Spiraling Through the Curriculum with Activity-Based Learning

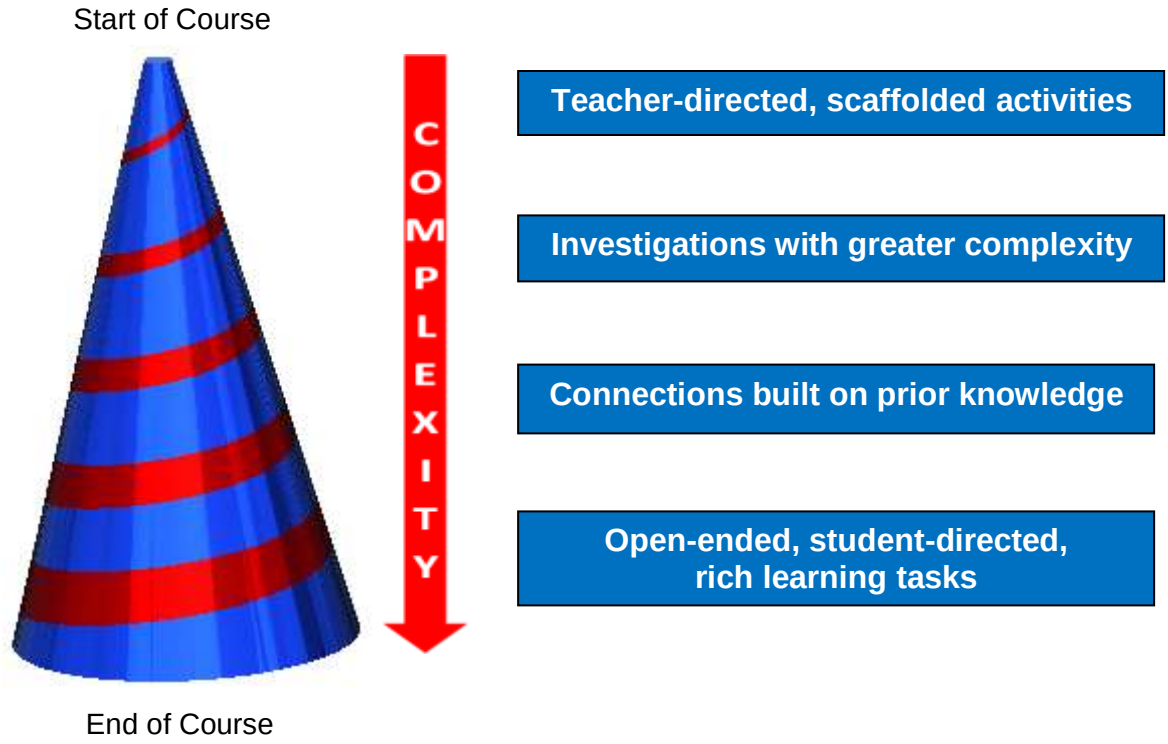
Alex Overwijk, Glebe Collegiate Institute, Ottawa-Carleton District School Board
Bruce McLaurin, Glebe Collegiate Institute, Ottawa-Carleton District School Board

Frustrated by the lack of engagement and understanding from our at-risk learners, we knew something had to change. We replaced unit-based teaching with activity-based learning. We created activities that meet students at their own level. We moved from covering the curriculum to uncovering the curriculum.

KEY IDEAS

- Learning through hands-on activities is a constant theme
- Activities often cover more than one overall expectation or strand
- Curriculum is spiraled or cycled. No more stand-alone units
- Students provide guesses with estimation to promote buy-in
- Skills are developed in the context of the activities
- Computational skills are taught on an as-needed basis
- Graphing calculators are assistive technology that allow at-risk students to access more complex concepts

SPIRALLING ACTIVITIES /TASKS



BENEFITS

- Spiralling creates repeated opportunities for gap-filling, reinforcement of concepts and assessment of learning
- Activities provide multiple entry points for all students
- Math concepts are explored through the context of the activity
- Increased student engagement
- Fewer discipline problems
- Collaborative learning environment
- Increase in accountable talk
- Increased student-awareness of overall expectations
- Improved exam results and retention of course material
- Natural opportunities for differentiated instruction
- Activities are high interest, hands on and "real"
- Increase opportunity for critical thinking
- More natural connections to the curriculum and within the curriculum
- Reduced time pressures to complete the course

WHAT IS NEXT?

