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Author(s): Ron Eglash
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When Math Worlds Collide: Intention and Invention in Ethnomathematics

Ron Eglash

Ohio State University

*Ethnomathematics is a relatively new discipline that investigates mathematical knowl-
edge in small-scale, indigenous cultures. This essay locates ethnomathematics as one of
five distinct subfields within a general anthropology of mathematics and describes
interactions between cultural and epistemological features that have created these
divisions. It reviews the political and pedagogical issues in which ethnomathematics
research and practice is immersed and examines the possibilities for both conflict and
collaboration with the goals, theories, and methods of social constructivism.*

Ethnomathematics is typically defined as the study of mathematical
concepts in small-scale or indigenous cultures. Working in many different
areas of the world, Ascher (1990), Closs (1986), Crump (1990), D'Ambrosio
(1990), Gerdes (1991), Njock (1979), Washburn and Crowe (1988),
Zaslavsky (1973), and many others (for reviews, see Fisher 1992; Shirley
1995) have provided mathematical analyses of a variety of indigenous
patterns and abstractions, while drawing attention to the role of conscious
intent in these designs. The theoretical basis of ethnomathematics raises some
fundamental questions for the social and philosophical studies of mathemat-
ics. If we take away the tautological definition of mathematics as "that which
is done by mathematicians," what is left to define it? Once we step outside
the acknowledged, professional mathematical community of the West, how
will we recognize mathematics when we run into it? At the same time,
ethnomathematics must answer to its use of the anthropological category of
the indigenous. Why should there be a *disciplinary* distinction between the
study of mathematics in one culture and the next? After all, the anthropolo-
gists of the nineteenth century who insisted on calling spiritual beliefs of
Europe "religion" and those of Africa "superstition" are today regarded as
misguided, to say the least (Wiredu 1979).

The first three sections of this essay will examine the cross-disciplinary niche occupied by ethnomathematics and show how it is distinguished from four other subfields of anthropological studies of mathematics through the interaction of cultural and epistemological categories. The next two sections review the political and pedagogical issues in which ethnomathematics research and practice is engaged. The final two sections suggest some possibilities for both conflict and collaboration with the goals, theories, and methods of social constructivism.

Five Subfields in the Anthropology of Mathematics

The anthropology of mathematics includes a variety of subfields. The five categories presented here designate fairly specific schools of thought and give some indication of how ethnomathematics is distinguished by its unique combination of cultural and epistemological issues.

1. Research on *non-Western mathematics* consists primarily of historical studies (e.g., Cajori 1896) based epistemologically on the idea of direct, literal translations of non-Western mathematics to the Western tradition. The cultural focus (which has continued in contemporary works, such as Joseph 1991) is on state empires such as the ancient Chinese, Hindu, and Muslim civilizations. For example, Needham (1959, 137) shows how the Chinese Chu Shih-chieh triangle can be mapped onto Pascal's triangle by a rotation of 90 degrees.

2. *Mathematical anthropology* uses mathematical modeling in ethnographic and archaeological studies to describe material and cognitive patterns, generally without attributing conscious intent to the population under study. The patterns are instead seen as the structural basis of underlying social forces or as epiphenomena resulting unintentionally from the nature of the activity itself. Classificatory systems for kinship (e.g., Morgan 1871) were the first of these models. Later refinements of mathematical anthropology (e.g., Kay 1971) expanded this analysis to a variety of social phenomena and increasingly complex mathematical tools.

3. *Sociology of mathematics* uses the methodologies associated with STS and the social construction of science to study the work and community of professional mathematicians (Restivo 1993). I do not wish to suggest that sociology is merely a subset of anthropology; the term simply derives from its common usage and from the sociologists' emphasis on urban settings in the West. These studies vary along the weak/strong axis: some examine social "influences" affecting the choice of the areas of inquiry, whereas strong constructivism strives for a "thoroughly social" portrait of knowledge.

4. Studies of *vernacular mathematics* focus on those who, while distinctly outside any mathematical professionalism (of either West or non-West), would not qualify under the old-fashioned anthropological category (now primarily used in Discovery Channel narrations) of an "ancient cultural tradition." Examples include studies of "street mathematics" by Nunes, Schliemann, and Carraher (1993; e.g., calculation by peasant pushcart venders), the "situated cognition" of Lave (1988; e.g., European women's knitting as algebra), and works with titles such as "folk mathematics," "informal mathematics," and "nonstandard mathematics" (see Gerdes 1994).

