POETIC LINES IN MATHEMATICS DISCOURSE: A METHOD FROM LINGUISTIC ANTHROPOLOGY

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> The hills my brothers & I created
> never balanced, & it took years
> To discover how the world worked.
> We could look at a tree of blackbirds
> & tell you how many were there,
> But with the scrap dealer,
> Our math was always off.
> ('Believing in Iron', Yusef Komunyakaa) [1]

In many contemporary mathematics classrooms, students discover how the world of mathematics works by talking about it. Creating linguistic meanings helps students create mathematical meanings. However, if communication is a central process for mathematical learning, we must account for the linguistic processes that allow students to construct mathematical ideas. While linguistic meaning is often considered a property of words, significant mathematical ideas – arguments, inferences, and relationships – can also be expressed through discourse structure. At times, the form of a student's statement can convey meaning as much as the isolated definitions of the words themselves.

The fields of linguistic anthropology and poetics offer a method of analyzing knowledge construction in discourse that involves the repetition of words, grammatical features, intonations or rhythms. Repetition creates ideas that transcend the sentence; the repeating elements are said to form "poetic" lines. Revoicing, when a teacher paraphrases a students' comment and speaks it back to the class, is a type of repetition that is familiar in mathematics education research (O'Connor & Michaels, 1993), but repetition can occur in discourse in more complicated ways. Repetition can occur in student discussions that do not involve a teacher, within the speech of a single student, and it can rely on sentence and paragraph structures that are more complex than typical instances of revoicing. Poetic structures in classroom discourse have been identified as a priority for research in the linguistic anthropology of education (Wortham, 2003).

In this article, I outline the academic history of repetition and I discuss examples of mathematical thinking that can be expressed through poetic structures. Because repetition requires attention to speech structures beyond words and sentences, I describe methods of representing repetition in transcribed discourse. Analyzing repetition can help researchers deal with transcripts more delicately and to perceive processes of meaning construction that go unnoticed in traditional forms of transcription.

Representing poetic lines

A student's explanation during a lesson on modular arithmetic (mod 5) illustrates this manner of transcription quite clearly (Pimm 1987, p. 57). First-year secondary school students sit in a circle and distribute Cuisenaire rods among themselves. Pimm renders the first part of the transcript as:

T: Stop a minute. What color is Debbie going to take? … (pause) David did you want to say something?

D: Yes, cos every fifth one from William is going to be a white, and every fifth one from the next person on is going to be a red, and every fifth one from the next person is going to be a green, eh? (The last noise being a questioning intonation possibly asking for confirmation)

(General confusion and discussion of this announcement.)

T: Is that right? Is what David's saying right?

P: (Partial chorus of yesses.)

T: Right, let's take the rods then quickly, so we can find out.

David makes his observation using strong syntactic parallelism. One means of highlighting this parallelism relies on indentation (Hymes, 1981):

1 Yes

2 Cos every fifth one
3 from William
4 is going to be
5 a white,

6 and every fifth one
7 from the next person on
8 is going to be
9 a red

10 and every fifth one
11 from the next person
12 is going to be
13 a green

14 eh?

Selection 1: Cuisenaire rods (Pimm)

David makes his observation using three poetic lines. The first poetic line (text lines 2–5) establishes a discursive pattern: *every fifth one/ from William/ is going to be/ a white.* The next two poetic lines (text lines 6–9 and 10–13, respectively) repeat this grammatical structure with different phrases in parallel positions. The line *from William* is echoed with the phrase *from the next person,* and the color words cycle through several possibilities. The repeated verb phrase *is going to be* makes the parallelism of the statement especially strong. The poetic line format also reveals another level of parallelism that is less obvious, but that has a significant function: the repetition of affirmations *yes* and *eh* are contextualization cues (Gumperz, 1982, p. 131) that allow David to signal how his speech is to be interpreted. They establish the boundaries of David's turn speaking, and their positive tone indicates confidence and a sense of responsibility for contributing a key mathematical idea. *"Yes,"* he does have something that he wants to say; his final echo of *"eh?"* is something of a conversational QED. Representing David's speech in indented poetic lines gives visual form to his reasoning and provides some indication of why it was persuasive enough to garner a "partial chorus of yesses."

