LETTING GO OF ASSUMPTIONS ABOUT HOW STUDENTS UNDERSTAND STATISTICAL LANGUAGE

USCOTS 2009 Breakout Session

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Motivation for Studying Language

- Language plays a crucial role in the classroom.
  (Thompson & Rubenstein, 2000)
  - means of communicating new ideas
  - way in which students build understanding and process ideas
  - method of assessment
- The use of a specialized vocabulary with a novice in a domain creates a "mystique" about the subject.
  (Lemke, 1990)

Lexical Ambiguity

Words or phrases that are the same or similar but can be used to express two or more different meanings.

Homonymy

Leaves of a tree vs. 7 minus 3 **leaves** 4

Polysemy

The factory makes a **product** vs. the **product** is the result of a multiplication

Homophony

Sum vs. **Some**, **Pie** vs. **Pi, Too/To/Two**

Shifts of Application

Statistics** vs. **Statistic

Motivation for Studying Lexical Ambiguities

- Learning the meaning of a word is a complex and incremental process (Leung, 2005).
- People connect what they hear to what they have heard and experienced in the past (Lemke, 1990).
- When commonly used English words are used as domain specific words students may make incorrect connections between words they know and words that sound similar but have specific meanings in statistics that are different from the common usage definitions

Motivation for Studying Lexical Ambiguities in the Undergraduate Statistics Classroom

- In a study of elementary school students it was found that detection of lexical ambiguities exhibited a steady, almost linear improvement across grades. (Shultz & Pilon, 1973.)

- Therefore, college students, once made aware of the ambiguities, should be able to correctly process the statistical meanings of the ambiguous words.

Research Questions for Pilot Study

- What are the meanings of the 5 target words most commonly used by students entering an undergraduate statistics course?
- What types of statistical definitions do students develop by the end of a one semester introduction to statistics course?
- Are certain pre-existing definitions more useful for developing statistical understanding?
- Do usage patterns change over time?

Pilot Study

Pre-Test

- n = 67 students
- Students gave a definition and wrote sentence for each word

Post-Test

- n = 50 students; 3 had not completed pre-test
- Students gave definition for everyday use and statistical use of each word

Pilot Study Pre-Test Results

Word	Number of Definitions	Most Common Definitions
Association	5	•Body of persons combined for common purpose (36) •Loose relationship (20)
Average	10	•Normal, typical, mediocre, common (25) •Mean (15) •Median or middle (11)
Confidence	3	Self-esteem, belief in, assurance (62)
Random	7	•An occurrence that is unplanned or haphazard (29) •Selecting: - without order or pattern (10) - without criteria (13)
Spread	9	•Scatter, disburse, distribute (25) •Smear, cover evenly (17)

Large Scale Study

- Fall 2008 Pre- and Post Test Design with data collected from three campuses

		Number of Students (Number of Instructors)		
Semester	Target Words	Michigan State University	Grand Valley State University	University of Louisiana at Lafayette
Fall 2008	association average confidence random spread	294(3)	392(7)	293(4)

Think-Pair-Share Activity One

- Write sentences and definitions for the statistical meanings of the words on the handout as you think a GOOD STATISTICS STUDENT would at the end of a one semester introduction to statistics course.
- Discuss your responses with your neighbor
- We will ask you to share your responses

Rubric Creation and Coding

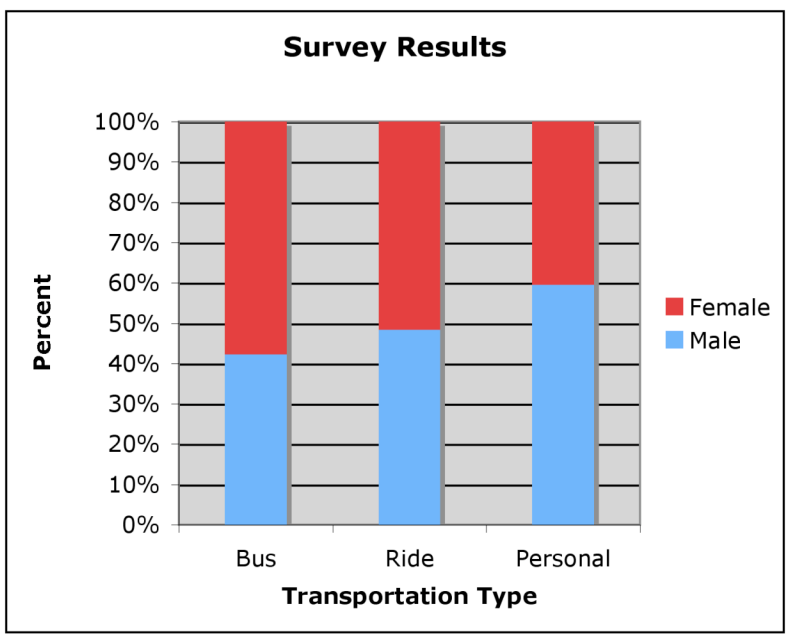
- For both every day and statistical meanings, coding rubrics were created based on the pilot test data.
- One researcher created the rubric and the other two used the rubric to code the instruments
- Disagreements were discussed and the rubrics were modified
- A random sample of the large scale study data were selected (validation sample)
- Each word was coded by two researchers
- Disagreements were discussed and the rubrics were modified

Initial Inter-rater Reliability	Pilot Study			Large Scale Study		
	Pre-Test	Post-Everyday	Post-Statistical	Pre-Test	Post-Everyday	Post-Statistical
Association	87%	59%	96%	80%	75%	75%
Average	78%	88%	96%	82%	85%	85%
Spread	55%	60%	98%	82%	81%	81%

Report out Definitions for Association

In order to plan transportation and parking needs at a private high school, administrators asked a random sample of 200 students how they get to school. Some rode the bus, some rode with parents or friends and others used "personal" transportation – bikes, skateboards, or walking. The table and bar chart summarize the responses from boys and girls.