5. Research in *ethnomathematics* focuses on small-scale (indigenous, traditional) societies (Ascher 1990). Its epistemological basis is not restricted to methods of direct translation, as in (1), but also includes the types of pattern analysis used in the modeling approach of (2). Unlike mathematical anthropology, however, this research generally strives to include conscious intent as an important component of the analysis.

All five of these categories can be seen as variants of the *anthropology of mathematics*, enabling us to compare different research programs. The categories are more or less in keeping with those already in use (cf. Bishop 1994), but they are not intended to be exclusive, to imply a nonexistent cohesiveness to the field, or to dampen enthusiasm for subdisciplinary neologisms. We begin with such terminology in order to analyze the ways in which cultural and epistemological features of these approaches interact.

Cultural Theory in the Anthropology of Mathematics

The cultural categories pertinent to these five subfields are by no means arbitrary; they reflect both traditional anthropological concepts and their postmodern revisions. From the traditional point of view, societies with complex social organization (e.g., labor specialization and political hierarchy) will tend to have greater technological complexity and thus also "higher mathematics." Regarded as a universal consequence of social organization, mathematics (as opposed to religion, for example) would then not be of great interest to an anthropologist interested in explorations of social diversity, nor would one expect the content of such knowledge to be socially shaped.

Of course, neither social scientists nor historians have been content with such descriptions, and two fundamental critiques have emerged. Much of STS research challenges the assumption that technical domains, such as mathematics, have little to offer in terms of social content (indeed, hard constructivists would find the very metaphor of "content" to be an error, since

it implies a nonsocial "container"). The other critique can be divided into its modern and postmodern forms.

Postmodern approaches, often allied with literary analysis (now frequently grouped as "cultural studies"), provide the contrast of orientalism versus primitivism. Ethnocentric discourse is often considered only in terms of the primitivist stereotype of people who are "close to nature" (whether the mean-spirited talk of "savages" or the well-intentioned romanticism of "children of the forest"). But as Said (1978) pointed out, another set of ethnocentric stereotypes posits subjects who are not too close to nature but, rather, too far from it. The "arabesque mind" of the Muslim, the Hindu who thinks only of karma, the Jew who thinks only of money, and the Buddhist who is divorced from emotion are all examples. Thus the British, who could not justify colonizing India for a primitive lack of mathematics (Adas 1989), could criticize Indian culture for not concretizing its mathematics to produce engineering: they were too abstract, just as primitives were too concrete, and only whiteness held the proper balance.

Given this formulation, it does not necessarily combat racial prejudice to extol the virtues of mathematical achievements in Chinese, Indian, and Islamic empires. But by the same token, the emphasis on advanced mathematics in these Empire Civilizations has also supported nonracist/nonethnocentric frameworks in modern anthropology. That is to say, simply positing that the societies with complex social organization (e.g., labor specialization and political hierarchy) have greater technological complexity is not inherently demeaning. As diasporic poet Amié Cesairé defiantly put it, "hurrah for those who never invented anything!" Indeed, the argument can all-too-quickly turn from equality to superiority, as those following Rousseau have argued for moral superiority of the absence of technoscience.

Even setting aside the question of ethnocentric prejudice, however, the linear model of cultural evolution has been questioned on "purely objective" grounds (this does not mean that the researchers were unmotivated but merely that such motivations were not cited as evidence for this argument, as they were for the postmodernist critique). Just as biological evolution has been revised from Lovejoy's (1936) "Great Chain of Being" to Gould's (1981) "copiously branching bush," so cultural evolution is now typically portrayed as a branching diversity of forms. Of course, there are tremendous differences between the theories that posit a cause for this variety (e.g., environmental adaptation vs. social self-determination), but the net result has been a much better appreciation for the possibilities of cultural diversity in technical knowledge.

Thus ethnomathematics, while not inherently allied to either modern or postmodern perspectives, can be seen as a reaction to the lacuna created by

the field of non-Western mathematics, in which the "empire" civilizations had precedent.[1] Its primary concern is what Ascher (1990, 1) defined as "The people . . . who live in traditional or small-scale cultures, that is, they are, by and large, the indigenous people of the places that were 'discovered' by Europeans." Ascher presents the ethnomathematics critique as merely an extension of cultural diversity: just as many indigenous groups create things we think of as "art" even though they have no analogous category of "artist," they can invent mathematical ideas without the category of "mathematician." But an art critic who maintains that the !Kung beaded headband is as aesthetically pleasing as the Mona Lisa does not challenge the anthropological framework. Evidence for complex mathematical ideas in small-scale societies requires seeing cultural evolution as a bush, not a ladder, since the mathematics that blossoms on later branches in some societies may be on earlier branches in others.