Although the repetition in David's commentary can be perceived easily without special transcription methods, it is important to note that the parallel structure is precisely the means by which he made his argument. If he had simply stopped after saying, "Every fifth one from William is going to be a white," his comment might have been taken as a perceptive but limited observation. By repeating the grammatical form of this sentence with further examples, he creates the impression that he has a generalized understanding of the modular arithmetic activity. David uses repetition to explain the system of modular arithmetic to his classmates. No single phrase or sentence expresses his inductive mathematical argument, but it is nonetheless unmistakable. The mathematical pattern is expressed through the grammatical pattern of parallelism. In this example, the discourse structure is identical to the mathematical argument.

The poetic function

David's commentary suggests that the word or sentence is not always the unit of thought. Repeated words, phrases or rhythms establish relationships within or across sentences that construct ideas, even when the concept is not directly stated. In literary poetry, for example, parallel forms can affect listeners when they are not immediately apparent. In the opening poem, Komunyakaa's lyrical free verse at first seems to defy the regularity of parallel structure. Thoughts and phrases flow across adjacent lines of text that are unbalanced, incommensurate. Line breaks seem not to matter. Still, covert repetitions act through the hammered rhythm *hów the wórld wórked…our máth was álways óff* (the three stressed syllables in each phrase are indicated with accents). The rhythmic association between these lines suggests an interpretation of the opening scene of the poem, that the inability to perform formal calculations symbolically represents the condition of feeling like an outsider who lacks access to social processes. The repetition helps establish relationships between ideas that are not expressed explicitly.

Ironically enough, the perspective that parallelism is central to poetic language has historical roots in mathematics. Jakobson's theory of poetic language (1960) presents a model of a channel linking a speaker and a hearer. Statements passing between the two are described in terms of various communicative functions. Jakobson relied heavily on the communicative theory of Austrian psychologist Karl Bühler (Duranti, 1997 p. 284n), and also drew upon the foundations of cybernetics, especially Shannon's information theory representation of functions or effects on the channel linking speaker and hearer with an intervening noise source (1963/1949, p. 34). Jakobson elaborated Bühler and Shannon's models by representing the linkage between speaker and hearer through six components:

Component	Function	Description and example
Addresser	Emotive	Exhibits the speaker's disposition. "I can solve that problem!"
Addressee	Conative	Reference to hearer, as in vocatives and imperatives. "David, can you solve the problem?"
Context	Referential	Denotative, informational messages. "We need a common denominator."
Contact	Phatic	Expressions that control the channel and turns at talk. "Wait a minute, let me try, I know how to do it!"
Code	Metalingual	Reference to the symbolic system that conveys the message. "What do we call the answer to a subtraction problem?"
Message	Poetic	The form of the message calls attention to itself. "Every fifth one from William is going to be a white, and every fifth one from the next person on is going to be a red."

Any statement in a mathematics classroom can be described in terms of one or more of these functions (see Sierpinska, 2005, p. 216), but in this article, I will consider how students construct mathematical meanings through the poetic function. Jakobson described this mode of communication in mathematical terms – "the poetic function projects the principle of equivalence from the axis of selection into the axis of combination" (Jakobson 1960, p. 358, original italics deleted). In other words, a speaker who places words into the grammatical units of a sentence or a series of sentences (the axis of combination) may select words that bear some similarity to each other: similar meanings, similar initial sounds, or similar rhythms. Words may even be associated with each other through the unique relationship of having opposite meanings (Silverstein, 1984, p. 183). The axis of selection refers to these sets of related words. The projection creates sentences in which words, phrases, sounds or rhythms recur in parallel form. This type of poetic structure is particularly suitable for expressing ideas based on comparison or on contrast. Any time a repetition causes listeners to attend to the form of the statement, or to use the form of a statement to construct meanings, the poetic function of language is in play.

