ABSTRACT: Ethnomathematics originated in the former colonies, in response to the Eurocentrism of the history of mathematics, mathematics itself and mathematics education. It has also found expression in several other contexts. It is a part of the broader framework that elaborates the social and political dimensions of mathematics and mathematics education but especially, the dimension of culture. This focus on culture examined in the unique context of South Africa makes visible both conceptual difficulties in its formulation and also difficulties with respect to its interpretation into educational practice. This paper explores a critique of ethnomathematics using the South African situation and conceptual tools of a critical mathematics education.

INTRODUCTION

The last decade has seen a substantial amount of literature elaborating the cultural, social and political dimension of mathematics and mathematics education (see for example Volmink et al., in press). Two perspectives, among others, have emerged: ‘ethnomathematics’ and ‘critical mathematics education’. While ethnomathematics seems to deal mainly with cultural and social issues, critical mathematics education has largely focused on social and political aspects. These perspectives are, of course, connected. We conceive of ethnomathematics and critical mathematics education as two important educational positions in the attempt to develop an ‘alternative’ mathematics education which expresses social awareness and political responsibility. In this critique, however, we take some of the ideas developed in critical mathematics education and the context of education in South Africa to raise questions for ethnomathematics.

‘MODERNISATION THEORY’

Curriculum thinking in mathematics education has increasingly, since the sixties, operated within the framework and assumptions of modernisation. According to one conception of modernisation, industrialisation is a progressive development. In some countries this industrialisation has come about in the last century and, accompanying it, a development of democracy has been witnessed. So also in a political sense, industrialisation can be
interpreted as a progressive force. Not only are material living conditions improved by industrialisation but a democratisation is supported as well.

In the 1950s a forcible economic development began to take place in the European and American contexts. It was conceived as a realistic possibility to plan a development towards a technological society without material needs. The very concept of development was intimately related to technological development. As an implication, much interest was oriented towards the qualification of the future labour force. This was conceived of as an education problem, and a radical curriculum reform was suggested. This was all wrapped up in an optimistic attitude towards technology. Progress, both economical as well as political, was related to the development of technology. Parallel to a uniform conception of technology followed a uniform conception of mathematics education. So mathematics education came to have a central role as it became implicated in this modernisation theory.

This modernisation theory was applied to ‘Third World’ countries. To support progress in these countries, it became important to support their industrialisation, and this included support for education, with a special emphasis on subjects conceived as essential to an industrialisation. As a consequence, ‘Third World’ countries were flooded by (text)books from the USA and European countries. ‘Westernisation’ in education became a consequence of modernisation theory.3 Anthony Giddens (1986) characterises modernisation theory in the following way: “Modernisation theory relates to the history of industrial society in a rather direct way . . . it is assumed that industrialism is essentially a liberalising force and a progressive one; and hence that the Western societies provide a model for ‘underdeveloped’ societies to follow.” (p. 137)

In the very brief background sketched here, a simplistic and naive relation is traced between, on the one hand, progress, liberalisation and industrialisation and, on the other hand, technological development (including a broad upgrading of mathematics education). The assumption is that these notions go neatly hand in hand and that they could be applied to any context. Ethnomathematics can be interpreted as a reaction to the cultural imperialism which is built into modernisation theory. A main concern for ethnomathematics is to come to identify the culturally embedded mathematical competences and, instead of thinking in terms of importing a curriculum, to think in terms of self-development. A curriculum can be related to an already existing competency in mathematics.

Critical mathematics education can also be described as a reaction to modernisation theory, but in this case as a reaction from within a highly technological society. A main concern for critical education was a cri-
tique of the assumption that industrialisation as such supported an attractive social, economical and political development. Industrialisation was seen also as a problematic enterprise which accompanied the development of new power-structures. Industrialisation developed hand in hand with bureaucracy and capitalism. Instead of ‘progress’, ‘suppression’ became an explaining term. The concern was, therefore, liberation, but a liberation quite different from (the caricature of) the notion which modernisation theory had embraced.