Finally, we should note that small-scale indigenous civilizations can also be a site of Western romantic diversions. Illusions of cultural purity and organic innocence are too easily projected onto these traditional cultures. For that reason, many researchers (and cultural workers, particularly artists) have developed a postmodern emphasis on hybridity, creolization, and other impure identities (cf. Minh-ha 1986; Anzaldúa 1987; Bhabba 1990). In addition, ethnicity is not the only way in which groups of people are marginalized. Thus the category of vernacular math has been used to refer to mathematics used by ethnic groups that are neither socially empowered nor traditionally indigenous (e.g., multiethnic peasants), as well as to other nonelite groups (e.g., working-class laborers, housewives, etc.).

Despite my implication of historical development, it is important to avoid singling out just one of these social groups as the cutting edge of social critique. If we take up hybridity as unfairly disregarded, that does not mean that we should abandon indigenous traditionalists. I have argued that the mathematics of small-scale societies has received less attention than that of non-Western state empires, but it is conceivable that a continued rise in anti-Islamic prejudice in the West could result in delegitimation of non-Western mathematics. Tibetan Buddhists struggling against the Chinese government may find it helpful to have some Buddhist math in their curriculum, but that will not aid the Tibetan animists (Caldararo 1995) struggling against Buddhist hegemony. Similar situations occur throughout the third world—among indigenous minorities in Latin America, African animists in Islamic nations, and so forth. And yet the hybridity of ethnically mixed societies—for example, the Islamic-animist syncretism often found in Africa—is better celebrated as a cross-cultural achievement (even in cases in

which it is only the ironic success of resistance through adaptation) than disregarded as impure or polluted.

Such heterogenous complexities are often cited as a critique of all attempts to categorize, as I have done here by distinguishing the five subfields. Portraits of a holistic "seamless web" of multidimensional relations are often suggested as the alternative. Although it is certainly an error to maintain rigid or impermeable boundaries, I would like to suggest that it is possible to overcompensate. Such holistic extremes, for example, have caused problems in attempts to introduce interdisciplinary studies and multiculturalism in educational curricula (cf. Roth 1994) in which historical and social context can be lost to a globalizing relativism. Maintaining the kind of historically composed typology suggested above can aid us in taking responsibility for those complexities.

Epistemology in the Anthropology of Mathematics

Despite the great variety of studies, there are fairly consistent relationships between the cultural sites on which research focuses and the epistemological concepts applied by researchers. This is particularly clear in the distinctions among non-Western mathematics, ethnomathematics, and mathematical anthropology.

Whereas non-Western mathematics relies on direct literal translation, mathematical anthropology is generally seen as revealing patterns that are not consciously detected by its subjects of study. In part this is due to a conviction that society is governed by forces unnoticed by its members (not only because such forces operated at levels beyond individual awareness, but also because regulatory mechanisms have to be covert, obscured, or otherwise protected from manipulation and conscious reflection). Mathematical anthropology also imitates the researcher-object relation in the natural sciences: if anthropologists were simply reporting indigenous discourse, then they would not count as scientists (as was indeed the case for non-Western mathematics, traditionally only a subject for historians).

An excellent illustration of this methodological distancing can be seen in Koloseike's (1974) model for mud terrace construction in low hills of Ecuador. Koloseike began with two hypotheses: either the Indians learned from the Inca stone terraces in the high mountains above (a somewhat orientalist assumption about the technological contrast between a state empire and tribal horticulturalists) or the terraces were unintentional by-products of cultivation on hillsides. He then made a list of nine observations that were relevant to deciding between the two. Of particular interest are the following:

3. The same hillside soil is used in rammed-dirt houses and fence walls, and these stand for years.
4. But I never saw a terrace being constructed, nor did people talk about such a project.
5. Small caves are often dug into the terrace face for shelter during rainstorms. That this potentially weakens the terrace face does not seem to concern people. (Koloseike 1974, 29-30)

Koloseike concludes that these terraces are the unintentional result of an accretion process from the combination of cultivation and erosion, and then proceeds to develop a mathematical model for the rate of terrace growth. I do not question here the accuracy of the model but, rather, the way that indigenous intentionality is positioned as an obstacle that must be overcome before mathematics can be applied. Even a small degree of awareness—being aware that a cave dug into a terrace face might weaken it—must be eliminated.