The poetic function can involve "proofreading, mimicry, aspects of emendation and editing, and stylistic and poetic concerns" (Hymes, 1964, p. 23). It can be appreciated, then, that the poetic function operates within self-referential statements that are not typically viewed as poetry. In classroom discussions, for example, many mathematical statements are editing or proofreading statements that focus on form. A student who asks, "Why did you add 3 to both sides of the equation? Why didn't you subtract it?" is attempting to refine an ongoing problem by using repetition: *Why did you* is replaced in parallel position with *Why did you not*. *Add 3* is replaced with the opposite idea *subtract it*. The contrasts that occur in these parallel positions focus attention on the form of the message. Parallelism allows a speaker to recognize an existing idea and modify it in a way that is concise and easy to understand. This type of revision is at the heart of collaborative mathematics discussions.

Parsing conversation into lines: controversial criteria

Not every mathematics discussion will exhibit line structure, but when one does, researchers must consider which criteria will best allow them to define lines. What features of discourse should we listen for when we decide to indicate a line break? The major division of thought on this issue is represented by Dell Hymes and Dennis Tedlock, scholars who each used Jakobson's poetics to understand Native American folk narratives. For Hymes (1981), lines are indicated by verb phrases and parallelism that can segment a story into lines, verses, stanzas, scenes and acts. [2] The terms verse, stanza and so on do not carry specific poetic meanings (as in measured verse, for example); instead they refer to different levels of patterning that sometimes unite lines into broader discursive units.

Instead of relying on syntactical structures, Tedlock (1983) uses sound features of oral discourse to mark lines. He argues that pauses, loudness, voice quality, and intonation contours in which vocal pitch rises and then falls are more authentic means of representing the drama of an oral performance. In large measure, this debate is a disagreement over the base data each scholar used. Hymes analyzed narratives that were collected and transcribed by early 20th-century folklorists. Without recordings, pauses were not available. Tedlock, on the other hand, analyzed narratives that he tape-recorded himself.

Hymes' and Tedlock's approaches can work well in concert with each other. Gee (1999), for example, follows Hymes' method of segmenting conversations into lines and stanzas (pp. 89–90). Like Tedlock, Gee (1999) tends to stress pitch movement as the major determinant of line structure (pp. 106–107), but indicates that a single unit of information is usually expressed within the line. Both approaches for locating line breaks should be considered in the analysis of transcripts, and the final choice of method must be determined by the characteristics of a particular recording. Hymes' method of listening for repeated grammatical structures or phrases lend themselves well to the expressions of logical reasoning that occur in mathematics classrooms.

The poetics of classroom discourse

In the selections that follow, I offer further examples of parsing classroom conversations into poetic lines based on repetition. The examples are chosen to illustrate the flexibility of the method. Highlighting repetition can describe processes of meaning construction within the speech of a single student, in multilingual dialogues, and in full-class discussions in which mathematical ideas are developed gradually through the contributions of many students.

Deductive reasoning in a student monologue

I have already discussed a case of inductive reasoning expressed through grammatical parallelism. In this selection, a student creates a deductive argument with an astonishing degree of repetition. Joshua was a freshman enrolled in my undergraduate developmental algebra class. On the previous day, a biology professor had visited the class to lecture on exponential growth. He emphasized the speed with which human lives lost to disaster are "replaced," as the presenter put it, by new births. In the next class meeting, I opened the discussion by asking the students to explain how we can reconcile our sense of sympathy and social responsibility with the reality of rapid population growth. Joshua expressed his view of the exponential growth model and, a bit hesitantly, tried to connect his mathematical and social understandings:

1	We thought
2	that the birth rate
3	is just going to keep on growing.
4	and also
5	that life expectancy
6	is going to be higher.
7	So therefore
8	the growth of population
9	is going to increase no matter what.
10	Those mass deaths are really
11	are important
12	because lives
13	are lost
14	but just because the birth rate increases
15	the people will be somewhat
16	like I don't want to say
17	replaced
18	but numberwise
19	they will be replaced.