The basic concern for ethnomathematics and critical mathematics education is therefore similar. Both reacted to the (naive) optimism build into modernisation theory. Ethnomathematics become a reaction to this optimism from outside the Western societies responding to the implications of modernisation theory in terms of cultural imperialism. Critical mathematics education become an reaction from within, replying to the actual colonisation of the lifeworld. However, even though these main concerns are shared, it is essential to develop a critique of both notions if we are to develop a deeper understanding of their relation to progress, democracy and technological development.

Ethnomathematics refers to a cluster of ideas concerning the history of mathematics, the cultural roots of mathematics, the implicit mathematics in everyday settings, and mathematics education. Ethnomathematics, as an educational idea, suggests that the content of mathematics education be rooted in the mathematics implicit in the culture with which the children are familiar. However, ethnomathematics not only refers to a perspective on mathematics education, but also to the implicit mathematics of a cultural group itself, as when we talk about the implicit mathematics in carpentry as the ethnomathematics of carpenters. Thus, ‘ethnomathematics’ can refer to a certain practice as well as to the study of this practice. In what follows we use ‘ethnomathematics’ in both senses, although we primarily think of ethnomathematics as including certain educational ideas and a research perspective.

The main problem in what follows, concerning our use of ‘ethnomathematics’, is not the existence of different meanings of the notion, but that we criticise the very notion of ethnomathematics. In this discussion, however, we continue to use the notion itself. We attempt to develop a critique of ethnomathematics, and we take critique to mean including examining both the strengths and weaknesses.

The thesis we concentrate on is that mathematics education can be improved by paying special attention to the ethnomathematics in the culture with which the children (students) are familiar. We direct our critique of the thesis to several different aspects: ethnomathematics and the South
African context; ethnomathematics and the meaning of the term ‘culture’, particularly the problematic nature of the use of this term in South Africa; difficulties in the definition of ethnomathematics; ethnomathematics and critical citizenship, where we discuss some of the political dimensions of the ethnomathematical concern; ethnomathematics and the perspective of the learner, where we especially comment on the focus on the background of the learner; and finally the ‘self-protection’ of ethnomathematics as a theoretical discipline. We begin with a review of some of the literature on ethnomathematics.

**FOUR STRANDS OF ETHNOMATHEMATICS**

Within the research and writing in ethnomathematics it is possible to identify at least four strands.

The first strand challenges the traditional history of mathematics. Historians of mathematics are criticised, firstly, for ignoring, devaluing, distorting or marginalising the contributions of cultures outside Europe to that body of knowledge that is paradoxically referred to as ‘Western’ mathematics. China, India, North Africa and the Arab World are recognised not only for their contribution to this mathematics but also in their own right as each having a mathematical history (see for e.g. Joseph, 1991). Secondly, only marginal attention, if any at all, is paid to the history of mathematics in cultures that have not directly contributed to ‘Western’ mathematics such as the American Indians (see for e.g. Closs, 1986) and sub-Saharan Africans (see for e.g. Zaslavsky, 1973; Gerdes, 1991a). This challenge has led to the consideration of *histories* of mathematics.

A second strand, which overlaps with the first, analyses the mathematics of traditional cultures, of indigenous peoples who may have been colonised but have continued with their original practices. This research may be broadly categorised as anthropological and has demonstrated that a wide variety of mathematical ideas are found in traditional cultures (see for e.g. Ascher, 1991). These cultures have been explored in relation to: number systems, gestures and symbolism, games and puzzles, geometry, space, shape, pattern, symmetry, art and architecture, time, money, networks, graphs or sanddrawings, kin relations and artefacts.

The third strand explores the mathematics of different groups in everyday settings showing that mathematical knowledge is generated in a wide variety of contexts by both adults and children. Much of this research has been generated through focusing on the connections between cognition, culture and context. In particular, the everyday practices of different groups are investigated such as dairy workers (Scribner, 1984), construction foremen (Carraher, 1986a), farmers (Abreu and Carraher, 1988),
child street vendors (Carraher, 1988), carpenters (Millroy, 1992), candy sellers (Saxe, 1990), shoppers (Lave, 1988) and fishermen (Schliemann and Nunes, 1990). All these groups have been shown to develop efficient strategies for solving mathematical problems in everyday situations. This research has broadened our understanding of the nature of mathematical knowledge and practices and has forced us to re-examine the notions of mathematical competency and ability.

