An Emerging Framework for Ethnography of Adult Mathematical and Numeracy Practices

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Frank is a senior lecturer at AUT University and teaches the numeracy component in the online Masters in Adult Literacy and Numeracy Education. Because Frank's degrees are in sociolinguistics and mathematics, he has interests in the intersection of discourse and mathematics as it is applied to adult mathematics learning.

This paper presents a potential ethnographical framework for examining in-situ adult mathematical practices. It results from a meta-analysis of over 400 articles and reports published on adult mathematics and numeracy practices in the workplace, everyday life, and assorted other situations where numeracy is present (for example, sports events). The framework is also informed by a combination of my own academic sociolinguistic and mathematical backgrounds. Consequently, it draws on a synergy of insights from sociomathematics, ethnomathematics, social practices theory, and the history of mathematics. It is envisioned that this ethnographic framework may assist in excavating mathematical practices at multiples levels (semiotic, material, discursive and diverse others), and thus provide a way forward to offering ,among other things some pedagogical insights on the teaching and learning of mathematics for adults.

Introduction

This paper sets out an incipient framework for an ethnography of adult mathematical practices. To some extent, it was "inspired" by the work of Dell Hymes and his well-known "Ethnography of Communication" (Hymes, 1964 & 1974). Saville-Troike took up the Hymesian framework and expounded its potential in more detail (Saville-Troike, 1982). As a sociolinguist, what struck me about the framework was the lack of any reference to mathematical practices. In fact, it is fair to say that mathematics seldom comes within the orbit of ethnographical considerations.

The current discourse on adult numeracy and literacy "skills" in New Zealand and many other OECD countries, which was brought to the radar screen by the recent All (Adult Literacy and Lifeskills) survey (for an overview in New Zealand, see Satherley & Lawes, 2007), has made numeracy practices an object of more intense investigation. The extant discussions of the results of the survey invariably equate numeracy 'scores' with numeracy 'skills'. If 'skills' are seen to be things performed in real settings, then this 'scores-equals-skills' equation is a considerable pedagogical and indeed epistemological leap. An ethnography of maths practices will put this 'scores-equals-skills' equation under the spotlight.

Two related concepts have already arisen in the course of this discussion: mathematics and numeracy. In the literature definitions of adult numeracy are most usually defined with respect to mathematical practices as they are carried out in real every day, and employment contexts. However, it must be acknowledged that the majority who define numeracy in this way seldom venture any definition of mathematics itself. There is then a certain sense that mathematics is taken for granted (Leng, 2002). It is seen as occupying an impenetrable domain of pure thought. There is thus a need "To haul this

lofty domain (mathematics) from the Olympian heights of pure mind to the common pastures where humans toil and sweat" (Struick, 1986, p. 280 . Struick cites Engels in Anti-Dühring.

Yet if an understanding of adult mathematical practices is to be entertained, some discussion of the contested area around a definition of mathematics is necessary. However, for the purposes of this paper, a potential definition will be left implicit within the emergent framework. An ethnography of mathematical practices opens up a space in which hegemonic, normalized, eurocentric mathematical norms can be interrogated (see Reinhart, 2012). Bakhtin (1982, 1986) refers to centripetal and centrifugal force at work in language formations – a concept I believe can be fruitfully applied in the mathematical sphere to enhance such an interrogation.

Rationale

An ambitious project then it is. My motivations, aside from those intimated above, are a love of mathematics, a desire to enhance mathematical pedagogy and andragogy, a concern for those who dislike maths, and most of all, an intense curiosity about what people really do when they do mathematics (practices that are often designated by agents as 'common sense' rather than mathematics).

Methodology

The method employed in this study falls under the general rubric of a meta-analysis. It is not strictly so. It has involved searching through hundreds of articles and viewing videos that explicitly or implicitly deal with actual mathematical practices. In other words, this project makes use of the labours of others and endeavours to seek a framework in the light of already explicated practices.

