His use of these hedges implicates his uncertainty and protects him from accusation of being wrong. Josh, on the other hand, is responding to something (inaudible, in the transcript) that another student has said, presumably an explanation involving the thickness of the layers for the difference in the two sets of data. Josh's hedged response marks a dispreferred turn (Levinson, 1983), a disagreement when agreement would be the preferred second part of the adjacency pair. It shows sensitivity on Josh's part and the word "politeness" would not be out of place.

Hedged language is in evidence, even in the textbook, albeit in an account of the activity of the Maryland students, who "thought the pattern looked somewhat linear". Here we have the suggestion of a double hedge: they "thought" (a plausibility shield) and "somewhat" (an adaptor). Josh's exposition of the textbook (lines 6-13) is hedged throughout (*e.g.*, their data was "a little bit scattered", a line that "seemed to" fit the data "pretty" well, no point is "really" far away). Finally, when he is trying to draw out the purpose of graph models from the class, Christy obliges with an answer (line 31), interestingly unhedged. It would seem that Christy's reply is not the one that Josh was looking for, any more than Abram's earlier attempt. Josh's response (line 32) includes "maybe", as his earlier one did (see above). It also includes the interesting particle "well", which, here, functions as a maxim hedge (Levinson, 1983), suggesting that the speaker is serving notice to the hearer that the contribution about to come will fall short in some respect of the requirements of one or more of Grice's maxims of cooperation. Here, it could be argued that Josh's reply to Christy is deficient with respect to both the maxim of quantity ("let your contribution be as informative as is required, neither more nor less") *and* the maxim of manner ("let your contribution be clearly expressed"). In any case, Josh's interchanges with Abram and Christy reveal his enquiry (lines 25-26) to be something other than a request for information (Ainley, 1988). Teachers' questions in classroom situations are exempted from the usual sincerity conditions for a question, *e.g.*, that the enquirer does not already know the answer to their question (Labov, 1970). My guess is that Josh is looking for an answer that brings out the predictive relationship between the model (the graph) and the phenomenon being modeled (the breaking weight), because that is what the textbook says. Arguably that is the *only* reason why one would take the trouble to plot points from the table of values and draw the line: apart, perhaps, from the sheer pleasure of noting the way each system mimics the other, although this potential satisfaction is distinctly dampened, as I observed earlier, by the at-best rough-and-ready correspondence between the two semiotic systems in this instance.

References

Ainley, J. (1988) Perceptions of teachers' questioning styles. In Borás, A. (Ed.) *Proceedings of the Twelfth Conference of the International Group for the Psychology of Mathematics Education,* vol. 1, pp. 92-99. Veszprém, Hungary: PME.

Andersen, G. (2000) The role of the pragmatic marker *like* in utterance interpretation. In Andersen, G. & Fretheim, T. (Eds.) *Pragmatic Markers and Propositional Attitude,* pp. 17-38. Amsterdam, The Netherlands: John Benjamins.

Channell, J. (1994) *Vague Language.* Oxford, UK: Oxford University Press.

Cutting, J. (Ed.) (2007) *Vague Language Explored.* Basingstoke, UK: Palgrave Macmillan.

Grice, H. P. (1975) Logic and conversation. In Cole, P. & Morgan, J. (Eds.) *Syntax and Semantics Volume 3: Speech Acts,* pp. 41-58. New York, NY: Academic Press.

Labov, W. (1970) The study of language in its social context. *Studium Generale* **23**, 66-84.

Levinson, S. (1983) *Pragmatics.* Cambridge, UK: Cambridge University Press.

Prince, E., Frader, J. & Bosk, C. (1982) On hedging in physician–physician discourse. In di Pietro, R. (Ed.) *Linguistics and the Professions*, pp. 83-96. Norwood, NJ: Ablex Corporation.

Rowland, T. (2000) *The Pragmatics of Mathematics Education: Vagueness in Mathematical Discourse.* London, UK: Falmer Press.

Lexical density and the mathematics register

CODRUTA TEMPLE

In US reform-based mathematics curricula, such as the Connected Mathematics Project (CMP) (Lappan *et al.*, 1998), mathematics is to be embedded in real-life situations and problems that students are expected to investigate and solve using mathematical tools. Learning mathematics thus appears to be a process that originates in students' everyday experiences and which consists of converting everyday (familiar, concrete, particular) knowledge into mathematical (new, abstract, generalized) knowledge. The texts to which students are exposed in such curricula aim to support this conversion through several of their features, two of which I will discuss with regard to this transcript—the embedding of mathematical genres within more familiar genres and the embedding of the mathematical register within the colloquial register. In discussing the latter, I will use Halliday and Matthiessen's (2004) definition of register as "the lexical and grammatical features that realize a particular situational context" (p. 9). The context includes what is talked about ("field"), the relationship between speaker and hearer or writer and reader ("tenor"), and expectations for how particular texts should be organized ("mode").