Our most recent layer to activity-based learning is working with students to co-create the criteria for assessing mathematical processes. Students then self-assess their own work using the agreed upon criteria. This improves student ownership of their learning and allows students opportunities for meta-cognition. This process is in its early stages but initial results are promising.

SUMMARY

Spiralling the curriculum around activity-based learning has benefits that far outweigh the challenges. Feedback from our students has been positive and results have improved. As educators we have reignited the spark and found new passion for classroom teaching. Our four year journey continues as this approach which began in our applied level courses finds its way into our higher level academic courses. It's all about the journey.

We have included outlines of two of our activities that we have had success with.
For more information please go to SlamDunkMath.blogspot.ca or mclaurinseries.blogspot.ca

26 SQUARES

This is the introduction activity for the grade 10 Applied Math course in Ontario. This initial activity is more scaffolded and teacher directed. This activity introduces six of the nine overall expectations in this course and takes about three weeks to complete. Graphing calculators are introduced to: create scatter plots, calculate regressions, generate tables of values, find characteristics of functions and explore mathematical questions.

1) Students cut squares out of paper with side lengths 1 to 26 which are kept in an envelope.

2) Calculate the perimeter and area of each square to explore linear and quadratic relations. Examine meaning of 4 in $P = 4s$. Spend time calculating slope using different points for $P = 4s$. Handout on lines and parabolas (table of values, pattern in table (first and second differences) , graphing, equation without graphing calculator, regression with graphing calculator, solving linear equations)
Consolidate characteristics of lines and quadratics with various scenarios.

Lines	Quadratics
a) Banquet hall $200 plus $10 per person b) Taxi $4 plus $.25 per km c) Bank account $1000 withdraw $50 per week	a) Ball thrown from 5 m, max height after 2 seconds, lands after 5 seconds b) Bird dives from 16m enters water 2m , exits 4m from base of cliff

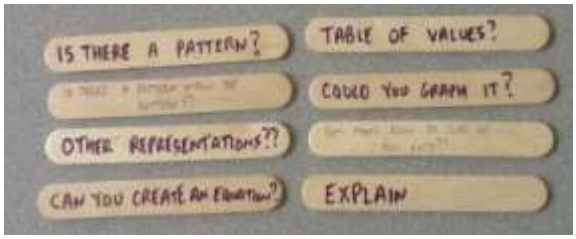
3) Play with squares to create shapes. (robots, etc.) Make something with 3 squares (wedding cake). Find a student who has made a triangle with the sides of the 3 squares. Use the concept of negative space if they need a prompt. Talk about different types of triangles and have students create them with the squares. Get all students to make one with an empty triangle in it. Randomly pick three out of the envelope and make a triangle –should lead to some not being able to- Triangle inequality $a + b > c$ with $a < b < c$. Ask them to find 3 squares that create a right triangle. Together make the connection that the areas of the two smaller squares equals the area of the biggest. We call this relationship `Sum of the Squares` (We never use `Pythagorean Theorem`). Have students find all possible combinations with squares side length 1 to 26. Consolidate with discussion and worksheet.
   Four families
   3-4-5, 6-8-10, 9-12-15,12-16-20, 15-20-25
   5-12-13, 10-24-26
   8-15-17
   7-24-25

4) Explore similar triangles by creating 3-4-5 triangle and one other triple from this family. Consolidate with discussion and worksheet.

5) Introduce trigonometry. Draw a 3-4-5 triangle on grid paper. Show relationship between areas of the squares. Measure the size of the angles with a protractor. Do the same for a 6-8-10. Ask about the angles in other members of the family? Angles in similar triangles? Would the angles in another family be the same? Investigate a different family. Explain opposite, adjacent and hypotenuse. Build a rudimentary trig table by measuring sides and angles. Introduce a formal trig table. Find the angle using a trig table without naming the trig ratios. Find a length given an angle and a length. Discussion and worksheet to consolidate.

CUP STACKING

This activity happens later in the course and is more open ended. Students take ownership of the problem by deciding on the question. Students invest a guess for their own stacking strategy.