Ethnography of mathematics.

What follows is an overview of what an ethnography of mathematics might consist of from a number of perspectives.

What is an ethnography of mathematics?

A broad definition of ethnography would be "people's actions and accounts are studied in everyday contexts" (Hammersley & Atkinson, 2007, p. 3). However, Hammersley and Atkinson acknowledge the complex and contested nature what ethnography is.

I have broadly divided an ethnography into three types and utilized the terms etic and emic first proposed by Kenneth Pike (1967). Firstly, there is an etic approach. I call this exo-ethnography. Here the focus is on bringing an outsider's 'grid' or framework to the mathematical practices of people in their assorted cultural settings. Secondly, there is an emic approach. I call this endo-ethnography. The focus here is on an insider's perspective (or a participant's perspective) on mathematical practices. Finally, there is the concept of an auto-ethnography where a person examines their own mathematical practices. There are of course important philosophical concerns with each of these approaches that have been well discussed in the literature (for example Hammersley & Atkinson, 2007). Each can be seen to offer advantages and disadvantages. In what follows, the emphasis is on an etic orientation (an outsider's view point).

Who does ethnography?

A range of researchers/practitioners from various disciplines have an investment in an ethnography of mathematical practices: ethnographers; anthropologists; historians; archaeologists; teachers and trainers; health and safety experts; policy makers; and of course mathematicians themselves.

Apart then from the obvious answer of researchers, an understanding of mathematical practices, both overt and covert, could well benefit all the disciplines. Mathematicians themselves may gain a deeper understanding of their practices which may in turn lead to alternative strategies and more elegant and significant mathematical outcomes.

Across the "divide" in the humanities and arts, practitioners could benefit from the explicit and implicit practices uncovered in a range of disciplines including art, dance (Gadanidis & Borba, 2008), design and music (Beer, 2005).

Where might an ethnography be done?

The ubiquitous presence of mathematics in daily lives answers this question. It also opens up spaces and domains where practices maybe compared and contrasted, for example classroom maths "versus" street maths (Saxe, 1988).

Why might an ethnography be done?

Our intuitions about mathematical practices are often wrong and practices are often so embedded, they become invisible. Also, formal maths practices in classroom are often cut off from practical mathematical uses in more informal domains. As a result, many adults carry with them often stark memories of seemingly irrelevant high school mathematical experiences. The endless, seemingly pointless, array of decontextualized algebra problems often 'bewitched, bothered and bewildered' many students as to the purpose of mathematics.

Yet mathematics in many ways has been and still is a high-stakes game. In hospitals, for example, this is certainly the case. And the repercussions of $E = MC^2$ have reverberated into this century. Whether it is the wave/particle paradox that supports quantum physics or the mathematical considerations that makes all sports winnable, or losable (in my experience), we live in a world saturated with numbers.

An emergent framework.

Hyme's original ethnography of speaking framework used the pneumonic: S-P-E-A-K-I-N-G. It can be elaborated thus: 1. Setting and Scene; 2. Participants; 3. Ends; 4. Act Sequence; 5. Key; 6. Instrumentalities; 7. Norms and 8. Genre (Hymes, 1973). I bear this in mind as I ask the most basic of questions.

It was Rudyard Kipling who coined the idea of "six faithful servants" (he called them serving men at the time). And so, for simplicity sake, this would be a good place to start.

Where is the mathematics being practised?

