

Mathematics Education and the Analysis of Language Working Group: Making multimodal mathematical meaning

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Introduction

The aim of this working group is to share the detail of how we work with language in our own mathematics education research. We dwell in the moment of analysis, in a way that is generally not possible to communicate in research reports, and share strategies and approaches. At this meeting, Alf Coles gave a brief introduction to conversation analysis (which had been discussed more fully at the last meeting) and then I offered some data and my own approach to analysis, based on a more multi-modal approach.

The aim of this working group session was to triangulate (Gorard and Taylor 2004) classroom discourse analysis (or conversation analysis) with multimodal analysis (Jewitt 2009) using multimodal transcripts (Bezemer and Mavers 2011). Kress and van Leeuwen (2001, 20) define multimodality as “the use of several semiotic modes in the design of a semiotic product or event” which includes other social semiotic resources such as gesture and movement. Recently Rampton et al. have argued for an eclectic approach to classroom research. They made a comparison of approaches to the micro-analysis of classroom discourse, including ethnography of communication, conversation analysis and a systemic functional approach. They concluded that all three approaches “offer more to the analysis of classroom discourse in combination than they do alone” (2002, 387).

We wanted to offer participants to the working group an experience of trying out two approaches to the analysis of the same transcript and to then discuss the process. We therefore had two versions of the same transcript, one with text only and one with multi-modal additions. In the remainder of this report, I describe multimodality as an approach to language, set up the multi-modal transcript used in the session, offer my analysis and conclude by sharing some of the comments by participants on the day.

Multimodal analysis

Multimodality refers to a field of application and approaches which attends “to the full range of communicational forms people use, image, gesture, gaze, posture, and so on, and the relationships between them” (Jewitt 2009, 214). There is an extensive literature on the impact of different modes and their effect in the process of meaning-making using images and visual design (Kress and Van Leeuwen 1996), gesture and movement (Martinec 2004), semiotic modes of colour (Kress and van Leeuwen, 2002) and mathematical symbolism and images (O’Halloran, 2005). I am interested in how, by drawing upon semiotic resources or nonverbal contextualisation, cues such as ‘figurative language and gestures’ and semantic content of the speech such as ‘talk’ are being juxtaposed in a bilingual classroom and the ways in which they provide pedagogic possibilities by creating a coherent package of meaning and action. In other words, it is not only what A says to B that sends a message, but also how A conveys the message.

Duncan (1980) believes the sociolinguistic aspects of language along with the co-occurring ‘nonverbal’ phenomena provide a better means of understanding of language use. The traditional definition of language and transcription does not include non-verbal communicative resources like body movements, gestures, facial expression as well as prosodic features (like stress and intonation) and other paralinguistic features like change in volume of speech (speaking louder or softer), change of pitch (speaking higher or lower) or proxemics (Hockings 1995), that is to say, “how people regulate themselves in space and how they move through space” (Collier 1995, 235).

A balanced combination of gesture and speech, that is without being restricted to verbal language solely, can support learners to construct meanings (Alibali 1999), assist learners cognitively in providing an avenue to communicate and convey thoughts (Kendon 1997), and help in turn-taking (Goodwin and Goodwin 1986). Moreover, in other studies, gesture becomes a visual resource that can assist students in resolving mathematics register confusion, such as the technical term ‘perpendicular’ (Castellón 2007). In addition, pointing gestures maximise the communicative effectiveness if vocabulary is limited (Volterra and Iversen, 1995).

Nonverbal contextualization cues often appear to precede or occur simultaneously with their corresponding speech-like vocalization which “may be moving in different directions and at different speeds” (Condon 1980, 51). Gesture and speech form an integrated system in an utterance and “gesture-speech combinations tend to be synchronous” (Goldin-Meadow and Butcher 2003, 96) which means that the two modalities convey related, if not identical, information (ibid, 94)

Classroom culture and transcription of the audio-visual recordings

I attended a British-Iranian school for observation and video recording in the UK. The school was held on a Sunday and the classroom teacher (T2) was going through some of the GCSE questions bilingually (using Farsi and English). That specific lesson consisted of bilingual learners from a Persian background who were in Years 9, 10 and 11 (aged between 14-16 years) in their mainstream schools. The analysis of this part is specifically based on the conversation of the teacher (T2) followed by a constructive comment by a learner whom I shall refer to as B3.