<table>
<tr><th>Timing</th><th>Teacher Moves</th><td rowspan="2"> 
What's the question?</td></tr>
<tr><td>Before students arrive</td><td>Photo of Mr. Overwijk with cup on floor showing on the overhead
Desks grouped in 3's
Groups of 3 by ability-pre determined (variable depending on who shows up)-name tags on the desks
Scrap paper for students to generate a question or questions
Cups, chart paper, markers, rulers, meter sticks ready and waiting
Stems ready and waiting</td></tr>
<tr><td>As students arrive</td><td>Hand them a cup, and encourage them to find their name at a set of desks
After announcements ask students to write down any questions that come to mind when looking at the picture
Write questions on the board and settle on "How many cups to reach Mr. Overwijk's height"-hopefully</td><td></td></tr>
<tr><td>10 min</td><td colspan="2">Have each group decide how they will stack their cups and fill in Guess Sheet for Cup Stacks (too low, too high, best guess)
Ask them if they need any information to help answer the question? Provide the information or the tools to get the information.
Once they are committed they can grab 10 cups, ruler, chart paper, markers, graphing calculator, anything else they need</td></tr>
<tr><td>5 min</td><td colspan="2">Outline product for chart paper. Title, Group members names, diagram (picture) of stacking plan, different representations (table, graph, equation)
Calculation of number of cups needed (multiple ways if possible)  </td></tr>
<tr><td>20 min</td><td colspan="2">Monitor group work and discussions
Any groups that have generated a poster can redo the entire process with a new stacking plan 
Question stems on popsicle sticks</td></tr>
<tr><td>10 min</td><td colspan="2">Exit Card – What did you learn? What are you still wondering?</td></tr>
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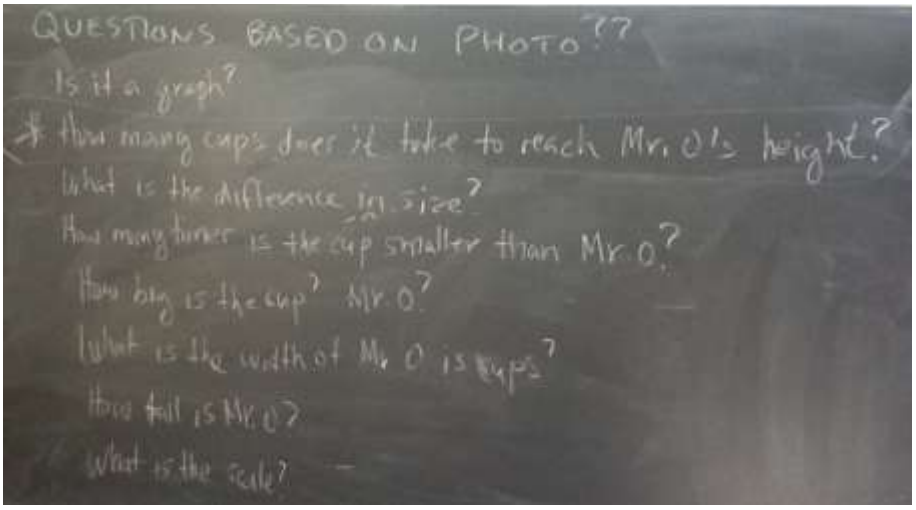
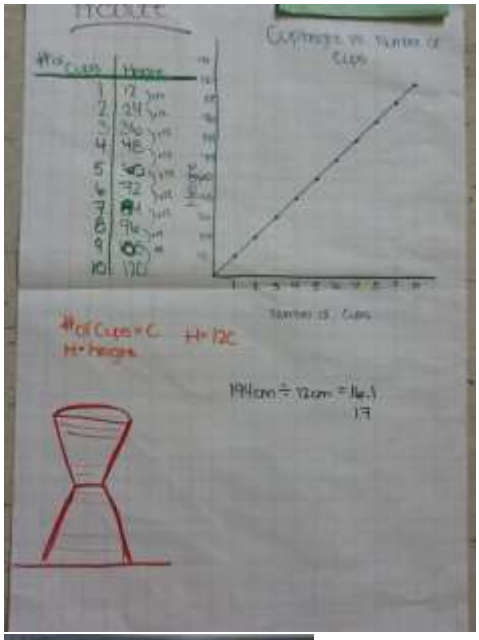
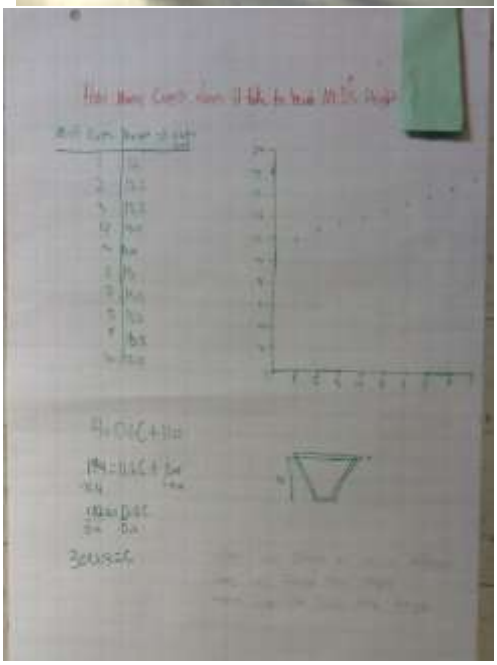