A fourth strand focuses on the relationship between ethnomathematics and mathematics education (see for e.g. Pompeu, 1992; Vithal, 1992). This strand is evident in several of the studies in the third strand which have also elaborated the connections (or lack thereof) between mathematics found in everyday contexts and that in the formal school system. While there are examples, particularly in the form of multicultural curriculum material (see for e.g. Gerdes, 1988a, 1988b, 1988c, 1990) illustrating how an ethnomathematics perspective may be used in a mathematics education, there are relatively few detailed descriptions of the actual implementation and outcomes of the use of such an approach within the formal school system. This is still an under-researched area compared to the above strands. Perhaps this is because it is in this area that ethnomathematics faces its most difficult challenge – that of impacting on the school mathematics curriculum.

In what follows, we concentrate our comments on the fourth strand which, in our view, is the unifying strand as it pulls together the other strands. In linking ethnomathematics and curriculum development, Ubiratan D’Ambrosio (1985) argues, particularly with reference to developing countries, that “the recognition and incorporation of ethnomathematics into the curriculum is essential” (p. 475). Ethnomathematics is seen as providing the foundation upon which relevant curricula can be developed. Paulus Gerdes (1988b) points out “the mathematics curriculum has to be imbedded into the cultural environment of the pupils” (p. 35). At ICME 6, Bienvenido Nebres (1988), in his plenary address, summed up efforts to link ethnomathematics with school mathematics in the following way: “His [D’Ambrosio’s] approach and that of others working on ethnomathematics is to change the canonical school mathematics curriculum to one which arises from and is closely related to the experience of mathematics in a given culture.” (p. 15)

‘ETHNOMATHEMATICS’: A TRANSLATION INTO EDUCATION

Let us consider some formulations from a specific context which refers to principles which link culture with education in general:
“Education shall afford positive recognition of what is common as well as of what is diverse in the religious and cultural way of life and the language of the inhabitants.”

“Each population group has the right to develop syllabuses in accordance with the world view and within the cultural framework of the population group itself.”

These principles seem to recognise the diversities of cultures as well as the idea that education should relate to these diversities. Naturally, such general statements cannot be interpreted when they are isolated from their context. Let us therefore quote one more principle taken from the same context but which begins to put the above into practice:

“The Government reaffirms that, in terms of its policy that each population group should have its own schools, it is essential that each population group should also have its own education authority/department.”

These quotations are all taken from the *White Paper on the Provisions of Education in South Africa* (1983) published during the height of apartheid education.

According to apartheid, each person in South Africa was classified racially into one of four ‘population groups’: ‘White’, ‘Coloured’, ‘Indian’ or ‘African’. Where you were born, what school you would attend, where and how you would live, work opportunities open to you – virtually all aspects of your life depended on this classification. To cater for the education of these different population groups, there were some 17 departments of education which were racially and regionally determined. The schools, segregated in similar ways, and the departments which administered them, varied along a number of other lines: for example, their funding and resources – with well-resourced White schools at the top end, under-resourced African schools at the bottom and the others somewhere in between. The deeply authoritarian and hierarchical nature of the education system could also be seen in the unequal power relations between the departments themselves and the way in which the schools attached to them, were controlled and administered. The outcome of this, for one aspect, the school syllabuses, was that in effect it was the syllabus developed by the white education departments that came to be implemented (with some modification because of resources) in all schools. This was particularly true of the mathematics syllabus. In practice, this translated into inferior rather than different curricula, especially for those at the bottom of the hierarchy. Thus, while the language of the Education White Paper in which a concern for culture in education is couched may appear benign and even acceptable, in reality, in the framework of apartheid ideology, culture took on a particular meaning enmeshed with race and its outcomes were devastating.
To South Africans, the language of ‘ethnomathematics’, particularly its articulation of a concern with culture in education, may appear all too familiar and conceptually rather close to apartheid education. It is not surprising therefore that ‘ethnomathematics’ in South Africa is interpreted in different ways. The use of the term ‘ethnomathematics’ usually requires detailed explanation; and often elicits heated debate which is not only educational or intellectual but also intensely political and emotive. Although the context in which ‘ethnomathematics’ arose and the issues it addresses, such as to culturally affirm the disadvantaged, there is a ‘love-hate’ relationship with it. Its ‘affinity’ to the rhetoric of apartheid education is painfully recognised. However, because ethnomathematics affirms people’s cultures, it is seen as ‘politically incorrect’ to critique it.