In addition, Koloseike's (1974) analysis reveals a particular cultural construction of the supposed universal attribute of "intention." As a West-erner, Koloseike is used to a society in a hurry. Projects to be done must get done, and always with someone in charge. The idea of a long-term intentional project, perhaps extending over several generations, or the constitution of collective intentionality rather than individual intent is not brought under consideration. It may well be that the mathematical model Koloseike offered not only was accurate but also had an indigenous counterpart.

Ethnomathematics, in contrast, has emphasized the possibilities for in-digenous intentionality in mathematical patterns. For example, Gerdes (1991) used the Lusona sand drawings of the Tchokwe people of Northeastern Angola to demonstrate indigenous mathematical knowledge. His analysis showed the constraints necessary to define a "Eulerian Path" (the stylus never leaves the surface and no line is retraced) and a recursive generation system (increasingly complex forms are created by successive iterations through the same geometric algorithm). Although it would have been possible to limit description of these features to the physical construction only (and thus hypothesize—as a mathematical anthropologist might have—that they are the result of an unconscious social process), these were, rather, placed in the context of indigenous concepts and activities. The Eulerian constraint, for example, was critical not only for definitions of drawing skill within their society but also externally when the Lusona were used by the Tchokwe as a way to deflate the ego of overconfident European visitors. More important, the construction of figures of increasing complexity was taught within an age-grade initiation system and thus indicated the conscious use of the iterative construction as a visualization of analogous iterations in cultural

knowledge.[2] Both served to make a stronger case for attributing intentionality to the indigenous creators.

Ascher (1990) notes the same type of Eulerian path drawings in the South Pacific, but these tend to be less recursive (i.e., they require combinations of different geometric algorithms, which Ascher likens to algebraic systems, rather than the fractal-like iterations through the same algorithm that dominate the African versions). Ascher describes the South Pacific drawings as primarily motivated by symbolic narratives, in particular their use by the Malekula islanders as an abstract mapping of kinship relations. Again, this is in strong contrast to the tradition of mathematical anthropology, in which kinship algebra was considered a triumph of Western analysis (and even a source of mathematical self-critique; Kay [1971] harshly notes the anthropologists' tendency to invent a new "pseudo-algebra" for various kinship systems rather than apply one universal standard).

Ascher's (1990) description of the Native American game of Dish shows this contrast in a more subtle form. In the Cayuga version of the game, six peach stones, blackened on one side, are tossed, and the numbers landing black side or brown side are recorded as the outcome. The traditional Cayuga point scores for each outcome are (to the nearest integer value) inversely proportional to the probability. Ascher does not posit an individual Cayuga genius who discovered probability theory, nor does she explain the pattern as merely an unintentional epiphenomenon of repeated activity. Rather, her description (p. 93) is focused on how the game is embedded in community ceremonials, spiritual beliefs, and healing rituals—specifically through the concept of "communal playing" in which winnings are attributed to the group rather than the individual player. Juxtaposing this context with detailed attention to abstract concepts of randomness and predictability in association with the game—in particular the idea of "expected values" associated with successive tosses—has the effect of attributing the invention of probability assignments to collective intent.

At the skeptical extreme in ethnomathematics, Donald Crowe has refrained from making any inferences about intentionality and insists that his studies of symmetry in indigenous pattern creations (cf. Washburn and Crowe 1988) are simply examples of applied mathematics. But since Crowe has restricted his work to only those patterns that *could* be attributed to conscious design (painting, carving, and weaving), it creates the opposite effect of mathematical anthropology's attempt to eliminate indigenous intent. This is evident in Crowe's dedication to the use of these patterns in mathematics education (particularly his teaching experience in Nigeria during the late 1960s, which greatly contributed to Zaslavsky's [1973] seminal text, *Africa Counts*).

Thus ethnomathematics differs epistemologically from non-Western mathematics by not limiting itself to direct translations of Western forms and instead remaining open to any mathematical pattern discernable to the researcher. In fact, even this description might be too restrictive: prior to Gerdes's (1991) study, there was no Western category of "recursively generated Eulerian paths"; it was only in the act of applying a Western analysis to the Lusona that Gerdes (and the Tchokwe) created this hybrid. And unlike mathematical anthropology, ethnomathematics puts an emphasis on the attribution of conscious intent to these patterns.

