Promoting algebraic thinking in the middle grades using spreadsheets.

Spreadsheets and algebra

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What is Algebra?

- Using and manipulating [algebraic] symbols
- Solving equations

Algebra Standard

Instructional programs from prekindergarten through grade 12 should enable all students to—

- Understand patterns, relations, and functions
- Represent and analyze mathematical situations and structures using algebraic symbols
- Use mathematical models to represent and understand quantitative relationships
- Analyze change in various contexts

Expectations for grades 6–8

Understand patterns, relations, and functions

- represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules;
- relate and compare different forms of representation for a relationship

Represent and analyze mathematical situations and structures using algebraic symbols

- develop an initial conceptual understanding of different uses of variables

Algebraic thinking

Algebraic thinking habits of mind:

- Building rules to represent functions
- Doing–Undoing
- Abstracting from computation
- Operations and structure

Functions and relations

Spreadsheets

- Dynamic nature
  - Ability to see immediate results of calculations
  - Ability to perform many operations at once (or the same operation over a range of values)
- Students seem to like spreadsheets!

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Spreadsheets

- A natural environment for the introduction of the concept of variable
- Students learn to be explicit about what they are doing:

  “Multiply by 3” vs “Multiply the number in A1 by 3”

Spreadsheets

- Spreadsheet applications haven’t changed much in many years
- There are versions for every kind of computer and operating system

Practical considerations

- Use a big size font!
- Plan in advance, adjust the software preferences accordingly.
- Make sure students have pencil and paper.

Hardy and Ramanujan

Once, in a taxi from London, Hardy noticed its number, 1729. He must have thought about it a little because he entered the room where Ramanujan lay in bed and, with scarcely a hello, blurted out his disappointment with it. It was, he declared, “rather a dull number,” adding that he hoped that wasn’t a bad omen. “No, Hardy,” said Ramanujan, “it is a very interesting number. It is the smallest number expressible as the sum of two cubes in two different ways.”

Guiding questions

- How does the rule work?
- Can I write a mechanical rule that will do this job once and for all?
- Now that I’ve found my rule, how do the numbers (parameters) in the equation relate to the problem context?

Difficulties of generalization

- Students may generalize too quickly
- Pattern spotting can remain trivial
- Students can generalize about the wrong properties
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**Justification**

- Students must give convincing arguments for the rules, to justify their generalizations.
- Many patterning activities are difficult to justify, and are not helpful to encourage students to build explicit rules from recursive relationships.

**Levels of sophistication in procedural thinking**

1. Students’ knowledge of a procedure is restricted to performing it
2. Students see a procedure as applicable to numerous instances rather than one particular case
3. Students can reflect on, decompose, and analyze a numerical procedure

**Guiding questions**

- How is this calculating situation like/unlike that one?
- When I do the same thing with different objects (numbers), what still holds true? What changes?

**Algebraic thinking**

Algebraic thinking habits of mind:

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- Abstracting from computation
- Doing–Undoing

Functions and relations
Operations and structure

**References**


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