A Conversation about Academic Language in the Mathematics Classroom in Light of the ELPS

ISSET
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“Understanding mathematics requires language capacity on the part of the learner.”

Jacobs, 2010
“Every mathematics teacher is a language teacher – particularly the academic language used to formulate and communicate mathematics learning.”

Lager, 2006
The Texas English Language Proficiency Standards (ELPS)

19 Texas Administrative Code § 74.4
Chapter 74. Curriculum Requirements
Subchapter A. Required Curriculum
§ 74.4 English Language Proficiency Standards

Adopted December, 2007
The ELPS

- Required curriculum grades K-12
- Social and academic language
- Integrated within content areas (mathematics, science, social studies, etc.) for all language skills
The Water Cube located north of Beijing City

Is this a cube?
What is the $y$-intercept of $y = mx + b$?

$\text{Yes or } (0, b)\text{?}$

Is the $y$-intercept the “starting point”? 

$y = mx + b$

$(0, b)$

$(-b/m, 0)$
The word “inverse” is a loaded term.

It confuses many students.

Why?
What is the inverse of 5?

-5 or \( \frac{1}{5} \)?
Is there such a thing as an inverse function?

Is \( f(x) = \frac{1}{x} \) the inverse function?
The Syntax of Mathematics

What does \((-3)^2\) mean?

What does \(-3^2\) mean?

Are these equal?
The Syntax of Mathematics

What does 3+5-7 mean?
What does (3+5)-7 mean?
What does 3(+5-7) mean?
What does (3+5-7) mean?
What does 3+5(-7) mean?
What does (3+5)(-7) mean?

Which expressions are equal?
The Syntax of Mathematics

What does $1/x+1$ mean?
What does $(1/x)+1$ mean?
What does $1/(x+1)$ mean?

Are these expressions equal?
The Syntax of Mathematics

What does $f^{-1}(x)$ mean?

What does $[f(x)]^{-1}$ mean?

Are these expressions the same?
The Syntax of Mathematics

What does \( \sin^{-1}(x) \) mean?
What does \([\sin(x)]^{-1}\) mean?

Are these expressions the same?
The Syntax of Mathematics

What does $\sin^2 x$ mean?

What does $[\sin(x)]^2$ mean?

What does $\sin x^2$ mean?

Which two expressions are equal?
The Semantics of Mathematics

3 less 5

3 less than 5

3 is less than 5
The Semantics of Mathematics

Write an equation using the variables S and P to represent the following statement: “There are six times as many students as professors. Use S for the number of students and P for the number of professors.”

Clement, Lochhead, & Soloway, 1979
English vs. Mathematics

Sequence – the following of one thing after another; a succession; a series

Series – a group or a number of related or similar things, events, etc. arranged or occurring in temporal, spatial, or other order or succession; a sequence
English vs. Mathematics

Sequence – A sequence is a function whose domain is the set of positive integers. e.g., 1, 4, 7, 10,…

\[ \{a_n\} = \{a_1, a_2, a_3, \ldots a_n, \ldots\} \]

Series – If \( \{a_n\} \) is an infinite sequence, then

\[ \sum_{n=1}^{\infty} a_n = a_1 + a_2 + a_3 + \cdots + a_n + \cdots \]

is an infinite series (or simply a series).
Does a cone have a face?
Does a cone have a vertex?
Slope

• Zero slope
• No slope
• Infinite slope
• Undefined

\[
\text{Slope} = \frac{\Delta y}{\Delta x}
\]
Words and Phrases to Avoid?
Words and Phrases to Avoid?

Reduce?

\[
\frac{8}{16} = \frac{1}{2}
\]

What could you say?
Words and Phrases to Avoid?

*Cancel or Cancel out?*

\[
\begin{align*}
4 - 4 &= \frac{4}{4} = 2 \\
\frac{2 + 4}{2} &= 3 \\
\frac{4 + 6}{2} &= 5 \\
\frac{x}{x} &= 1 \\
\frac{\sin x}{x} &= \frac{\sin x}{x} \\
\frac{\ln 2x}{x} &= \frac{\ln 2x}{x}
\end{align*}
\]
Words and Phrases to Avoid?

*Flip?*

\[
\frac{4}{1} \rightarrow \frac{1}{4}
\]

What could you say?
Words and Phrases to Avoid?

Flip?

What could you say?
Words and Phrases to Avoid?

Flip?

\[
\begin{array}{c}
\frac{2}{7} \div \frac{8}{21} \\
\end{array}
\]

What could you say?
Flip?
Words and Phrases to Avoid?

*Plug in?*

How would you evaluate the expression $3x + 5$ when $x = 4$?
Simplify or solve?

Cross multiply or invert and multiply?

\[
\frac{12}{5} = \frac{2x}{8} \quad \quad \quad \frac{5}{12} \div \frac{15}{8}
\]
How do you interface colloquial language with academic language in the mathematics classroom?

Should you??
What can be done to make mathematics language accessible for English language learners?