Situating Ethnomathematics: The Political Context

In addition to its epistemological conflicts, ethnomathematics is immersed in sociopolitical struggles. These conflicts have often been as much a motivation as an obstacle. Zaslavsky, whose 1973 text is often regarded as the first of its genre, attributes her project to the civil rights activities of the 1950s, which resulted in an increase in African studies materials in her school and thus alerted her to the conspicuous absence of material on African mathematics. Gilmer, current president of the International Study Group on Ethnomathematics, cites her identity as an African American mathematician in the 1950s as fundamental to her own motivations. D'Ambrosio, a primary organizer for efforts in Latin America, was inspired by a UNESCO project he attended in Mali in 1970 and was later influenced by the social critique of Paulo Freire. Gerdes (1991) and Gay and Cole (1967) were specifically motivated by local efforts to overcome the colonial legacies of pedagogy in the third world.

Yet, even in the postcolonial context, there is controversy over ethnomathematics. Njock (1994) notes that some of the African mathematicians have explicitly objected to the inclusion of ethnomathematics in any aspect of their discipline, much in the same way that ethnophilosophy has been rejected by some African philosophers (for reviews of this debate, see Mudimbe 1988; Appiah 1992). In Senegal, mathematician Sakir Thiam has promoted mathematics pedagogy in Wolof, making use of base 5 number words to improve early addition skills, but his efforts are not necessarily welcomed by the nonmuslim ethnic groups, who have been combating Islamic hegemony for centuries and would prefer that math texts remain in French. Father Engelbert Mveng, a founder of indigenous philosophy studies in Central Africa, as well as a valued colleague in my own ethnomathematics fieldwork in Cameroon, was recently murdered in what appears to be an attempt to oppose his cross-cultural efforts.

Pedagogical Challenges:
The Politics of Epistemology

If ethnomathematics is controversial in the third world, then it is not difficult to see how it engenders conflict in the first, in which the political ties mentioned above interact with both its cultural and epistemological categories. In some of these discussions (cf. Jackson 1992), any tie to "political" motivations is described as an inherent defect, a loss of scholarly status, and thus (unless one is willing to deny the kinds of historical connections mentioned in the previous section) ethnomathematics can be eliminated out of hand. Moreover, it is indeed possible to cite cases in "ethnosciences" in which ideological motivations are at fault. For example, the accounts of science teaching in ancient Egypt provided by an Afrocentric teaching guide, in the "Portland Baseline Essays," include many unsubstantiated claims (cf. critiques in Oritz de Montellano 1993; Martel 1994). Given the a priori hostility to ethnomathematics, and its own potential flaws, its application to education has been understandably difficult. Nevertheless, there are several reasons why such efforts are worthwhile.

The education reform efforts that consider ethnomathematics include multicultural mathematics (Nelson, Joseph, and Williams 1991), critical mathematics (Skovmose 1985), humanist mathematics (White 1986), and situated cognition (Lave 1988), among others. These approaches generally cite cultural alienation from standard mathematics pedagogy for minority ethnic groups (as well as other identities; see Keitel et al. 1989 for a detailed listing). Another important motivation is the idea that individuals from dominant groups will tend to have better relations with subordinate groups if they are exposed to more egalitarian presentations of the other's culture. Finally, there is also the contention that extreme (for example, racist) views of biological determination of intelligence can be combatted by presenting mathematical knowledge generated by these subordinated groups.

The problem of "cultural alienation" does find support in field research. Powell (1990), for example, notes that pervasive mainstream stereotypes of scientists and mathematicians conflict with certain aspects of African American cultural orientation. Similar disjunctures between African American identity and mathematics education in terms of self-perception, course selection, and career guidance have been noted (cf. Hall and Postman-Kammer 1987; Boyer 1983). One critique maintains that if there is alienation, then the solution should lie in making teaching materials more universal rather than more local. A similar suggestion has been employed in response to sexism in the word problems of math textbooks, but research reviewed in Nibbelink,

Stockdale, and Mangru (1986) indicates that gender-neutral examples have been inadequate, and they recommend reinstating gender with more balanced presentation of both male and female figures. Similarly, attempting to get rid of all cultural reference would reduce the quality of the textbook for everyone. Concrete examples are important for learning application skills, enhancing general interest, and reaching a wider range of cognitive styles. And there are many culture-specific elements, such as the Greek names of Euclid and Pythagoras, that it would be absurd to eliminate. Cultural balance appears to be a better strategy than cultural obliteration.