Here the primary consideration is given to the general environment where people are practising maths overtly or covertly. Words like event, situation, domain and episode come to mind. The 'setting and scene' of the Hyme's pneumonic is in view here. Any environment from a lecture theatre to a cross-country event can be included (Figure 1).
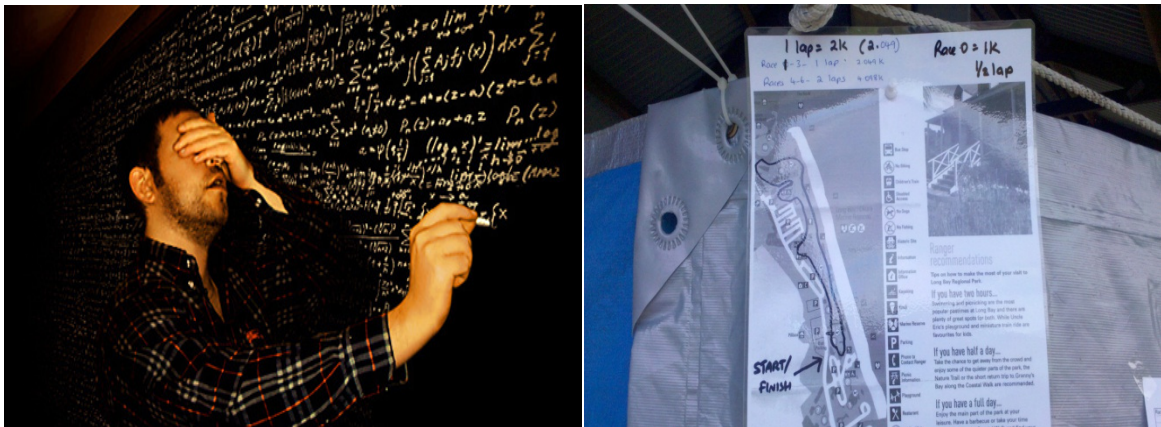

Figure1. Formal and informal domains (a 'lecture' and a cross-country event.)

What does the mathematics involve?

Needless to say, some professional mathematicians would delimit mathematics to what professional mathematicians do. However, this paper sees mathematics in its broadest context. If any emphasis is to be placed, it would that mathematics has much to do with the 'science of patterns'.

We tend to presuppose that every maths event involves solving a problem. However, there is also an element of play, performance and patterning. Below we look at what mathematics might involve (from an etic point of view).

1. The material environment.

Here the material environment is under consideration in terms of 'objects' (see Riss, 2011). Some artefacts are obvious or explicit – of course textbooks, calculators, computers, white/black boards spring to mind in more formal mathematics settings. In informal settings, there are tools, instruments, blueprints, maps and plans. There are all manner artefacts that mediate mathematical processes including the human body. Some artefacts are less obvious or implicit – particularly in the process of estimation. Hymes' notion of 'instrumentalities' is in view here. Some artefacts (and processes) can be thought of in terms of "black boxes" (Williams and Wake, 2007). Here, by means of processes, instruments, routines, agreements, division of labour and so forth, mathematical processes become solidified and extremely opaque to outsiders. Indeed it would be the role of an ethnography of maths to 'unpack' such black boxes. Of note, the maths practices of the renaissance were very much reliant on artefacts. Oosteroff (2011) discusses the practices of Mutio Oddi as a case in point.

2. The semiotic environment

The material environment intersects with the semiotic environment (a key example is formulae). Semiotics refers to the sign systems humans "invent" and use to construct meanings. This area would include language, discourse and genres in general as well as multiple other sign systems. These might include, symbolic orders, multiple representations, inscriptions, traces, and hierarchies of abstractions.

Proxemics and in particular gesturing (see Rasmussen, Stephan, & Allen, 2004) can also be seen under the purview of semiotics. The notion of 'genre' from Hymes comes closest to this idea of semiotics.

3. The rules of the game.

Here, I allude to Wittgenstein and his notion of "language games" (Wittgenstein, 1953). In Hymes' initial framework, 'norms' would fit with this realization. Formal mathematics is the subject par excellence which insists on norms, rules, conventions, theory, prescriptions, canons (e. g. Euclid), classifications, syllabi, assessments and policy. However, in all contexts of explicit or implicit maths use, there are norms, social norms, conventions, and "recognition and realization rules" (Bernstein, 1996).

Who does mathematics?