It must be emphasised that in drawing attention to apartheid education in South Africa we do not imply that the political concern of ethnomathematics is somewhat suspicious. We completely sympathise with and acknowledge the ethnomathematical concern as part of a radical and progressive mathematics education. But we wish to demonstrate how easily rhetoric associated with ethnomathematics or a superficial reading of its theory/practice may be subverted towards goals directly opposite to those envisaged within it. The concern is that of how ‘ethnomathematics’ could be read as a justification or rationale for apartheid education. That this possibility actually existed in South Africa can be demonstrated in the way in which ‘Fundamental Paedagogics’ which in its European roots, associated with a humanistic approach to education, was subverted in South Africa to underpin apartheid education (see Suransky, 1995).

The South African experience raises questions that any serious attempt to implement a mathematics education that integrates an ethnomathematical perspective must resolve. To us this ‘awkward similarity’ in language indicates a conceptual weakness in ‘ethnomathematics’. The construct cannot become the unifying term for progressive mathematics education in the new South Africa. A critique is essential.

‘ETHNOMATHEMATICS’ AND CULTURE

It is a decade since ethnomathematics was coined by D’Ambrosio (1985) as “the mathematics which is practised among identifiable cultural groups such as national-tribal societies, labour groups, children of a certain age bracket, professional classes, and so on” (D’Ambrosio, 1985, p. 45). Later, D’Ambrosio has suggested that ethnomathematics is “the arts or techniques developed by different cultures to explain, to understand, to cope with their environment” (D’Ambrosio, 1992, p. 1184). We see that ethnomathematics has been broadened and that the notion of culture becomes
essential in the definition. In these definitions ‘ethnomathematics’ refers to ‘mathematics in a certain practice’. However, these definitions naturally influence ethnomathematics seen as a study of these practicess.

In South Africa we witness a corruption of the concept of culture. This is demonstrated in a paper by Basil Moore (1994) which is based on interviews with a wide range of people in South Africa, including academics and educationalists. During colonisation, the concept of culture, taken from anthropology, was used to ‘discover’ and describe indigenous peoples. This perspective could be captured as: “Their ‘culture’, although primitive and uncivilised, is interesting.” Later, the concept of culture was politicised by the Afrikaners in their struggle against the English as cultural and political identities were fused. This perspective can be summarised as: “Their culture is not our culture.” The end of colonisation marked the beginning of not only a politicised but also a racialised concept of culture as apartheid came into being. Culture came to refer to ‘race’, and the basic idea was: “A strong culture must be based on an ethnically pure group.”

Therefore a problem with ‘ethnomathematics’ in the South African context is the use of ‘ethno’. Etymologically the prefix ‘ethno’ is a borrowing from the Greek term ‘ethnos’ meaning ‘nation’. In its modern use it is a combining form indicating ‘race’, ‘people’, ‘culture’, ‘ethnic’ or ‘ethnological’. Thus the actual use of the word does not assist in resolving the uncomfortable reference to ‘race’ but rather deepens it.

From the literature on ethnomathematics it is clear that ethnomathematics is based on a broad interpretation of the notion of ‘ethno’. Writers in the field have emphasised that ‘ethno’ should not be taken as relating to race (D’Ambrosio, 1985, 1987; Borba, 1990) but rather as denoting or deriving from the cultural traditions of a group of people. In South Africa, concepts of culture, ethnicity and race are not only intertwined but also carry strong divisive and negative connotations. In the South African context, ‘cultural difference’ provided the ideological foundation for apartheid education and served as the fundamental principle for organising all aspects of life. ‘Cultural groups’ were defined racially and ethnically through categories such as ‘white’, ‘black’, ‘Indians’, ‘Zulus’, ‘Afrikaners’ and so on. Based on such definitions it was argued that individuals could be categorised into these ‘cultural groups’ and that education had to be provided separately for different groups. So even though it may be made explicit that ‘ethnomathematics’ is not “a racist doctrine” (Zebb, 1989) it is vulnerable to being associated with meanings that relate to the racism of Apartheid.

