# Frame Analysis in Mathematics Education

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*As the field of mathematics education attempts to marry interpersonal and informational aspects of mathematics teaching and learning, conceptual tools from social disciplines (e.g., sociology and sociolinguistics) are being (re)visited. This paper offers Goffman's theory of framing as a source of analytic tools for studying prompts for and orchestration of social arrangements in classroom mathematical activity. As interactional roadmaps, frames guide the construction of local social interaction and positions in relation to broader activity. Here, frames are considered in relation to storylines and figured worlds, and the benefits and limitations of frame analysis are explored.*

## Introduction

A teacher asks for a volunteer to lead the class through the next homework problem, which involves finding the area of an oblique triangle drawn on a Cartesian graph. A student volunteers and walks the teacher through a solution strategy, which the teacher writes on the overhead. The solution involves creating a rectangle around the triangle, and sectioning the rectangle into pieces to find the area of the triangle inscribed in it. The following interaction ensues:

ESME: Am I doing this wrong?
TEACHER: I don't know. We are gonna talk about it in a second. So this is what we have. Is that an okay representation? And Esme is saying that what I drew… it's going to give us draws a triangle. If I am right, Esme, it's gonna give me just this right here. (Teacher colors part of the triangle red.)
ESME: Yeah. Well no. I'm gonna get the area right there. (points to a different part of the rectangle)
TEACHER: Okay
ESME: And then I'm gonna divide it in two.

TEACHER: Okay. And that's to get this this red part here? (Esme-*mmm hmm*). Okay, so what do we think, folks? Is that right? (students shouting things) So she takes the area of this whole triangle? Let's do it! So what is the area of the rectangle Esme, not the whole rectangle, but the blue rectangle (writes $A_{\Delta}$ = on the overhead).

ESME: 2 times 5, 10

TEACHER: 2 times 5. Do we all agree with that part? (a student says loudly "*Yes*") 2 times 5. And then she says she's going to divide it in half. She says which gives us 5, right? Is 5 that red part? Is that what you think is 5?

ESME: Yes

TEACHER: Does everyone agree with that? (Esme looks to classmates)

STUDENT: (loudly) That's how you do it?

TEACHER: She says that 5 is the red part. Remember this is the triangle I screwed up when I showed you the first time, right?

STUDENT: I got 4 ½.

TEACHER: You got 4 ½ for that red part? You can go ahead and sit down Esme. We will discuss it.

One way to interpret this exchange is as a case of a student presenting a solution to a mathematics problem. A closer analysis reveals that the student, Esme, is exercising agency over mathematical concepts, and that the teacher is positioning her with the authority to do so (Gresalfi, Martin, Hand, & Greeno, 2008; Pickering, 1995). Yet, there are other aspects of this brief exchange that supported students like Esme, a Latina who began the class believing that she was poor at mathematics, to view themselves as mathematically capable (Hand, 2003, 2012).

The teacher's talk in this episode also seems to have a coaching feel to it. How do aspects of these discourse practices relate to the coaching feel? What is the relation between the "feel" of a mathematics classroom and mathematics learning? The aim of this paper is to illustrate how aspects of social interaction can cue the organization of particular "frames" (Goffman, 1974) or "scenes" (Burke, 1941), that have a recognizable feel to them. These frames, in turn, invite social arrangements, which over time influence the ways that individuals view themselves, others, and their joint activities.

## Cuing Social Arrangements

In the last twenty years, the field of mathematics education has turned to social theories of learning and development to explicate the how pedagogic practices and systems influence and are influenced by social processes and structures (Lerman, 2000; Morgan, 2014; Valero & Zevenbergen, 2004). In particular, researchers have been concerned with classroom discourse practices and texts that are characteristic of particular kinds of communities and member identities (Gee, 2000; Wenger, 1998). Not satisfied with accounts that treat local classroom communities as isolated units, researchers concerned with issues of equity and power are also attempting to bring socio-political structures and technologies that function broader levels of human activity into view (Gutiérrez, 2007; Skovsmose, 1994). According to Morgan (2012),

> It is necessary to take such [higher-level social] structures into account in order to be aware of the ways in which phenomena apparent within a particular social practice may arise from or have impact upon the lives of the participants beyond that practice and to be able to consider the possibilities of more equitable practices. (p. 182)

Morgan echoes what a growing number of researchers in mathematics education internationally regard as a crucial direction for research in mathematics education.