Here a lot of trajectories merge. Is the mathematical practice solo or social? What networks and/communities are involved? There are issues around identity and subjectivities which inevitably lead to questions of power structures on one hand and psychological dispositions towards mathematics on the other. There are issues around whether maths understandings are purely cognitive or whether there is an embodied, situated dimension. Supposed binaries also come into play: expert/novice; teacher/student; foreperson/labourer; and official/athlete.

Implicated in the 'who' then are the dispositions that the 'players' may carry towards mathematics. Certainly maths anxiety is a phenomenon that can haunt many mathematical efforts.

How is the mathematics being done?

Firstly, I refer to something said earlier. Mathematics practises might be thought of in terms of problem, play and performance, and the search for patterns.

Related to this is the supposed binary of concrete versus abstract. See Roth & Wang, 2006) for an analysis of this binary. For practical purposes this binary will be invoked here, but with the understanding that it needs to be critiqued.

The concrete might involve such familiar dimensions of counting, measuring, shaping, forming, estimating, moving, calculating, proving, puzzling, grouping and so forth.

The abstract could include such processes as: strategizing (local and/or global); abstraction; deduction; induction; pattern searching; analysis; exploration; modelling; encoding and decoding; tabulation; graphing; hypothesising and so forth. Of course some of these clearly overlap with the concrete processes previously mentioned.

At another level are the organizational processes of routines, division of labour, transfer, task decomposition, idiosyncratic procedures and assorted mathematical repertoires. Practices may be particularly implicit as for example in dance.

Why is the mathematics being done?

Again we return to the now familiar theme of problem, play, performance and pattern making.

Leading the fray among these is no doubt the problem solving dimension. Sometimes play turns into problem solving. Some of Riemann's work/play with non-Euclidean geometries seemed to have had little use at the time. However, years later, it was to Riemann's work that Einstein turned in order to develop both the special and general theories of relativity. Einstein was able to solve the problem of how gravity works with a new configuration of space-time that was a direct consequence of Riemann's "play".

The question of what are the purposes, goals, objectives is important, especially so for students learning maths and pondering its relevance to their lives.

Conclusion

Finally, I want to finish with a somewhat superficial and artificial table which compares 'Academic mathematics' with 'real world mathematics' (I use the terms loosely). However, the table is only indicative of deeper insights that might be achieved through an ethnography of mathematical practices.

Table 1. A comparison of academic versus real world practices.

O Accuracy	O Estimation
O One right answer	O A number of possible answers
O Individualist orientation	O Social/collaborative orientation
O Axiomatic	O Pragmatic
O Generalisable principles	O Local problem solving strategies
O Formal system of signification	O Functional system of signification
O Subject positioned in terms of maths ability	O Subject positioned not in terms of maths ability
O Context is secondary	O Context is primary

○ Absolute knowledge	○ Provisional knowledge
○ Maths as a stand-alone entity	○ Maths as a practical social consciousness
○ Closed self-referential discourses and genres	○ Open routine discourses and genres
○ Specialised regulations on language – on definitions and strict manipulations of formal objects	○ Everyday uses of language – fluid definitions, multiple manipulations of informal objects
○ One is positioned as incompetent.	○ One is automatically positioned confident by self and others

The above table is simply a basic look and what a potential framework may achieve. Many areas of the incipient framework outlined above are not considered in the table. The table tends to focus on rules, semiotics and identity.

Next on my agenda is to seek out a possible pneumonic for the framework and bring more order to it. There will also be the need to justify an etic approach to maths practices.

Clearly the applications are many in uncovering what people actually do when they engage in mathematics practices. Hopefully, such an understanding will lead to enhancing pedagogical, assessment, syllabus and policy decisions. It may also help with an understanding of how transfer of mathematics across domains may be accomplished.

By ethnographically comparing practices across domains it will assist in making classroom mathematics, whether in child or adult contexts, more relevant, meaningful and exciting.

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