T2 and learners in this classroom were engaged in solving arithmetic questions from a textbook on the whiteboard. Initially there was a task to simplify $\frac{2}{(\frac{1}{3})^{-2}}$ which exhibited a challenge to learners. T2 recommended just focussing on $(\frac{1}{3})^{-2}$ and forgetting about the numerator for the time being. He then demonstrated that any number ‘A’ to the power of a minus integer ‘-B’ can be rewritten as ‘one over A’ to the power of a positive integer ‘B’. T2 offered this method of procedure as he wanted to avoid negative powers.

Different understandings of what is Given and what is New: Reading directions in mathematics

In this transcription, the left hand column illustrates the verbal interactions only and the right hand column signifies the multimodal nature of the classroom. Based on the idea of what is ‘Given’ and what is ‘New’, Kress and van Leeuwen (1996, 187) believe that “[t]he elements placed on the left are presented as Given, the elements placed on the right as New. What is given is what the viewers are already familiar and

agree upon but what is New, on the other hand, is not yet known and viewers must pay special attention to it. They have also acknowledged ‘culture’ and ‘social constructs’ which can attach different values to reading directions e.g. right to left or top to bottom. The multimodal transcript convention I have used is as follows:

T	Teacher	B	Boy
[]	Non-verbal communication	{ }	My Translation
<u>Underlining</u>	The specific point in the utterance where non-verbal contextualisation cues occurred simultaneously.		
<i>Italics</i>	Farsi transliterated into English		
Normal font	English language		
Dots	Each dot represents one second of silence		
Change in font size	Change in volume of an utterance: the bigger the font is, the louder the pronunciation. The smaller the font is, the quieter the pronunciation of the term.		

- 1 T2: *chi migoftam, migoftam agar darim A be power of minus B, it's equal to what?* {what was I saying, I said if we have A to the power of minus B, it's equal to what?} [4: Teacher puts a^{-b} on the whiteboard as he is completing his utterance]
- 5 B1: A over B
- 10 T2: . . No . . it's one over 'a' be power of . . 'b' . . *chera, chon really . man be tore mamooly doost nadaram ke che kar bekonam?* { . . No . . it's one over 'a' to the power of . 'b' . why, . because really, . normally I don't like to have what?} [10: slight laughing noise in the background]
[10: teacher writes $\frac{1}{a^b}$ on the whiteboard]
- Bs: Negative [a few boys say negative at the same time]
- 15 T2: Negative as a power *dashte basham*. {I don't like to have negative as a power} *pas* {so} I just take this one, that bit, I just take it out. [15: Intonation, emphasis on the term 'power' as well as a hand gesture to indicate the position of power]
[17: Deictic gesture, referring to the denominator of the complex fraction]
- 20 *Man daram chi, one over three be power of minus two.* {So I have one over three to the power of minus two} [20: Teacher puts $(\frac{1}{3})^{-2}$ on the whiteboard as he makes this utterance]
[22: He points with his index finger¹ illustrating one at the top. He is holding his index finger up with the rest of his fingers closely

B3: oh,
 ye one
balash
mizari {oh,
put a one at
the top}



curled, which could possibly indicate one. The location of his index finger is not horizontal as most pointing gestures are, but semi-vertical, more vertical than ordinary pointing gestures tend to be.]

Analysis of the verbal form of the conversation

In lines 3-5 T2 started off by stating a general rule in mathematics that is usually and frequently used in algebra. T2 uses a shared pronoun ‘we’ to engage with a wider audience and stress the importance. The ‘we’s run through T2’s explanation to encompass and refer to the ‘common practices’ by others who use this algebraic method. Pimm (1987) discusses the use of ‘we’ in mathematics pedagogy and argues that the function of ‘we’ is authoritarian. In contrast, when T2 expresses his opinion towards negative powers (lines 12) he then uses the personal pronoun ‘I’. By saying “I don’t like to have negative as a power” (lines 16-17) refers to the personal preferences of T2 illustrated by the use of ‘I’. The use of the first personal pronoun ‘I’ by T2 clearly exhibits a subjective and a particular point made by T2 that he personally does not appreciate this practice as opposed to the use of the shared pronoun ‘we’ to refer to what could possibly be considered a common practice.

