What do we know about asking questions?

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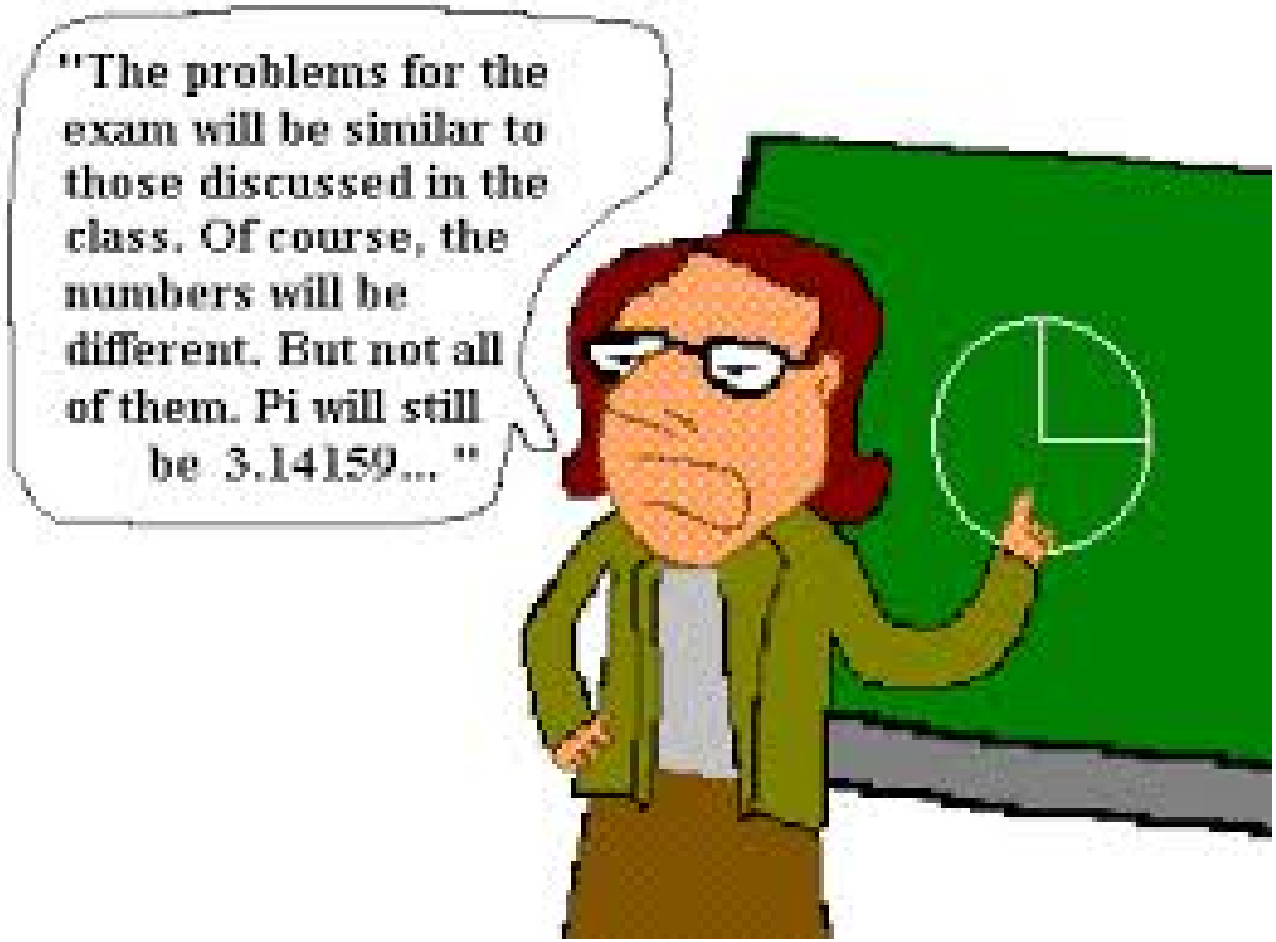
"The problems for the exam will be similar to those discussed in the class. Of course, the numbers will be different. But not all of them. Pi will still be 3.14159... "

Background:

From a project description 2009:

Many conversations about assessment stop at a decision about how much weight the final exam and the continuous assessment should carry. A better discussion includes a determination of the purpose of each assessment task - whether it is to be diagnostic, formative or summative. What really interests me is how as teachers we actually word and structure the individual assessment items we set, to elicit responses which indicate what kind of learning has taken place, and how we then assign marks or grades to them.

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Focus

- Mathematics and statistics
- Tertiary level
- ‘Traditional’ assessments, such as assignments, tests and exams

Rationale 1: These assessments are here to stay, so how can they be most effective?

Rationale 2: Observation: How I word a question can affect how well it is answered.

Rationale 3: There are analyses and meta-analyses of multiple choice testing, and guides for writing them.

When it comes to other question styles, in maths, there is no consolidated literature.