To date, researchers have drawn on a number of theorists and philosophers of social theory to prod the field in this direction. As described in a recent special issue of *Educational Studies in Mathematics* (2014), prominent among the social theorists informing critical studies of mathematics education are Basil Bernstein, and French philosophers Michael Foucault and Pierre Bourdieu (Morgan, 2014). Loosely categorized as critical theories provide important perspectives on the reproduction of dominant power structures through pedagogic practices and systems. Methods used to analyse these relations, however, have been less readily available for researchers focused on classroom mathematical activity. As a result, analytic techniques such as discourse analysis, critical discourse analysis (CDA) and structural functional linguistics (SFL) have been employed to operationalize critical theories with respect to classroom mathematical activity

(Herbel-Eisenmann, Choppin, Wagner, & Pimm, 2012). These methodologies enable researchers to study the construction of classroom structures and member positioning in moments of classroom discourse. I offer yet another methodological approached based on the theories of framing by Erving Goffman (Goffman, 1967, 1974, 1981).

Frame analysis has been employed by sociologists (Benford & Snow, 2000), cognitive psychologists (Bateson, 1972; Tversky & Kahneman, 1981), sociolinguists (Tannen, 1993), political scientists (Coburn, 2006; Oakes & Rogers, 2006), and learning scientists (Engle, 2006; Hammer, Elby, Scherr, & Redish, 2005) to understand how individuals come to orchestrate activity together. Frames signal to participants in the activity (often tacitly) what it is that they take themselves to be doing (Goffman, 1974). They position certain actions and responses as reasonable, while rendering others nonsensical or even detrimental to desired outcomes (Tversky & Kahneman, 1981).

In this paper, frames are conceptualized as co-constructed in interaction (Greeno, 1989). They do not proceed social activity, but instead are bid for, ignored, contested or orchestrated in moments of interaction by interlocutors (Tannen, 1993). At the same time, frames point to social practices and processes at a broader levels, which lends familiarity to them among groups of individuals. Cuing a frame, then, also prompts the organization or dismantling of socio-political hierarchies and structures in local social arrangements.

This paper explores the advantages and limitations of employing frame analysis to study the relation between classroom mathematical activity and broader socio-political processes.

## Frames as Interactional Roadmaps

Frames are interactional roadmaps in the sense that they cue participants to the goals, routines, and expectations under which they are interacting in a particular context (Bateson, 1972; Goffman, 1974). For Engle (2006),

> …a context has been framed when someone uses meta-communicative signals that help establish what the participants are doing together in it, when and where they are doing it, and how each person is participating in it… (p. 456)

By signalling a particular framing of on-going social interaction, an individual makes a bid for the activity to be interpreted and to proceed in a particular way. This bid may or may not be taken up by other parties in the interaction. Similarly, the construction of the frame does not dictate the interaction that follows within it. Similar to a dramatic "scene" (Burke, 1941), a frame invites participants to embody roles and actions that render the scene recognizable to others, while allowing for flexibility and improvisation.

Frames are recognizable to groups of people in part through their connection to broader social imaginaries (Taylor, 2004). A social imaginary represents the systems of meanings, symbols, and ideals that are implicit, but ubiquitous in the collective life of individuals (Taylor, 2004; Thompson, 1995). In a sense, they are "backdrop" that renders engagment in constellations of social practices in a particular place and time coherent and relevant.

Frames offer connections between broader scales of collective social activity, or *figured worlds*, and the trajectories of participation that particular (groups of) individuals assemble in their local activity with respect to these worlds, or *storylines*.

## Frames, Storylines, and Figured Worlds

Holland, Lachiotte, Skinner & Cain's (1998) notion of figured worlds is a popular analytic framework for producing accounts of broad spheres of collective activity that individuals point to and call up in joint social interaction. In part imagined and in part real, figured worlds enable researchers to account for relatively stable and broad scales of social activity, circumscribed by mutual experiences, interests and lifestyles, (re)made in the everyday activities of individuals. Analysing the construction of worlds in moments of social interaction, however, is challenging. Frames offer an analytic "middle ground," whereby researchers can study and theorize particular worlds through the scenes that comprise them.

One way to conceptualize the type of scenes/frames that make sense in a particular figured world is through the concept of storylines (Harre & van Langenhove, 1999). According to Harré & van Langenhove (1999), storylines articulate particular subject-positions for participants that are telling them through their interactions.

