) Open tasks
2) Unstructured tasks
3) Problems of the week
4) Provocations
5) Real-world problems
6) Talking points
7) Number talks
8) 3-act tasks
9) Always, sometimes, never
10) Looking at mistakes
Open Tasks

Encourage multiple methods, pathways and representations.

Benefits

- Require a high level of cognitive demand
- Foster a growth mindset
- Allow for multiple strategies
- Help students see that math is multi-faceted and that there is more than one way to solve a problem

**Leo the Rabbit**

Leo the Rabbit is climbing up a flight of 10 steps. Leo can only hop up 1 or 2 steps each time he hops. He never hops down, only up. How many different ways can Leo hop up the flight of 10 steps? Provide evidence to justify your thinking.
Unstructured Tasks

Make your structured tasks unstructured!

Encourage:
- Collaboration
- Student Agency
- A productive struggle

Teacher role:
- Make time
- Effective questioning
- Scaffold
- Create a supportive environment

Source: 2008 Bowlands Charitable Trust
Unstructured Tasks

Designing a box for 18 sweets

You work for a design company and have been asked to design a box that will hold 18 sweets.
Each sweet is 2 cm in diameter and 1 cm thick.
The box must be made from a single sheet of A4 card with as little cutting as possible.

Compare two possible designs for the box and say which is best and why.

Make your box.

Source: 2008 Bowlands Charitable Trust
Provocation

A provocation will provoke thinking!

It Can be:

...a picture
...an experience
...a thing

What math do you see?

Problem Pictures
How could you provoke your students’ thinking?

Visit the provocations around the room, what math does it provoke?
Problem of the Week

Problem-solving is the new basic skill!

- Scenario, not a problem
- Authentic
- Low-floor, high-ceiling
- Come with extensions
- Many strategies

NCTM's Math Forum

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The Math Forum’s Problems of the Week Scenario

**Crossing the River with Ogres**

Six ogres and two gnomes set out on an expedition. They came to a river they wanted to cross.

They found a small boat tied to a tree. It could carry two gnomes or one ogre. The boat must always be rowed by someone.
Real-world problems

Authentic.

Interesting.

Engaging.

Unstructured.

Child-directed.

Nigeria’s plastic bottle house
Talking Points: How To

Round 1: One person at a time.
- Read the statement aloud
- Say if you agree, disagree or are unsure
- Explain your reasoning

Round 2:
- Go back around
- Say if you still agree, disagree or are unsure
- Explain reasoning only if you changed your mind
Talking Points

Student-centered.

Safe-zone for mistake-makers.

Allows for everyone to be heard.

Develops curricular competencies.

Encourages 8 practices.

2+2+2+2=8 is an example of multiplication.
Number Talks

**Purposeful conversations.**

Designed to elicit specific strategies.

Elements of a good talk:

- Classroom environment
- Classroom discussions
- The teacher’s role
- Purposeful problems

Source: https://mathbeforebed.com/
Looking at Mistakes

Mistakes grow your brain!

“Research shows that teaching can be more effective when mistakes and misconceptions are revealed and discussed”
Swan, 2006

- Dear Abby Letters
- Mistake of the week board
- Check your work
Purposeful Questioning
Guidance for questioning

A. Plan to use questions that encourage thinking and reasoning.
B. Ask questions in ways that include everyone.
C. Give students time to think.
D. Avoid judging students responses.
E. Follow up responses in ways that encourage deeper thinking.

Try to think ahead...where will your students get stuck...what can you ask?
The Chicken Run Problem

What questions could you ask to help scaffold the students’ understanding of this problem?

Source: Bowland Charitable Trust, 2008
Discussion Questions

- What different types of questions do Mark and Amy use?
- What different functions do their questions serve?
- What kind of discussion have their questions stimulated?
- Which of these types of questions do you usually use? Why?
- What mistakes do teachers tend to make when asking questions?
Quick Tips for questioning

A. Use a no-hands up rule to allow everyone thinking time.

B. Avoid teacher-student ping-pong! Instead T-S1-S2 -T.

C. Use think-pair-share and consider leaving it at that!

D. Don’t label responses as good, yes, nearly…and definitely not bad!

E. Encourage students to elaborate, question, speculate, make connections.
Collaborative Learning
3 Act Tasks

Act One:
- motivates the student.

Act Two:
- Provide background knowledge needed to solve the problem.

Act Three:
- the big reveal!

Source: RoundRock Independent School District 3 Act Tasks
Act Two

What information might help you solve the problem?

- There are 81 bulbs per streamer.
- There are 75 bulbs per star.

Source: RoundRock Independent School District 3 Act Tasks
Act Three

ZILKER HOLIDAY TREE

Facts and History
The Zilker Tree stands 155 feet tall and is composed of 39 streamers, each holding 81 multicolored, 25-watt bulbs - totaling 3,309 lights. At the top of the tree, a double star measures 10 feet from point to point. The double star displays 150 frosted bulbs. This unique spiral pattern of lights was created by City of Austin electricians. At its circumference, the tree measures 380 feet. The diameter is 120 feet. The base of the tree is made up of 19 utility poles, each 14 feet tall, arranged in a circle around the Moonlight Tower. On December 10, 1967, the first tree was lighted by Mayor Pro Tem Mrs. Emma Long. In subsequent years this honor has been awarded to the young winner of a city-wide tree art contest.

TOP CONTENT
★ Barton Springs Pool
★ Pools & Splash Pads
★ Zilker Metropolitan Park
★ Austin Nature & Science Center
★ Golf ATX

Source: https://austintexas.gov/zilkerholidaytree
Reflection Questions

1) Was it helpful for you to have some think time before you discussed it with a group?
2) How would you describe your role in the group?
3) Did each member assume a different role? Why do you think this happened?
4) Did you feel uncomfortable or threatened at any time? If so, why?
5) Did the discussion stay on task or wander?
6) How would the assigning of group roles have helped or hindered the experience?
How to have effective collaborative learning

Effective collaboration requires two things:

1) Group goals
2) Individual accountability.

Dylan Wiliam
Reflection
Goals for next week...

Pick one inquiry task that you **WILL** implement next week.

Write it down now and begin to plan!
Thank you!

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