Rich Problem Solving Tasks

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Rich
Problem Solving Tasks

ICTM ISTS Conference 2014
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1. Make sense of problems and persevere in solving
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.
Mathematics is like a video game;
If you just sit and watch,
you're wasting your quarter
(and semester).

Steve Benson
In under 2 minutes, can you think of any 4 odd numbers (including repeated numbers) that add up to 19?

(Ball 2005, p. 26)

ODD  +  ODD  =  EVEN
EVEN  +  EVEN  =  EVEN
ODD  +  EVEN  =  ODD
EVEN  +  ODD  =  ODD
Engaging Problems

Tell me and I'll forget;
Show me and I may not remember;
Involve me and I'll understand.

Native American Quote
Pattern Blocks

Given the three block patterns, identify how the pattern is growing from Case 1 to Case 3.

Represent this growth

How did you approach this?
Engage Students

* Put at pairs on whiteboards
  * Don’t have enough whiteboards, use the windows
* Hand-held whiteboards
* Foster discourse
“establish classroom contexts in which questioning and proving are the norm” (Hodgson & Riley, 2001, p. 728).

Adopt a “philosophy of getting them to ‘work it out for themselves’ in response to questions” (Benson & Findell, 2012, p. 2).
Let face cards = 10 and Aces = 1
Deal 25 cards face up off the top of the deck
Note the “lucky 7th card"
Place the 25 cards at the bottom of the deck
Deal 3 cards face up
Add the value of the three cards, let it be X
For each of the 3 cards, deal face down as many cards as it takes to get to 10
Put all 3 piles at the bottom of the deck
Deal X cards off the top of the deck, face up.
The X + 1 card, will be the “lucky 7th card"
Deal 25 cards face up off the top of the deck

Note the “lucky 7th card” 7

Place the 25 cards at the bottom of the deck 34

Deal 3 cards face up 31
**Why does this work?**

* Deal 3 cards face up
* Add the value of the three cards, let it be \( X \)
* For each of the 3 cards, deal face down as many cards as it takes to get to 10
* Put all 3 piles at the bottom of the deck

\[
31 - (10-a) - (10-b) - (10-c)
\]

\[
31 - 30 - (a + b + c)
\]

\[
1 - X
\]
Deal $X$ cards off the top of the deck, face up.

The $X + 1$ card, will be the “lucky 7th card”

- **Ann Halteman** Focus on Math Seminar, December 3, 2008
Ryan's Card Piles

* What does this introduce?
  * Patterns
  * Algebra
Teacher-Centered

- The sage on the stage
Student-Centered

* Guide on the Side, not the sage on the stage

* A Danger of Social Constructivism
Content-Centered

* Uses many of the same pedagogies as student-centered
What is the center of your classroom?

- Draw discourse arrows on your seating chart
- Are all questions directed to you?
- Do you repeat student questions?
- Do you present fully worked problems?
- Do you follow dead end suggestions?
The Teacher’s Role

- “Shifts from conveyer of information to one of moderator and observer of students’ thinking” (Maher & Martino, 1996, p. 197).

- Connects students to the mathematics and methods they need to solve problems.
THINK OF A NUMBER WITH TWO DIGITS. FOR EXAMPLE 43.
ONLY IN MATH PROBLEMS CAN YOU BUY GO CANTALOUPES AND NO ONE ASKS WHAT THE HELL IS WRONG WITH YOU.
Four Levels of Cognitive Demand

* Memorization
* Procedures Without Connections
* Procedures With Connections
* Doing Mathematics

* Stein, Smith, Henningsen, and Silver 2000, p. 16
Four Levels of Cognitive Demand

Memorization

* Reproducing a fact learned from memory
* Not ambiguous
* No connection to concepts or underlying meaning

2 + 7 =

Represent ¼ as a decimal and a fraction
A recipe to follow
Low cognitive demand
Little ambiguity
Focused on the answer, not the process

Davis wants to tile his rectangular room which is 8 feet by 10 feet. How many square feet of tile will he need to purchase?
Focus on the procedure to create deeper understanding

A path to follow may be suggested

Often multiple representations are used

Requires mental effort

Using base-ten blocks, show that .17 is less than .2

Jon lists his house with a realtor that takes a 4% commission. He owes $92,000 on his house. How much does Jon’s house need to sell for to cover his debt?
Complex thinking

No path or recipe to follow

Students need to access necessary knowledge

Cognitively demanding

In my bag of candy ½ of the pieces are red, 1/3 are blue, the remaining 21 are white. How many pieces are in the bag?
Four Levels of Cognitive Demand

- Memorization
- Procedures Without Connections
- Procedures With Connections
- Doing Mathematics

- How would you categorize what we’ve done?
  - 4 Odd Numbers
  - Pattern blocks
  - Ryan’s Card Piles
  - Magic Gopher
  - Wolfram Alpha
Four Levels of Cognitive Demand

- Memorization
- Procedures Without Connections
- Procedures With Connections
- Doing Mathematics

* Students who perform best on project-based problem solving were in classrooms in which tasks were implemented at high levels of cognitive demand
  Leutzinger, L. ICTM Journal, 2010

* Good teaching demands a blend of all four levels
Ideas from Dan Meyer

https://www.youtube.com/watch?v=BlvKWEvKSi8

* How much water do you use in the shower?
  * How long does it takes to fill up a gallon
  * Average amount of time spent in the shower
* Exploring surface area using cheese blocks of same volume but different surface areas
  * Which takes longest to melt in the microwave
* Using plastic cups... how many cups will you have to stack to be the height of your teacher
Ideas

* What could you do with newspapers
  * Work with place value
  * Purchase car
* Give students a large amount of frequent flier miles to plan a trip around Europe with.
  * What topics could you cover with this?
* What can you do with census data?

Kristin Kanaskie 2011 Fall ICTM Journal p. 4
Ideas

* Visit a creek
  * Estimate depth
  * Estimate water flow (Math’s Teacher, May 2012)

* A bag of oranges
  * Volume
  * Peel it to find surface area (Math’s Teacher, Oct. 2011)

* Stack oranges for space
Idea

* Turning everyday living activities into math
* Have students record, survey, analyze, and collect data:
  * number of texts send/received a day
  * hours of sleep
  * hours of T.V.
  * hours of favorite activity...
* Students can collect data in a journal and expand using graphs and calculations
Design a mini-golf course
Pull up Hy-Vee’s on-line add
Have students present a problem of the week
  * Google doc of problems
References

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