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Describing mathematical learning

- Skemp: instrumental, relational
- Schoenfeld: resources, heuristics, control, beliefs
- Tall: advanced mathematical thought versus advanced mathematical thinking
- Bloom's taxonomy http://www.celt.iastate.edu/teaching-resources/effective-practice/revised-blooms-taxonomy/

(Unashamed plug: Module 2 of the AustMS on-line unit *Effective teaching, Effective learning in the quantitative disciplines*)

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Perhaps less familiar

- SOLO (Biggs)
- MATH Taxonomy (Smith, Wood, Coupland et al 1996)

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Going SOLO

Structure of the Observed Learning Outcome

- Pre-structural
- Uni-structural
- Multi-structural
- Relational
- Extended abstract

Looks at the response that students make - but it is possible to write questions that do not invite or trigger responses at all levels.

Should an exam find out what students can do, or what they can't?

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Mathematical Assessment Task Hierarchy

Group A	Group B	Group C
Factual Knowledge	Information Transfer	Justifying, interpreting
Comprehension	Application (new situations)	Implications, conjectures, comparisons
Routine use of procedures		Evaluation

Context matters.

Styles of Questions

53 Ways to Ask Questions in Mathematics and Statistics (Ruth Hubbard, 1995)

The standard types of questions had become established before the extensive study of what it means to “learn mathematics”.

State a definition, theorem Use a formula Carry out an algorithm Classify mathematical objects Solve a word problem Proof Show that . . . Use a “new” definition Multiple choice, true/false (target common misconceptions)

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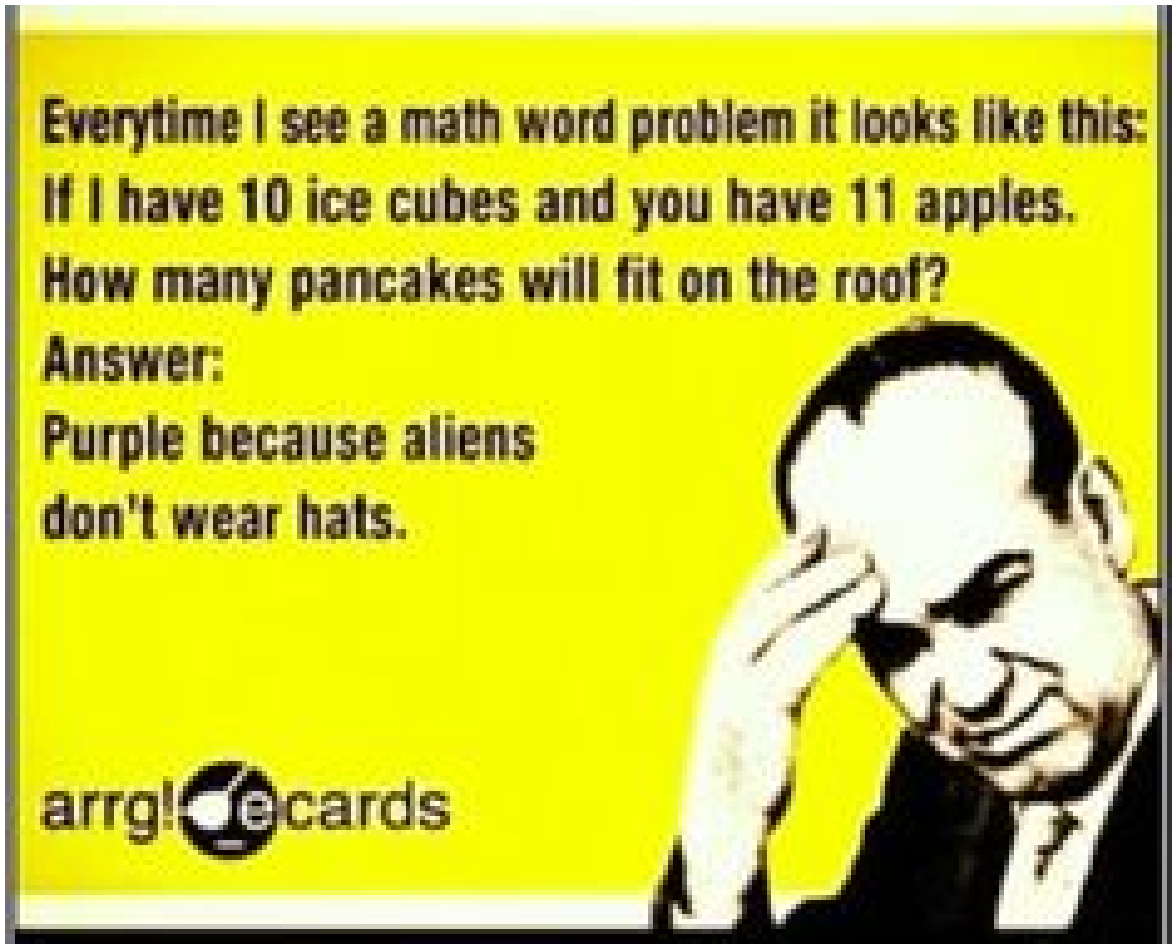
Everytime I see a math word problem it looks like this:
If I have 10 ice cubes and you have 11 apples.
How many pancakes will fit on the roof?
Answer:
Purple because aliens
don't wear hats.
arrg! ecards

Difficult questions

Fisher-Hoch and Hughes (1996)

- Statistical analysis to identify difficult questions
- Identify the source of difficulty (17)
- Trial modifications of these questions
- Described
  - valid (intended) difficulty lying in the mathematical concepts or processes
  - invalid (not intended) difficulty

Sources of unintended difficulty can be: language, context, presentation, amount of working memory available, pictures

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An example and a confession

In the nineteen nineties, a well-known American toy company produced a range of talking dolls each of which said four distinct phrases. Each doll's phrases were randomly chosen from a list of 270 phrases. This was intended to give the impression that the dolls were individual.