Selection 2: Population growth

In this selection, poetic lines can be defined based on the student's verb phrases *is going to, are* and *will be.* The shifts from one verb phrase to another form three stanzas (1–9, 10–13, and 14–19). Each stanza addresses a specific topic. In stanza 1, Joshua explains his understanding of the exponential growth model. In stanza 2, he expresses his sympathy for people whose lives were lost, and in stanza 3, he returns to the mathematical model and affirms that "numberwise," the population will return to prior levels. Each of these themes is developed through three repetitions of each verb; in text lines 16–17, the verb phrase *will be* is unexpressed, but it nonetheless plays a grammatical role because it is implied by the past participle *replaced.* With this analysis, each stanza has three poetic lines. In the first stanza, the poetic lines correspond to text lines 1–3, 4–6, and 7–9; in the second stanza, the poetic lines correspond to text lines 10, 11, and 12–13; and in the third stanza, the poetic lines correspond to text lines 14–15, 16–17 and 18–19. This selection shows that even spontaneous discourse can exhibit a high degree of parallel structure. Repeated phrases establish a working rhythm that helps the speaker build upon his own ideas and establish a sense of logic or inevitability for his conclusion.

In stanza 1, Joshua expresses a mathematical argument – that the combination of high birth rate and increasing life expectancy produces high population growth, despite the small flaw in mathematics vocabulary, *the growth of the population is going to increase* rather than *the size of the population will increase.* He uses repetition to assert that the variables of life expectancy, birth rate, and population are all related mathematically. In line 7, by saying *so therefore,* he tries to create the deductive argument that population level depends on the first two variables. As in the modular arithmetic example, Joshua does not express an equation or a mathematical relationship explicitly. Instead, he relies on parallelism to convey his sense of the logical connection among variables.

Next, Joshua undertakes the difficult step of trying to connect a mathematical idea to the world of human values. He wants to express agreement with the population biologist, but he seems uncomfortable doing so. He is concerned to establish himself as a caring person who believes that human lives are valuable, and he qualifies several potentially controversial statements: *mass deaths are really important, I don't want to say replaced, they will be somewhat replaced* (see Rowland, 2000).

As Joshua begins to bridge mathematical and humanistic understandings of disasters, he depends on the structure of the mathematical argument to justify what he apparently fears may be an unpopular statement. The threefold repetition of lines in the next two stanzas allows him to move forward with the sense of logic that he established in the mathematical model of stanza 1. Then, in stanza 3, he uses the "rhythm of three" that he has already established to tie all of his commentary together. His first poetic line in stanza 3 (14–15) refers back to the math model of stanza 1. His second poetic line (16–17) refers to his humanistic statements in stanza 2. In his final poetic line (18–19), he refers again to stanza 1 with "numberwise," to stanza 2 with the word "replaced," and finally he is able to state his agreement with the Malthusian model which is the overall intent of stanza 3.

In this way, the threefold pattern that Joshua used in his original deductive statement was repeated throughout the statement at multiple levels: three stanzas, each with three poetic lines, and a conclusion that references three parts of the entire statement. This student's complex, recursive use of deductive logic is unlikely to be fully appreciated without careful analysis of parallel structures. Repetition allowed this student to construct a mathematical model and to use it to express a social opinion.

Repetition in a collaborative, bilingual discussion

In the previous two selections, parallelism allowed students to express personal mathematical arguments. Parallelism can also account for constructions of mathematical ideas that take place in collaborative discussions. In the next selection, Spanish-speaking third graders compare a parallelogram and a trapezoid (reproduced from Moschkovich, 1999, p. 16). Recomposing this scene in poetic lines, the conversation looks like this:

1	Julian:	Porque si
2		Nomás estas sides
3		get together pero de
4		este
5	Mario:	Y este lado
6		no
7	Andres:	No
8		porque mira,
9		aqui tiene
10		un lado chico
11		y un lado grande
12		y tiene cuatro esquinas
13	Julian:	See?
14		They get together,
15		pero acá no
16	Andres:	Acá no

Selection 3: Trapezoids and parallelograms [3]

In this transcription, indentation organizes repetitions of similar phrases into columns so that they can be traced over several speaking turns, as in the phrases *estas sides/ este/ este lado* (lines 2, 4, 5) and *tiene un lado chico/ tiene cuatro esquinas* (lines 9, 10, 12). Both Tannen and Silverstein use this method to represent poetic structures in conversation (Tannen,1989, pp. 71–73; Silverstein, 1984).