One of the consequences of the confounding and conflating of the concepts of race and culture, is that the concept of culture has come to have different meanings in current debates about the reconstruction of
education in South Africa. In opposition to the racial view of culture, Moore (1994) identifies two basic but not mutually exclusive views found in South Africa. The first has its roots in anthropology and argues that the concept of culture is useful in that it helps identify and describe important aspects of differences in and between communities. In this view culture is taken as a given within which peoples’ lives are shaped. The second view sees culture as a social and political construct that can be used to interpret, organise and structure society. Here the concept of culture itself is questioned and is seen as having to be understood in the context and the purposes for which it is being used.

Some descriptions of ethnomathematics tend to approximate the former view of culture. However, ethnomathematics examined in terms of the second view makes it possible not only to describe the mathematical practices and ideas in a particular culture but also to focus on questions like: Why are some of these valued and not others? How are they distributed? Who has access to them and for what purpose? In this way ethnomathematics can be seen as a social and political construct which is also ideological.

This critique of ethnomathematics is also raised by Volmink (1994): “...when I appeal to the literature on ethnomathematics, I see again only the rich, the influential, the powerful, the privileged having direct access to and control of mathematical ideas in their own cultural contexts ... for example, ... the priests, ... the rich landowners ... Power refers to relations among individuals or groups based on social, political, intellectual and material asymmetries that have been created by the structures of societies. These asymmetries, across gender, race and class are constantly reproduced.” (p. 57)

Thus one difficulty with the notion of ethnomathematics is that while it identifies culture as an important point of orientation, the research in ethnomathematics usually does not specify much about the relation between culture and power. Recent research, however, points to the need to broaden it in this direction. In her study on the mathematics of carpenters in South Africa, Millroy (1992) points out that a politicised concept of culture is essential: “In countries where the political and economic dominance of one group over all others has been entrenched for many years the concepts of power and conflict are central to a discussion of culture.” (p. 29)

Such an interpretation can also be seen in another study in which an ethnomathematical approach was taken in the mathematics education of the landless people of Brazil. Gelsa Knijnik (1993) states: “Words such as culture are not neutral, cannot be understood in a unitary and autonomous sense, disconnected from the asymmetric power relations of the social space. Culture is intrinsically related to the social power of those who pro-
duce it and reproduce it.” (p. 150) Her research indicates that the analysis of the ethnomathematics of any cultural group must include for the people of that group a critical orientation towards their own ethnomathematics. They must come to understand the strengths and weaknesses of their mathematical knowledge and practices in relation to knowledge and practices of other cultural groups, be they the dominant or subordinate groups of that society. Therefore, a political analysis of the concept of culture is crucial in ethnomathematics.

The ethnomathematical practice, generated by a particular cultural group, is not only the result of interactions with the natural and social environment but also subjected to interactions with the power relations both among and within cultural groups. Ethnomathematical studies have demonstrated how this has been played out between the Eurocentrism of academic mathematics and the mathematics of identifiable cultural groups, but have not equally applied this analysis to an analogous situation that occurs within an identified cultural group.

Understanding culture in relation to power is equally important within education. It is precisely the issue of power that distinguishes the arguments for considering culture in the education of groups such as the Maori in New Zealand and other marginalised people from that of Afrikaners in South Africa. Afrikaaners and other more privileged groups in South Africa draw on these same arguments (for example to support their demand for separate schools) but do so from positions of power (social, economic or political). Universal arguments for ethnomathematics can be used to mask other political agendas (for example as a means to maintain privilege), and therefore ethnomathematics must be debated and understood within specific contexts and the existing dominant power relations.

‘ETHNOMATHEMATICS’ AND THE PROBLEM OF DEFINITION

A step further in the development of the notion of ‘ethnomathematics’ is taken in the definition of D’Ambrosio (1994). Here, the concept is broken into *ethno-mathema-tics*. *Mathema* refers to understanding and coping with reality. *Tics*, coming from the Greek notion of *techne*, refers to techniques and art. This interprets mathematics as the ‘techniques of understanding’. As every technique of understanding is culturally embedded, the prefix *ethno* is essential. Thus, ‘ethnomathematics’ comes to mean the culturally embedded techniques of understanding. In this way the definition includes much more than originally understood as ethnomathematics.