In lines 20-1 T2 writes $(\frac{1}{3})^{-2}$ on the whiteboard followed up by an immediate response from B3. In the proceeding lines 22-3, what B3 had in mind was in the form of $(\frac{1}{\frac{1}{3}})^2$ which differed slightly from T2’ version in the form of $(\frac{1}{3})^{-2}$ as there was a missing 1 at the top (in the numerator). In lines 22-3 B3 switches between his linguistic resources (Farsi and English) and announced: “oh, *ye one balash mizari*” [Oh, put a one at the top]

B3 started off his statement with ‘oh’. ‘Oh’ is regarded as “an element of surprise” (Roth 2009, 105). Moreover, the expression ‘oh’ “revealed the attainment of a crucial awareness” (Radford 2009, 118) as B3 was conscious of the fact that the task was not yet completed. B3’s language choices contributed to the negotiation of meanings within the ongoing flow of bilingual talk in this complementary school. Moreover, it is in the bilingualism of the lesson that the full message is conveyed.

Multi-modal analysis

Gesticulation, the spontaneous hand movements produced while talking (Kendon, 1980) is a ‘tightly linked system’ (Kita 2009, 145). In general, index-finger extension pointing often tends to be in synchrony with speech (Masataka 2003). In lines 22-3 B3 refers to the missing one by locating his referent in space and time for his interlocutors. B3 accomplishes this dually, by pointing and talking. A balanced combination of gesture and speech can be used as a significant pedagogic visual tool to clarify meanings in a multilingual mathematics classroom (Castellón 2007).

B3 produced a gesture which was an ‘abstract deixis’, in the sense that the gesture points to no concrete target (McNeill 2003). B3 has employed a hand gesture synchrony and co-expressively as he was talking about the ‘missing one in the

numerator' on the whiteboard. By doing so, he shifted from auditory to visual representation in order to convey a concept by pointing. In this case, there was no object to point to as the numerator was missing.

B3 gestured with index-finger pointing with the palm vertical, with the other three fingers tightly closed. The index-finger pointing with the palm vertical indicates a referent that is relevant to the focus of the current discourse (Kendon and Versante 2003). It is in contrast with the thumb pointing. Pointing with the thumb is often used to point "when it is not important to establish the precise location or identity of what is pointed at" (Kendon and Versante 2003, 121).

B3's linguistic and semiotic resources regulate the process of meaning-making. For example, B3's pointing gesture was composed of (1) demonstrating (holding up his index finger to demonstrate one) (2) indicating (the location of one at the top by indicating it semi-vertically) and by drawing upon his linguistic resources at his disposal, to accompany the nonverbal communication. B3's index-finger pointing appeared to be in complementary rather than contrastive distribution. B3 made a hand gesture in which he did not have to "rely on speech alone to convey an idea" (Castellón 2007, 45) and was in synchronic relation with the linguistic expression used. This synchronic relation between the two modes (verbal and semiotic) signifies as an indication of sympathy and rapport.

Conclusion

In discussion of the transcript above (which was presented without my own analysis) participants reported that a conversation analysis approach (in which they were given the text only) was almost impossible. The issue of methods of transcription is relevant here as in general, for conversation analysis, many prosodic features of the text are signalled in the transcription convention, which was not the case in what was offered participants. A comment was also made that researchers doing a conversation analysis will generally have had access to the rich video or audio data from which the text is created and that this is perhaps highly significant in terms of being able to make sense of the language.

At the end of the meeting we discussed ideas for future meetings and there were four offers of data with which we could work. It seems therefore that there is energy for this group to continue and we hope to meet at the next BSRLM day conference in June.

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