The first five sentences of Problem 1.2 (see Figure 1) contain many of the ingredients of the narrative genre. They tell a story about a class (protagonist) in Maryland (setting) who, in an indefinite past (setting), encountered and solved a problem (plot). Just as in any story, the focus is on the protagonist, who is the subject of all the five sentences ("a class in Maryland", "they", "they", "the class", "they") and is involved in a series of material and mental processes or actions ("did", "combined", "found", "organized", "made, "thought", "drew"). The plot unfolds in time ("The class *then* made a graph of the data") and its development is spurred on by the protagonist's reasoning and purpose ("They thought the pattern looked somewhat linear, *so* they drew a line to show this trend"). Even though they contain technical vocabulary ("average", data", "table", "graph", "pattern", "linear"), the five sentences are closer to the colloquial register than to the mathematical register at least in two of their characteristics:

their lexical density (roughly, the number of content words in a clause [1]), which is rather low (at 4.14), and their heavy reliance on definite articles, demonstratives and possessives that refer to the context of the story ("*the* bridge-thickness experiment", "*the* results", "all *the* groups", "*their* data", "*the* data", "*the* pattern", "*this* trend").

The sixth sentence in the text is no longer in the genre of the narrative. The shift to a different genre (which I call "teacher talk") is signaled by the shift from the past tense to the present tense, as well as by the subjects of the clauses in the sentence, which become inanimate and abstract ("this line", "the points") and are now involved in exclusively relational processes ("is", "are"). The change in subjects and processes alters the text's register by altering its *field*, while the fact that the lexical density of the sentence goes up to 5.5 alters its *mode*. The *tenor* also changes: while in the first five sentences the voice of the text was telling students a simple story, in the sixth sentence, the same voice becomes authoritative: it makes value judgments ("a *good* model") and supports them with arguments ("[…] *because* […] the points on the line are close to points from the experiment").

The changes in field, mode and tenor bring the sixth sentence closer to the mathematical register than the previous five were, making it potentially more difficult to understand. Somewhat paradoxically, the one feature of the colloquial register that is retained (the use of deictic elements such as "this" or "the") only adds to the difficulty. The referents for "*this* line", "*the* relationship", "*the* thicknesses tested", "*the* points on *the* line", "points from *the* experiment" are partly in the first five sentences, partly in the table preceding the sixth sentence and partly in the graph following it. To make sense of the sixth sentence, therefore, the students would have to be able to read closely and with ease not only the narrative, but also the two mathematical text types: the table and the graph.

The seventh sentence is the one that, still in the genre of "teacher talk," makes the transition from the particular to the general by establishing a relationship between "the line that the Maryland class drew" and the new mathematical concept, "graph model," where the former is an example of the latter. Once introduced, the new concept is defined in the eighth sentence, which is fully in the mathematical register ("A graph model is a straight line or a curve that shows a trend in a set of data"). No more references are made to the experiment of the Maryland class. The sentence is context-independent and expresses a generalized relationship between mathematical objects using an impersonal tenor and a lexical density of 9.0. The transition from everyday knowledge to mathematical knowledge, from the particular to the general, has been completed.

As if to alleviate the impersonality of the definition, the ninth sentence reverts to the genre of "teacher talk" and to a register closer to the colloquial one. The lexical density drops to 7.0 and the subjects of the two clauses become "you", changing both the field and the tenor of the text and making it refer, at least apparently, to students and their actions. As David Pimm remarked, though, the personal pronoun "you" is used ambiguously in this sentence, disguising what is intended as a statement of the general purpose of graph models in the form of a casual suggestion to students ("You can use it to make predictions …").

The students in Josh's class fail to grasp the meaning of the ninth sentence, in spite of (or, perhaps, because of) its informal tenor. When Josh asks a seemingly simple comprehension question ("What's the purpose of a graph model"), both Abram (line 27) and Christy (line 31) answer by referring not to the ninth sentence, but to the fifth sentence: that is, not to the purpose of graph models in general, but to the purpose of the Maryland class for fitting a line to their set of data. This suggests that both students had comprehended and retained the details of the narrative, but had not necessarily followed the shifts in genre and register through which the move from the particular to the general was constructed in the text that they had read.

It also suggests that students are likely to pay more attention to genres and registers that are already familiar to them than to more mathematical genres or registers with which they may be less familiar. And yet, as many educators have repeatedly emphasized (*e.g.*, Halliday & Martin, 1993; Morgan, 1998; Schleppegrell, 2004; Sfard, 2008), students' developing familiarity with the latter is critical to their learning of mathematics. Let me add, as a final comment, that it is also critical to students' making sense of the hybrid texts of reform-based mathematics curricula, whose meaning depends on readers' command of both everyday and mathematical language, as well as on their ability to switch between the two.

Notes

[1] According to Halliday and Matthiessen (2004), "lexical density" is the ratio between the number of lexical items and the number of non-embedded clauses in a sentence. Disciplinary registers tend to be lexically dense, that is, to pack a large number of lexical items into one sentence.

References

Halliday, M. & Martin, J. (Eds.) (1993) *Writing Science: Literacy and Discursive Power.* Pittsburgh, PA: University of Pittsburgh Press.

Halliday, M. & Matthiessen, C. (2004) *An Introduction to Functional Grammar* (3rd edition). London, UK: Hodder Arnold.

Lappan, G., Fey, J., Fitzgerald, W., Friel, S. & Phillips, E. (1998) *Thinking with Mathematical Models (Teacher's edition).* Menlo Park, CA: Dale Seymour Publications.

Morgan, C. (1998) *Writing Mathematically: The Discourse of Investigation.* London, UK: Falmer Press.

Schleppegrell, M. (2004) *The Language of Schooling.* Mahwah, NJ, Lawrence Erlbaum Associates.

Sfard, A. (2008) *Thinking as Communicating: Human Development, the Growth of Discourses, and Mathematizing.* New York, NY: Cambridge University Press.