	Transportation Type			
	Bus	Ride	Personal	Total
Male	30	42	25	97
Female	41	45	17	103
Total	71	87	42	200



QUESTION: Write a few sentences summarizing what the table and chart show about the association between gender and transportation type for the students in the sample.

STUDENT RESPONSE: The table and chart reveal little association between the genders. The highest association between genders is in the category of "ride."

QUESTION FOR AUDIENCE: What does the student mean?

Statistical Definitions of Association

Definition	Number of Subjects	
	Pilot Study	Validation Sample
Incorrect statements: not about relationships or comparing	10 (21%)	3 (5%)
Having something in common	3 (6%)	10 (16%)
Numerical comparisons	10 (21%)	9 (14%)
Indeterminate relationships or linkages	15 (31%)	23 (37%)
Relationships between variables	9 (19%)	16 (25%)
Not classified	1 (2%)	2 (3%)

Report out Definitions for Average

From CBS News, May 12, 2009: President Obama's call last year for "shared sacrifice" doesn't extend to federal employees, at least based on the details of his administration's 2010 budget released this week. There's little belt-tightening in evidence in Washington, D.C.: Counting benefits, the **average** pay per federal worker will leap from $72,800 in 2008 to $75,419 next year.

From MSNBC, June 14, 2009: The Sierra Club has endorsed Feinstein's version (of the Clunker Car Bill). The director of the environmental group's Green Transportation campaign says the House and similar Senate bill are structured to sell cars more than to get gas guzzlers off the road. She thinks it's not too much to ask that the final legislation does both. "Automakers already produce a fleet of cars that exceed the current 27.5 mpg **average** so we should ensure our tax dollars go to help sell cars that are above that **average**."

Statistical Definitions of Average			Number of Subjects	
			Pilot Study	Validation Sample
Measures of Center	Mean	Word only	11(22%)	26(35%)
		Statistical: incomplete or inaccurate	5(10%)	11(15%)
		Statistical: complete and accurate	9(18%)	17(23%)
	Median	Word only	1(2%)	1(1%)
		Colloquial: in the middle, normal, standard	3(6%)	6(8%)
		Statistically correct	0	0
	Mode	Word only	0	0
		Colloquial: majority, most common	5(10%)	5(7%)
		Statistically correct	1(2%)	0
Other Definitions	Sum		4(8%)	2(3%)
	Frequency		1(2%)	0
	Approximation		2(4%)	0
	Representative number		2(4%)	1(1%)
	Number used in inference		1(2%)	0
Not classified			4(8%)	6(8%)

Report out Definitions
for
Spread

Said the statistician from west Texas…

Howdy! Welcome to my ***spread*** and make yourself at home. Go ahead and ***spread*** out your papers and help yourself to all the food – it's quite a ***spread***, huh? Be sure to try some of that butter ***spread***; just ***spread*** a little on a cracker. Yum! And take a look at that fancy tablecloth; my grandma made that ***spread*** for me. Once you're all settled in we'll open up that ***spread***sheet and see if we can't figure out the ***spread*** of those data.

Statistical Definitions Spread	Number of Subjects	
	Pilot Study	Validation Sample
A spreadsheet (with data)	14(30%)	8(11%)
Range	5(11%)	20(27%)
Data (in a spreadsheet or list)	14(30%)	1(1%)
To space numbers apart	1(2%)	2(3%)
Scattered numbers	2(4%)	2(3%)
A non-specific measure or calculation	2(4%)	0
Equal distribution	1(2%)	4(5%)
Distribution of numbers	1(2%)	12(16%)
Measure of variability	0	11(15%)
Non-specific information from figure or graph	2(4%)	5(7%)
Not classified	5(11%)	9(12%)

Think-Pair-Share Activity Two

- Now that you have seen the results, select one of the three words: association, average or spread and think about how you might introduce that word differently from what you have done before.
- Discuss your responses in groups of four
- We will ask you to share your responses

Think-Pair-Share Activity Three

- Brainstorm a list of words that you would be interested in having us research.
- Discuss your responses with your group
- We will ask you to share your responses including a summary of why you think the word is worthy of study.

Future Directions

- Create Rubrics for 5 new words on which data were collected in Spring 2009: Bias, Error, Independence, Normal, Significant.
- Analyze the Data collected in the 2008 - 2009 large scale study
- Create Teaching Modules, based on the data, for target words
- Assess Teaching Modules, linking to student learning outcomes

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