We see this tendency also as problematic. If every practice which includes mathematics can be called an ethnomathematical practice, what then is the point of coining the term? The broader the concept becomes,
the less the content left in a statement like: Mathematics education should be based on the ethnomathematics of the children’s culture. This difficulty of broadening or opening up the definition is linked to the difficulties with ‘ethno’ . Should a strict definition of ‘ethno’ be maintained, the notion of ethnomathematics becomes politically suspicious. The alternative is to include culture in its broadest way in ‘ethno’, and then the concept loses content.

This however, does not mean that the concept loses all its functions. It could get a new function such as helping to formulate a programme for studying mathematics in its cultural context. It is, in fact, possible to suggest the existence of a fifth strand in the research and writings in ethnomathematics. More recently Gerdes (1994), Knijnik (1994), Barton (1996) and D’Ambrosio (1989) appear to mark a significant shift by defining ethnomathematics as a research programme. However, even within the context of a research programme there are some difficulties that need to be dealt with.

The first relates to the difficulties identified with the prefix ‘ethno’ and conceptions of culture or cultural group underpinned in such studies. Given the particular (corrupted) interpretation of the prefix ‘ethno’, a case could be made to suggest that an ‘ethnomathematical’ research programme has existed in South Africa. The apartheid era spawned numerous studies in which specific racial, ethnic or cultural groups were identified and some aspect of their thinking, attitudes, conceptions etc studied – for example “A Paedagogical Study of the Black Man’s Mathematical Ability” (Berg, 1977). The ethnic and racial separation of people easily lent itself to such studies. Moreover, such studies were sometimes used to justify the policies and practicities of Apartheid Education.

There is also a difficulty with the suffix ‘mathematics’, which has to do with coming to recognise or identify ‘mathematics’ embedded in a particular environment (see also Ascher et al., 1994). Millroy (1992) describes the dilemma facing research in ethnomathematics as a paradox: “If ethnomathematics is the study of the different kinds of mathematics in different cultural groups and it is impossible to recognise and describe anything without using one’s own frame of reference then how can anyone schooled in the formal conventional mathematics identify any form of mathematics other than that which resembles conventional mathematics.” (p. 11)

A related difficulty is that of the problem of circularity in definitions. Either ‘ethnomathematics’ can be defined by using explanations which do not include mathematics (a way of doing this is indicated by D’Ambrosio’s explanation of ethno-mathematics), or the definition must include
the word ‘mathematics’. While the first strategy runs the risk of being too broad, the second runs the risk of introducing a certain perspective on mathematics in the definition of ‘ethnomathematics’. This is naturally not a problem from a logical point of view, but it can be perceived as problematic to the extent that the perspective (on mathematics), presupposed in the definition, is exactly the perspective which ethnomathematical research tries to challenge. Almost all definitions or descriptions of ‘ethnomathematics’ feature the term mathematics in various ways as ‘mathematical knowledge’, ‘mathematical ideas’, mathematical activities’ or ‘mathematical practices’. In this way the definition easily runs into a circularity.

These comments are not intended to suggest that some better definitions can be found (and nor do we find it possible to make simple definitions of ‘critical mathematics education’). The difficulties of definition are to be seen as a further indication of the importance of a critique of the construct. ‘Ethno’ provides difficulties, ‘mathematics’ as well.

‘ETHNOMATHEMATICS’ AND CRITICAL CITIZENSHIP

The political impact of ethnomathematics as a research programme is prominent in all four strands but especially in the fourth strand having to do with education: How does an ethnomathematical interpretation of mathematical knowing serve the empowerment of the students? Naturally, ‘empowerment’ is an open concept. It can easily be used rhetorically. So, the question is, is it possible to provide ‘empowerment’ with a more specific content when we consider the basic thesis of ethnomathematics (that mathematics education can be improved by considering the cultural background of the students)?

Ethnomathematics expresses an ‘appreciation of the culture’. But ‘culture’ does not necessarily express ‘harmony’, it can also include antagonisms and conflicts. The thesis that mathematics education shall consider the implicit mathematics of a culture implies that ethnomathematics comes to participate in actual cultural conflicts. Ethnomathematics comes to influence the situations which it tries to reflect in education. ‘Appreciation of culture’ is a political stand, and an ‘appreciation’ need not support an ‘empowerment’.