The follow-up activity is creating cup towers to test solutions.
Solutions include linear, quadratic and cubic relations.





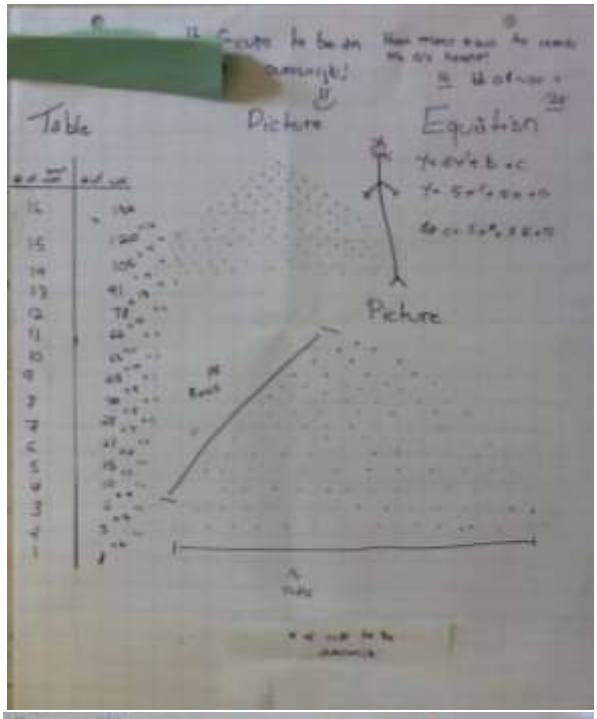
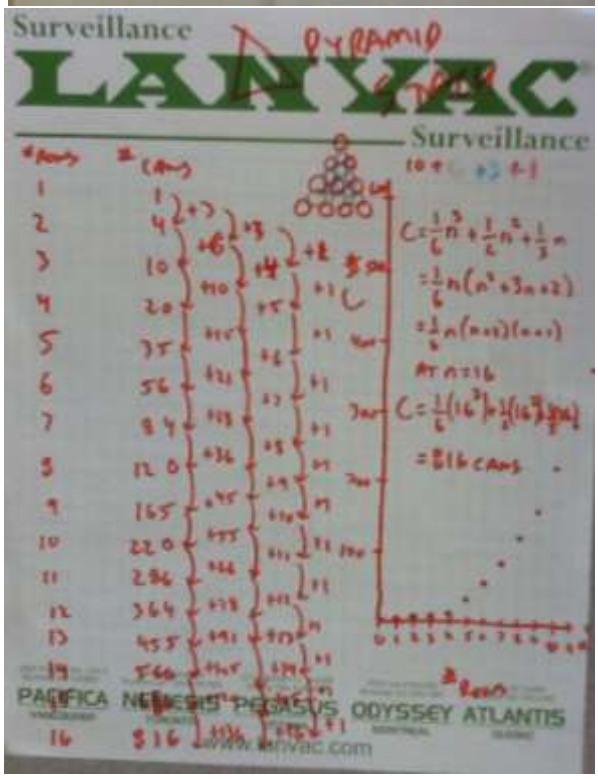


Table
Picture
Equation
Picture


Surveillance
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