One of the strongest characteristics of this discussion is its quality of closeness and cooperation. Much of the sense of shared purpose and collaboration depends on the speakers' use of numerous repetitions, both in Spanish and in English. All of the opening bids to speak, for example, are repetitions. Julian's *este* is echoed as Mario's *y este lado no* (lines 4–6). This final *no* is echoed as Andres' *no porque mira* (lines 7–8). *No porque mira* also repeats Julian's initial comment *porque si,* and in turn is repeated with a code-switch from Spanish into English in Julian's *See?* of line 13. The *no* that occurs in lines 6 and 7 is repeated again as Julian's and Andres' *acá no* in lines 15 and 16. These opening repetitions smooth the transition from speaker to speaker as each student recognizes the others' contributions.

The students use repetition even as they shift between languages (see Setati, 1998). Their parallelism is a generalized structure for creating meaning that can transcend languages.

Because the repeated lines in this conversation are very short, they could instead be analyzed in terms of revoicing. But by considering the conversation in the more general terms of repetition, we can gain a better understanding of mathematical collaboration processes. Revoicing is most commonly identified as a teacher's deliberate action that models correct mathematical usage or that facilitates student discussions. In this conversation, however, students use repetition freely without any intervention from the teacher through the function that Tannen (1989) calls "production." Repetition "facilitates the production of more language, more fluently" (p. 48) because repeated phrases create units of meaning that speakers can interpret easily and act upon.

When speakers repeat these bits of meaning, they work together to build ideas of greater mathematical significance. In selection 3, there is a series of repetitions focusing on the sides of the figures: *estas sides/ este/ este lado*. Then Andres' commentary transforms this series of phrases into a new repetitive structure based on tiene (it has) but maintaining a link to the theme of lados: tiene/ un lado chico/ y un lado grande/ y tiene cuatro esquinas. Andres broadened the focus of the group to the structure of the whole figure and used repetition to explain differences in side lengths – the major mathematical accomplishment of the group. In a fully spontaneous manner, the transformation from one repeating series to another was the central mechanism of collaboration and of the construction of mathematical knowledge. The students in this conversation developed and shared parallel structures, in both English and Spanish, so that their mathematical understanding "got together," not just the sides of the figure!

Repetition in a collaborative disagreement

In the final selection, students in my undergraduate algebra class try for the first time to find a common denominator for the sum of rational expressions. The problem on the board was

$$\frac{3}{5xy} + \frac{7}{6x^2}$$

In contrast to the previous selection, this collaborative discussion involves clear disagreements. The interplay of collaborative debate and consensus building are central processes in constructivist mathematics discussions. Here, repetition was the primary means through which students refined conjectures, formed alliances, and negotiated their own learning priorities:

1	Sue:	So first thing, let's look at our common denominator.
2		What do we need to have?
3	Frank:	A common denominator,
4		30.
5	Jon:	30
6	Rafael:	something x
7	Lars:	65
8	Sue:	We've gotta have
9		a 30
10	Kiana:	30 … 30 … x … y
11	Frank:	No
12	Rafael:	Just x
13	Frank:	Just $30x$ cause it's not uh, uh
14	Sue:	It's just $30x$?
15	Linda:	We need to have a
16	Kevin:	We need that y
17	Linda:	We need
18	Kevin:	We need the y
19	Frank:	Why we need the y?
20	Linda:	30 … x … squared … y
21	Lars:	Because without, you'd have to make the other one
22	Jon:	Why we need the 30 x y?
23	Frank:	Because the other one ain't got a y.
24		They gotta be the same.
25	Lars:	Why can't you just multiply 5 times 5 xy
26		and then you'll get 30 xy and
27		then you multiply,
28		I'm sorry, 6 times $5xy$
29		and then 5 times $6x^2$
30	Rafael:	It's just $30x$
31	Sue:	Okay, How many people think it's this (pointing towards 30, the first in a list of conjectures compiled on the board, to poll the class for level of consensus).