In support of the theory that overemphasis on biological determinism creates a learning deterrent, Geary (1994) reviews cross-cultural studies that indicate that whereas children, teachers, and parents in China and Japan tend to view difficulty with mathematics as a problem of time and effort, their American counterparts attribute differences in mathematics performance to innate ability (which thus becomes a self-fulfilling prophecy). Thus it is possible that even if the "cultural alienation" theory is incorrect, the opposition to biological determinism provided by ethnomathematics would be of positive benefit to the students. Although no formal studies have yet been carried out, Anderson (1990), Frankenstein (1990), Gerdes (1994), Moore (1994), and Zaslavsky (1991) have given anecdotal reports of positive results in using ethnomathematics to teach minority students.

Despite these optimistic outlooks, there are still many potential difficulties in applications to pedagogy. Williams (1994) suggests that any multicultural science teaching implies that minority students have less aptitude than white students, since it gives them "special treatment." Although this sounds similar to politically conservative critiques of affirmative action, the accusation of a patronizing stance has also been made from the opposite end of the political spectrum:

> Where there is "multicultural" input into the science curriculum it tends to focus on so-called "Third World Science" and involves activities like making salt from banana skins . . . . The patronizing view of the "clever and resourceful native" which underlies such practice is not far removed from the racist views of "other peoples and cultures" which pervade attempts at multicultural education. (Gill, Singh, and Vance 1987, 128)

This critique touches several difficulties. There is a danger of singling out minority students and increasing their "otherness," a possibility of reductive presentations of minority cultures, and, perhaps most pointedly, an ahistoricizing effect in which romantic portrayals of a mythically "pure" tradition overshadow the political actualities of third world experience.

Strong Constructivism as an
Obstacle in Ethnomathematics Pedagogy

Given the heterogenous collection of social constructivist research, it should be possible to apply some of its theoretical and empirical findings to aid in the ethnomathematics pedagogy project. Such collaboration is tempered, however, by the fragile relation between ethnomathematics and the mathematics education community, and the mistaken identification of ethnomathematics with strong constructivism.

Mathematics occupies a unique position at the end of the soft science/hard science spectrum. The first objection typically raised in casual discussion of constructivism is "surely you don't believe that 2 + 2 can sometimes be 5?" Because mathematics itself functions as a signifier for opponents of strong constructivism, critics often assume that something called "ethnomathematics" must be in favor of it. In other words, ethnomathematics suffers guilt by association through the assumption that it is related to the strong form of social construction of science.

This is ironic since almost all[3] statements on the subject in ethnomathematics writings assert the opposite: they typically hold that there is a potential universal mathematics, of which each culture's individual mathematics (to use Plato's terminology) partakes. Cultural variation is seen only as the result of asking different questions, not getting different answers. Thus ethnomathematics discourse is generally only a weak version of constructivism. It suggests that each culture's mathematics is, in some sense, a lower-dimensional projection of the (according to Gödel, never-attainable) higher-dimensional whole. Because this assumption makes it likely that some projections are better than others, ethnomathematics does not even espouse cultural relativism, to say nothing of a strong version of constructivism. Relativism does play a part in legitimizing the diversity of social forms in which mathematics is said to take place—we can trace graphs in sand instead of paper—but 4 plus 4 has to be 8, even if it is written in base 5.

As noted by Tymoczko (1986) and others,[4] even those mathematicians who do not subscribe to the Platonist philosophical outlook typically present the alternative views—logicism, formalism, intuitionism, and so on—as "private" theories in which "there is one ideal mathematician at work, isolated from the rest of humanity and from the world, who creates or discovers mathematics by his own logico-intuitive processes" (Davis 1988, 140). Given this outlook, and the powerful influence of the professional mathematics community on mathematics education,[5] the mistaken association of strong constructivism with ethnomathematics can be damaging to the efforts to use ethnomathematics in pedagogy.