(a) What is the exact probability that two such dolls selected at random said the same four phrases?

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Language

In our questions, students encounter

- Words specific to maths e.g. hypotenuse, eigenvalue
- Words which occur in maths and in everyday language, but with different meanings e.g. reciprocal, integrate
- Words with roughly the same meaning in both contexts e.g. less, sum

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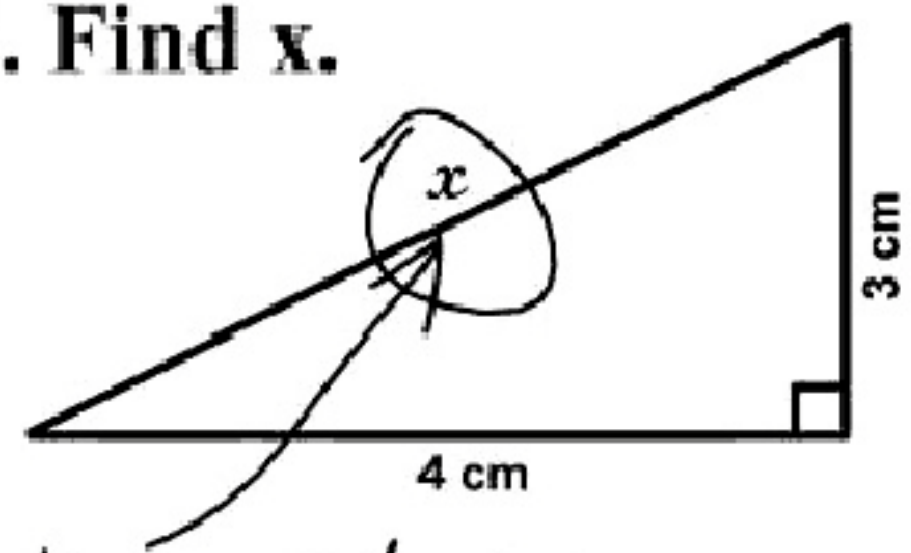
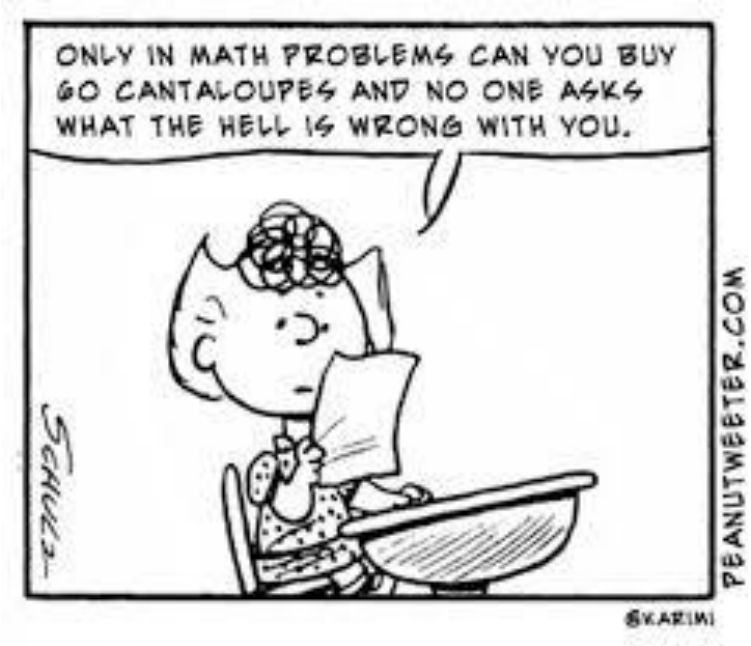
3. Find x.



Here it is

How real is real?



Word problems

Picture frame, lolly, tapestry

“Suspend knowledge” of the real.

This works for me

- Steps (e.g. pulling out information in word problems)
- Re-entry points
- Information that confirms work so far
- Marking

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More from the same example

One of the 270 phrases was considered by the public to be inappropriate . . .
Let B be the event that a doll said the inappropriate phrase. Let R be the event that a doll was returned for any reason . . .
It is known that 6% of all dolls purchased in America are returned. Suppose that 40% of customers with a doll which said the offending phrase chose to return it.

(e) What is $P(R)$, $P(B)$ and $P(R|B)$?

(f) Are R and B independent events? Give a reason for your answer.

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Un-conclusion

Tacit knowledge

Uncollected, conference proceedings

Work in progress . . . I'll let you know how it turns out.

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