Selection 4: Denominator of a rational function

The students in this scene struggle with the issue of whether to find a least common multiple, a greatest common factor, or some blend of these two ideas. Jon, Rafael and Frank argue for a denominator with few factors: 30 is posed first, and this is transformed into $30x$. Kiana, Kevin and Linda argue for including more factors in the common denominator. Collectively, the latter three pose $30xy$ and $30xy^2$ so that their conjectures move the discussion towards the least common multiple.

Frank starts off the discussion by saying *A common denominator… 30.* With this comment, he names the Jakobsonian axis of selection and his classmates begin filling it with conjectures. The students consider the coefficient first, then the possibility of a factor of x, then of x and y, and then of multiple factors of y. Students generate these conjectures for collective evaluation by repeating each other's suggestions with slight modifications [4]. In line 10, when Kiana introduces the possibility that variables will be in the common denominator, she spoke in her usual politely authoritative manner, using pauses between the components of her denominator: *30 … 30 … x … y*. Frank and Raphael promote the method of the greatest common divisor and, while they do not fully agree with each other, they seem to build an alliance to reject Kiana's conjecture. Frank, Raphael and Jon each repeat portions of each other's conjectures in lines 4, 5, 6, 12, 13 as they try out a series of conjectures: *30 … 30 … something x … just x … just 30x.* Then, in line 20, Linda offers the correct denominator using a series of emphatic pauses similar to Kiana's. Linda's repetition and refinement of Kiana's $30xy$ in both content and sound suggests that she is listening to Kiana and supporting her. Tracking repetitions in this way allows researchers to give evidence for the pathway that knowledge takes through a classroom as ideas and alliances emerge.

The strongest phase of repetition occurs in lines 15–19 when Linda and Kevin insist on including a y in the denominator. This moment was arguably the most important in the discussion. The strong parallelism created the collective need to shift from conjecturing to justifying, so much so that Frank transforms the repeated phrase into a question: *Why we need the y?* Emphatic parallel statements by Laura and Kevin shifted their classmates' attention towards their unpopular but correct conjecture, and the shift was confirmed by the opposing alliance through a question that maintained the parallel form. After this point, students began to offer longer, more complex lines as explanations. For teachers who emphasize communication, choosing the proper moment to guide students to higher-order, reflective discussions is a key aspect of the delicate craft of this pedagogy (Cobb, Boufi, McClain & Whitenack, 1997). Students in this discussion accomplished the shift through parallel structures in their own discourse with little guidance from their instructor.

Parallel, poetic structures emerge in collaborative discussions like selections 3 and 4 because the editing and production functions of repetition facilitate the interactive construction of knowledge. Students build conjectures by making small changes to others' suggestions. Then, through the production function of repetition, students establish units of meaning that they agree are relevant to the task. The production function allows classmates to signal their opinions in an efficient manner and to transform mathematical ideas into better ones. In both selections 3 and 4, a repeating series transformed into a different repeating series that became a significant collective achievement. Here, a series of conjectures was transformed into a repeating series on the importance of the variable y. In this case, the variable y was the mediating link; the shift allowed students to guide their own discussion. As Tannen (1989) puts it, repetition "gives the impression, indeed the reality, of a shared universe of discourse" (p. 52). In collaborative discussions, repetition is a linguistic form that allows students to build, improve and transform mathematical ideas.

Discussion

Jakobson's view of poetics revitalized the study of storytelling and ritual speech in linguistic anthropology (Bauman & Sherzer, 1989). It has also been used to document the poetic qualities of ordinary speech (Friedrich, 1986; Silverstein, 1984; Tedlock 1983).

Jakobson's poetics was widely influential in linguistic anthropology for two reasons. First, it did not rely on a distinction between literate and oral expression. Hymes' discovery of poetic line structure in Native American narrative, for example, demonstrated that a non-literate indigenous culture could produce aesthetically complex narratives. In this sense, Jakobson's poetics helped democratize the study of aesthetics. Second, the study of parallelism provided a point of entry for anthropologists who wished to understand aesthetics in an unfamiliar language and culture. Repetitions of grammar, words, sounds, and rhythms draw attention to the form of a message and focus attention on ideas that the speaker believes are important. These same repetitions, therefore, offer structural, observable evidence of significant ideas. Jakobson's poetics allowed anthropologists to identify cultural constructions of meaning that were outside of their own experience.

