Sabbatical Mini-Report #2:
Here's a Story … Ignore the Story!

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We can call them "applications", or we can call them "word problems"; most of our students call them "story problems". [Technically speaking, a "word problem" is simply the natural language (English, for example) equivalent to the mathematical problem to be completed; a "story problem" describes a physical situation for the mathematics, while an "application" describes a situation where an output is needed … and mathematics is involved in creating the output. See the Koedinger and Corbett reference.]

Ignore the Story?

Susan Gerofsky (2004) takes a linguistic approach to the story-problem genre. She creates an analysis, where there is a "set up", which covers the location and the characters; the "information", which is the data needed to solve the problem; and the "question". She then interviewed students and teachers in various schools about story problems. Students (starting with elementary school) will uniformly create unrealistic story problems, regardless of the nature of the problems there teachers have been presenting.

In other words, there is a "Here's a story … Ignore the story" premise behind story problems (as students see them). Whether we see them as realistic or not, students will see the "story" part as something to ignore. (The 'characters' are used by students, but often this develops into a confusion of labels and variables … T becomes Tom, not "Tom's Income" or "Tom's Income (dollars)".)

In fact, we often create story problems with this principle in mind. Our story may use words unique to the location ('mow the lawn in 2 hours'), but the story itself is extraneous to the procedure the student needs to perform. In some cases, the story we provide is needed to access the proper mathematical relationships – but only at a very general level; the specifics are almost always ignored. The same mathematics is to be done whether we present 'car', 'train', 'plane', 'boat', or 'bike', even though we don't always present information that is consistent with the particular object. A time of 3 hours is realistic for a plane, probably okay for a car or train, but does not make much sense for either a boat or a bike.

> Examples of "ignore the story" (from Math112):
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> Pg 459, #63: A team has 45 games scheduled. How many teams are in the league if each team plays every other team once? Use the formula $2N = t^2 - t$, where N is the number of football games that must be scheduled in a league with t teams when each team plays every other team once.

Notes: All of the words here are only needed to map the quantities to the correct variable in the formula; it's a good thing, too – the phrase "every other team" has two meanings! (Plays 'all other teams' versus 'plays alternating teams'.)

Pg 561, #17: A commuter plane leaves an airport traveling due south at 400 mph. Another plane leaving at the same time travels due east at 300 mph. Find the distance between the two planes after 2 hours.
Notes: The words here are only needed to generate the correct mathematical model (right triangle) … except for the '2 hours' part, which many students miss (at first). In this case, students must ignore the story! Anybody who has watched planes taking off realizes that all planes START in the same direction, and that two planes would not take off at the same time.

Example of "ignore the story" (from Math107 Practice Tests):
Math107 Practice Test 6, #23: A water balloon is dropped from an apartment window. The height of the balloon can be modeled by $h(t) = -16t^2 + 485$ where h is the height in feet above the ground and t is the time in seconds. What is the balloon's height after 2 seconds?
Notes: The words here are only needed to map the quantities to the correct variable. Students must ignore the story, since a water balloon falling 485 feet is a dangerous thing.

Math107 Practice Final, #34: Mrs. Dorn operates a soybean farm outside of Grinnell, Iowa, and she often needs to mix specific chemicals. One day she wants to apply pesticide to a large field. A 79% pesticide solution is to be mixed with a 65% pesticide solution to form 42 liters of a 74% solution. How much of the 79% solution must she use?
Notes: "Why isn't Mr. Dorn doing this? Everybody knows mothers should avoid pesticides!" "74% pesticide solution? That doesn't sound safe!" Students must ignore the story if they are to have any chance of solving this one – except for the words "mix" and "solution", which are there to trigger the correct model.

Besides Gerofsky, Gates and Vistro-Yu address this type of issue. They use the "Goldilocks Principle" relative to story problems … "Not too much … not too little … just right!" By this principle, just enough 'story' is provided to call it a story – without too much of a story.

The point here is this: We need to be aware of how students generally process "story problems". Evidence indicates that they ignore details when possible, and that we write problems where this is needed. If this is true, then using a lot of story problems does not make the material realistic – there is no connection between those problems and where the student might actually use mathematics. **Call it the "SP Game"** … we write the problems, the student needs to work the puzzle, and we all ignore the specific story involved.

Are they "hard"?

Difficulties with 'story problems' arise from multiple sources. First, some common words can be used in either the 'story' (to be ignored) OR in the information (needed). [Think of words like 'for', 'or', 'and' … and many others.] Students must access the proper domain, based on the clues in the phrases. Story problems exist in both the 'real world' and in the 'mathematical world'; see the book by Frank Smith.

Another source of difficulty may be surprising. Research is raising suspicions that some students are less able to ignore the story. In their work, Gates and Vistro-Yu present evidence that lower social classes are not as able to ignore 'context' (the story). [These authors write from a British perspective, thus the 'social class' phrase.] The theory is that people from middle class (and higher) are able to ignore context because they do not face survival issues every day; poorer families and neighborhoods involve a critical need to attend to context. Therefore, when a student based in this survival-mode faces a story problem, their attention may actually get 'stuck' on the story – preventing them from attending to the information needed to solve it. [For some details, you could see page 53 of their chapter.]

> *Take a look back at the 4 examples. Read each from a different perspective – as a student from an unsafe (survival-oriented) environment. Is there a risk that could catch your attention? Would you be able to ignore the context and just deal with the mathematics?*

Another factor in 'difficulty' is sequence: If the problem is not written in the standard order (set-up, information, question), students tend to have more trouble.

In some situations, the story problem becomes easier for students than the mathematical problem it represents. In particular, the "word problem" (natural language equivalent) allows students to solve the problem without employing formal transformations – working backwards, guess & check, etc. (See Koedinger & Corbett, page 71.) This raises the issue: What is the objective being assessed? If we just want an answer, then using word problems (without regard to method) is fine. If we want the translation to algebra, then we can not just focus on the answer – especially if we use word or story problems.

In their discussion of this result, Koedinger and Corbett suggest that we remember the principle: "The student is not like me!" In other words, just because we consider a particular problem easy or difficult does not mean that students experience it that way. Sometimes, students see the more complicated problems as 'easier' – because more information is given; simple problems appear difficult at times, because the student worries about other information that might be needed (with good reason).

Story problems do tend to be 'hard' in the minds of our students; the successful students learn strategies for ignoring the right things and interpreting the small set of words that make a difference. We need to be clear on our rationale for including (or emphasizing) story problems.

Situated Learning … "all story problems, all the time"

For some, the whole 'story problem' concept is imbedded within a "situated learning" framework. In this approach, learning mathematics is consistently presented within physical situations (whether manipulatives are used or not). The research on situated learning is most definitely "mixed", and the theory behind it has weaknesses. See Krajcik and Blumenfeld, page 319, and Anderson et al (2000) for some reviews. Situated Learning is often attached to a 'constructivist' approach; constructivism is a larger issue to be dealt with separately. The concept of situated learning also relates directly to some 'standards-based' ('reform') school mathematics curriculum, and that also is a larger issue to be addressed on its own.

References:

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