Within these constraints, I see three possibilities for a positive theoretical relationship between ethnomathematics pedagogy and social constructivism. First, we could make use of characterizations by those constructivists who have pointed out the error in conflating ethnomathematics with strong constructivism. As Restivo (1993, 252) notes, "these are not, in fact, alternatives to modern mathematics, but rather culturally distinct forms of mathematics." Second, if constructivist arguments (either weak or strong) were independently made more convincing to the mathematics community, it might encourage them to be more open to ethnomathematics. And third, if constructivists were able to find alternatives to the weak/strong dichotomy (cf. Haraway 1988), the conflict could also be mitigated.

In addition to these possibilities, there are also several areas in which ethnomathematics and constructivism share concerns and could perhaps eventually benefit the pedagogical efforts indirectly through mutual collaboration.

Commonalities in the Research Frontiers of
Social Constructivism and Ethnomathematics

The three areas of common interest suggested here are not meant to be exhaustive; this essay will, I hope, encourage others to add to the effort.

The metaphor of translation. I have distinguished between non-Western mathematics and ethnomathematics with the rather loose idea of "direct, literal translation" and implied that the modeling approach was something else—but what? Similar problems have arisen with the use of "translation" in constructivist science studies. For example, Fuller (1988) makes use of the Peircean claim to an invariant content in translation as a critique of knowledge production theory. In discussing the classic controversy between the supporters of phlogiston versus oxygen theories, for instance, he contrasts Quine's underdetermination thesis, which would see alternative descriptions of roughly the same "cognitive content," with Kuhn's view of two mutually exclusive contents. Similar questions can be asked in ethnomathematics: was Gerdes (1991) simply translating the Lusona into two preexisting Western categories or actually creating a new one?

Lest this seem a mere philosophical word game, consider the challenge from Lerman (1992, 9), who suggests that only illustrations from non-Western mathematics (e.g., Vedic multiplication) be used in the classroom, because if "geometrical patterns in traditional crafts are studied . . . pupils can feel that their culture is being made to appear primitive." Here, our problem is not contesting claims for invariant content but, rather, the reverse: how can we

specify similar content (geometric knowledge) in radically different state-ments (e.g., basket weaving vs. Euclidean constructions)?

One approach would be to note how Lerman's (1992) characterization of ordinary mathematics pedagogy overlooks the frequent use of geometric "craft" examples from the West, such as the putative appearance of the golden rectangle in the ancient Greek parthenon or the use of the Eiffel Tower as an example of fractal geometry. Watson-Verran and Turnbull (1995) effectively outline this argument in their comparison of Gothic cathedral construction with various examples from ethnomathematics, while turning "translation" into "mutual interrogation."

Intentionality. The recent emergence of agency and intent as a subject of constructivist theory suggests that there could be a useful exchange with similar issues raised in ethnomathematics. Latour (1994), for example, proposed that since agency was often denied to non-Western subjects ("pre-moderns") under colonial anthropology, the idea of nonhuman agency in STS (Haraway 1991) could be helpful in new anthropological critiques. In a direct application, this seems like a step backward. Because the problem was essentially a restricted attribution of humanity (the primitive as too natural to be fully human, the Oriental as too artificial), giving agency to the nonhuman does not attack the problem at the source. It does no good to say, "Since DNA and silicon chips have agency, you can have it too." If anything, it would seem to diffuse and disable a valuable concept just at the moment when it is needed most.

Nonhuman agency could, however, be used to help question the assump-tion that indigenous societies cannot have science because of a static episte-mological homeostasis. As Latour (1993, 42) points out, the standard anthro-pological account of this obstacle to indigenous science contends:

> By saturating the mixes of divine, human and natural elements with concepts, the premoderns limit the practical expansion of these mixes. It is the impossi-bility of changing the social order without modifying the natural order—and vice versa—that has obliged the premoderns to exercise the greatest prudence.

But if the "natural order" is chaos—if it is a self-modifying, ever-changing agency—then perhaps the indigenous social order could be modeling itself as similarly self-changing (cf. Eglash 1995a, forthcoming; Eglash, Diatta, and Badiane forthcoming).

Conversely, the encounters of ethnomathematics with intentionality can be useful to STS formulations. In elucidating the ways in which intentionality is culturally determined, we can open up questions of agency, credit for

discoveries and inventions, local community interactions with the environ-
ment and technology, and other areas. Does intentionality differ among
various scientific subcultures? How might the difference between collective
intention and individual intent matter for STS?[6]

Universality. As noted previously, one factor in creating a distance be-
tween ethnomathematics and STS is the pragmatic difficulty in gaining
curricular acceptance for ethnomathematics: it is already hard enough to get
ethnomathematics into the classroom, so why be weighed down with the extra
baggage of strong constructivism? But there are also social theories at work
in keeping this relation fixed. This concerns ideals both of ethnic harmony
and of equal opportunity. In the African American coming of age film *Boyz
N the Hood*, moral icon Ferous Styles (played by Larry Fishburne) warns two
students after the SAT exam: "Most of those tests are culturally biased to
begin with—except the math. That's universal." A metonymic relation be-
tween universals in humanism and those of mathematics is implied: if math
can transcend empiricism, then perhaps it can transcend cultural barriers as
well.