Despite differences in subject matter, there are theoretical resonances between the studies of oral traditions and of mathematics discourse. Just as literate expressions are often valued more highly than oral ones, the formal register of our discipline is sometimes valued more highly than the legitimate ways in which learners express mathematical ideas (Barwell, 2005; Street, 2005). As we have seen, poetic structures can be the form that students use to express both inductive and deductive arguments and to build mathematical ideas in collaborative discussions. Although more research is needed to determine the prominence of poetic structures in mathematics discourse, listening for them may provide a system for identifying a student's attempt to construct an argument. Because the method is formal, that is, it focuses on language structure, it provides a means of entering into students' thought processes and maintains at least some measure of independence from the analyst's perspective on what ideas count as mathematical.

Poetic discourse can express mathematical thinking in varied learning situations. But what can account for the affinity of poetic structures and mathematical ideas? Why do students express mathematical ideas using forms of discourse that can, in other contexts, be poetic? We can see this by considering that in Jakobson's perspective, poetic speech is inherently organizational. Indeed, he called parallelism a poetic function deliberately, because it maps related ideas into an established grammatical structure. This sorting and arranging of ideas based on similarity and contrast is arguably a mathematical way of thinking.

More directly, the self-referential nature of poetic language, the attribute of a message that heightens attention to its own form, allows speakers to manage issues that arise in communicatively oriented mathematics classrooms. Clearly, focusing on the form of a statement occurs in mathematics discussions when students must refine each other's ideas. But further, the form of the message establishes relationships among ideas that are not always expressed explicitly. When discourse structure is used to convey a thought or a conjecture, ideas are condensed into a template of meaning on which others can act efficiently, as when *We need the y* became *Why we need the y?* While processing an idea for the first time, parallelism helps a student organize thoughts in a structured way and to form the idea into a "unit of meaning" that the class can refine later in the conversation. The unit becomes a sign and repetition is an implicit rule for generating related signs (Ernest, 2008). The poetic function, therefore, is a linguistic means by which students create "taken-as-shared" sociomathematical norms within their classroom (Cobb, Stephan, McClain & Graemeijer, 2001). The transformation of one unit of meaning into another is quite literally a linguistic construction of mathematical ideas. Parallelism is a multi-functional feature of language that allows people to "think out loud" about the relationships among ideas.

Conclusion

The potential to trace the construction of mathematical meanings, in students' terms and in very different settings, suggests that this approach merits further attention in mathematics education research. Researchers who wish to make a careful account of how mathematical meanings are expressed, shared and refined in classroom discourse may find the study of poetic structures to be a powerful tool. Taken together, the editing and production functions of poetic structures allow this discourse form to handle several important features of constructivist learning. Repetition helps individual students build mathematical arguments and models. In collaborative discussions, it allows students to create shared units of meaning and transform them into better mathematical ideas. Mathematicians are accustomed to finding meaning in form, structures and relationships as much as in numbers themselves. Through the poetic function, mathematical meanings can be expressed through the form, not merely the words, of language.

Notes

[1] 'Believing in Iron' by Yusef Komunyakaa is reprinted with the kind permission of Wesleyan Press.

[2] Incidentally, one of Hymes' major contributions to ethnopoetics could be considered a form of ethnomathematics embedded in narrative convention. Hymes found that many Native American folktale traditions rely on a narrative device of presenting situations through event descriptions that occur in combinations of either threes and fives or twos and fours. A cultural convention of how much evidence makes a description feel complete and authoritative can create fairly consistent mathematical patterns in narrative.

[3] The translated exchange is (Moschkovich, 1999, p. 16, Moschkovich's translation):

Julian:	Because … just these sides get together, but on this side only.
Mario:	And this one, no.
Andres:	No, because look, here it has a small side and a large side and it has four corners.
Julian:	See? They get together, but not here.
Andres:	Not here.

[4] This selection illustrates one of the disadvantages of using indented line format. Standard transcription methods of representing the many overlaps or interruptions that occurred in this conversation use indentation, too.

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