Wagner & Herbel-Eisenmann (2009) view multiple storylines as characteristic of figured worlds, as they relate to relationships among individuals participating in and configuring them. Storylines, then, guide the negotiation of different scenes in the world, and the direction these imagined scenes take serve to reshape storylines at various scales of activity.

The opening clip illustrates the proposed relations between these concepts. The mathematics class featured in the episode was the subject of a larger study that examined the nature of opportunities to learn mathematics for US high school students from non-dominant ethnic, racial, and socioeconomic backgrounds (Hand, 2003, 2012). Analysis of transcripts of social interaction captured through video over the course of a school year revealed that features of the teacher's discourse were characteristic of what Hoyle (1993) has describes as a *sports commentary frame*. Drawing on Goffman, Hoyle identified discursive techniques that were constitutive of this frame, which included: a) extensive use of action verbs, b) third-person narrative, c) distinctions between, "you", "us", and "them", d) vivid and detailed descriptions of action, e) if-then projections, and f) physical shifts to direct attention to plays (or in this case, mathematical productions). These techniques can be seen, for example, when the teacher narrates Esme's solution strategy, describes her mathematical actions in detail, and re-voices the justifications Esme produces for them. While the sports commentary frame necessarily points to a figured world of professional sports, it's unclear how this world relates to classroom mathematics learning.

It is helpful to focus on particular storylines in the figured world of professional sports, through which the sports commentary frame may be getting organized. How are the students getting positioned and positioning each other in this episode? What are they entitled and expected to do with respect to mathematical activity? One potential storyline that figures the world of sports is that players are engaged in making strategic decisions about their plays, based upon their read on a situation. This storyline positions players as skilful and rational actors. Highlighting aspects of the players' decisions and the intended and unintended consequences can lead to improved performance on the part of individuals and the team. Within this storyline, players are viewed as members of a team that depend on each other to be successful, and who are entitled to participate in the broader sports

community. (Of course, numerous other storylines are perpetuated in the figured world of sports, some of which are less affirming of players.)

How does this storyline function with respect to the teacher's pedagogical goals? One of her explicit goals was to invite students to articulate and evaluate each other's mathematical reasoning as a community. This activity resonates with the storyline above, about students being capable, entitled and obligated to recount the rationale behind their solutions strategies. By cuing the sports commentary frame, then, the teacher was *reinforcing* a less common storyline in the figured worlds of mathematics for groups of students who are typically marginalized, with one from the figured world of professional sports. The sports commentary frame reinforced positionings of students with respect mathematics that were less stable than those typically organized in mathematics classrooms. Put another way, the frame served to disrupt traditional status hierarchies around race, ethnicity, language, and class that are perpetuated in and through mathematics teaching and learning.

The next section explores the advantages and drawbacks of frame analysis for mathematics education research.

## Analyzing Framing

One strength of frame analysis is the discernment of subtle meta-discursive signals that trigger interpretations of activity (which may or may not be intended by the interlocutors). For example, frames "at play" in mathematics classrooms may illuminate why participants are cued to move in and out of different social arrangements (Hammer et al., 2005). For example, the teacher may not have intended to organize a coaching frame, but doing so had important implications for students' uptake of opportunities to reason mathematically.

A second strength of frame analysis is the ability to conjoin analyses of "relational" aspects of mathematics classrooms with content learning. To separate discourse within the sport commentary frame from mathematical discourse would be a difficult and unproductive task, since they are constitutive of each other. Frame analysis maintains the glue between social positioning and what individuals come to know and do (Greeno, 2009).

A third strength of frame analysis is observing how frames perpetuate or disrupt broader social hierarchies in local activity. Social arrangements that are organized through a frame often involve storylines for participants based on social categories such as gender, race, class, etc. (Hand, Penuel, & Gutiérrez, 2012). Shifting frames may offer new storylines for individuals who are typically marginalized through the activity.

A significant limitation of frame analysis is identifying when and what is a frame, and who gets to decide. Frames are necessarily partial, cultural objects. Fragments of frames are continually being assembled and disassembled from differing points of views in interaction (Voigt, 1994). They are also connected to particular social and cultural communities, and thus, marked to one group of people and unmarked to others.

A second limitation is that frames will necessarily overlap with and interpenetrate each other. It's complicated to analyse to which frames individuals are responding in a given moment, and to which figured worlds particular frames are pointing. Thus, as the field attempts to make this social turn, the concepts described above will require careful consideration and deliberation. However, seeking answers to these questions may enable researchers to discern features of mathematics classrooms that give them a distinct feel and offer particular possibilities to their learners.

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