This framing of local versus universal knowledge status cuts deeply into
theoretical issues shared by constructivists. Consider, for example, the way
that math teachers make *strategic* use of universalism in teaching number
representation. Western students learn base 10 notation as a local skill (our
first lessons in writing numbers and counting), but eventually it becomes an
invisible universal (after years of practice it becomes unnoticed, a transparent
window on the world of numbers). A few years later, students must be
reminded of its presence, and often cultural variation in base notation is then
used (growing up in California, I was introduced to the Mayan base 20 in
fifth grade). Finally, students learn that *any* number could be used as a base;
there is a universal principle behind it all. Could such dynamic alternation
between the universal and the local be applied in social constructivist analy-
ses? Conversely, taking a lesson from constructivists, perhaps mathematics
teachers could find options for their alternations in something other than a
static ending in the obligatory finality of universalism.

When teaching anthropology of mathematics at the University of Califor-
nia, I once worked with a Latino student who was particularly critical any
time I brought up a strong anti-universalist position. In our conversations, it
finally became apparent that there was a religious principle at stake. He was
a devout Catholic and saw similarity between the reconciliation of his Native
American heritage with the Universal Church, and the Platonic view that the
apparent cultural diversity in mathematics is actually due to derivations from

a single universal source. In other words his local, culturally specific view-point was intimately tied to constructions of universality.[7] Both reflexive critiques of STS—the caution against localists demanding absolute, universal application of localism—and new alternatives in the debate (e.g., Haraway's [1988] "situated" objectivity) call for investigation of these strategic, dynamic, and multidimensional approaches to positions along (and beyond) the localism-universalism spectrum.

Conclusion

As multiculturalism is increasingly felt in the humanities, its comparative absence in science curricula is likely to send the wrong message to students, implying that math, science, and technology are restricted to the European cultural heritage. If there is to be a successful multicultural curriculum in the sciences, it will depend on disciplinary diversity. The anthropology of mathematics can contribute a multifaceted array of approaches, methodologies, and theoretical perspectives.

Notes

1. This observation has been made by others, for example, Katz (1992).

2. The use of iterative scaling forms to visualize iterations of social knowledge in African age-grade initiations is not unusual (Nooter and Robbins 1989; Eglash 1995b).

3. Bishop (1994, 15) raises the question: "Is there one mathematics appearing in different manifestations and symbolizations, or are there different mathematics being practiced which have certain similarities?" But he does not resolve it in either direction.

4. Despite their low numbers within the professional mathematics community in general, it is quite interesting to note how many of these philosophical rebels are actually mathematicians themselves, in comparison with, for example, the number of outspoken social constructivists in physics. Paradoxically, this may be precisely due to the extreme position of mathematics on the soft science/hard science spectrum; having little or no concern over empirical issues may have allowed them to relax a guard that must be maintained for the physicists (cf. Traweek 1988).

5. Indeed, one mathematician who read an earlier draft of this article kept insisting that "mathematics education" should be used only in reference to upper-division preparation for a career in mathematics and that the proper term for me would be "mathematics instruction" (a phrase I balk at since it implies rote memorization rather than understanding).

6. For an excellent examination of the contrast of individual versus collective intent in law, see Rosga (1995).

7. He received an A on his adamantly pro-universalist historical analysis. Some Latino/a students in the same course embraced the opposite perspective.

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Ron Eglash received his M.S. in Systems Engineering from University of California, Los Angeles, and his Ph.D. in History of Consciousness from University of California, Santa Cruz. He was a human factors engineer at National Semiconductor, was a Fulbright Senior Research Fellow at the University of Dakar, and is currently a lecturer in Comparative Studies at Ohio State University. His recent publications include "African Influences in Cybernetics" in The Cyborg Handbook *(Routledge, 1995), and "The African Heritage of Benjamin Banneker" in* Social Studies of Science *(forthcoming).*