The notion of power has also to do with the role of mathematics in society. The thesis of the formatting power of mathematics holds that mathematics participates in producing new inventions in reality. Mathematics not only provides new insights that may change interpretations, but mathematics may also actually change reality – colonising and reorganising parts of it. Mathematics not only provides a way of ‘looking’, it also provides a way of ‘doing’.

This thesis has been developed with a
highly technological society in mind but it has significant implications for developing countries.

The relationship between mathematics, society and technology can be analysed in terms of ‘thinking abstractions’ and ‘realised abstractions’ (see Keitel, 1993; Keitel et al., 1993; Skovsmose, 1994). The type of abstractions exemplified by mathematical concepts and mathematical modelling are thinking abstractions. They are themselves a reflection of and have a base in real abstractions (e.g. relations in exchange of goods). Thinking abstractions are transformed into social or realised abstractions through formalisation of language and action. Explicit mathematics becomes a system of implicit mathematics, converted by its continual and repeated application to reality. While thinking abstractions remain in ‘theory’, realised abstraction are reified and materialised as symbols, technological constructs and organised systems, real things or forces which shape peoples’ lives. In this way, mathematics not only creates ways of describing and interpreting reality but becomes a means for reconstructing reality and includes a prescriptive function. Every culture and society has developed a range of realised abstractions (e.g. time, space and money). The problem is that as societies become more technological, people are having to act in a system that embeds increasingly more and complex mathematics without explicitly knowing or understanding the underlying mathematical abstraction processes. The result is a ‘black box’ which one has to trust in the form of a machine, a specialist, or an institution. In this sense mathematics is formatting society.

A crucial question for a mathematics education which tries to support the development of a critical citizenship concerns the sort of competences that might be developed: Which competences express an empowerment? One possible interpretation relates ‘critical citizenship’ to the thesis of the formatting power of mathematics. A critical citizenship might help people to interpret the nature of ‘expertise’ in society in which the formatting power of mathematics is exercised. The question is: What does ‘people’s mathematics for people’s power’ mean when we have a technological society in mind? These considerations have put the critical evaluation of mathematical modelling on the agenda for critical mathematics education (especially as it has been developed in Scandinavia and Germany). It is not obvious how a familiarity with the mathematics bound in the (local) cultural context can become a means to ensure a critical attitude towards applications of mathematics. Therefore, the concept of critical citizenship has to be analysed with ethnomathematics in mind.

While the notion of the formatting power of mathematics has been discussed with respect to highly technological societies, its implication for
less developed countries is perhaps even more important as these countries strive to develop their own technologies, often in the image of those technologies transferred in various ways to poorer countries. In such countries, the formatting power of mathematics might appear even more formidable. When large sections of the populace are not literate, let alone technologically and mathematically literate, and those in power make decisions which intimately affect everybody – about taxes, benefits, etc. – with the use of technologies based on complex mathematical modelling, a problem of democracy becomes urgent. This is a significant and critical problem that the mathematics education in any country must attempt to deal with.

Does an ethnomathematical approach develop a competence which resists domination in the actual culture? Furthermore, could ethnomathematics itself become implicated in the formatting power of mathematics? Is there the possibility that ethnomathematics, in the very process of interpreting the activity of, say, basket weaving, invents new (mathematical) structures which then colonise and rearrange the reality of basket weaving? According to the thesis of the formatting power of mathematics, one way of seeing the ethnomathematics endeavour is as an attempt to interpret practices found in different cultural groups in terms of mathematical concepts and models. That is, to identify and establish thinking abstractions that underpin these practices. In ethnomathematics, it is the very existence of these abstractions that is taken seriously. They are seen as providing cultural affirmation and entry into mathematical abstractions themselves. But for whom? The ethnomathematicians, the practitioners, the students? By and large we do not hear the voices of the people whose practices are thus interpreted – the weavers. What are the implications for the people whose cultural practices or artifacts are seen as embedding mathematics? The question here is, does ‘defrosting mathematics’ or developing it from some practice represent a neutral activity without consequences?

Within the ethnomathematics literature we are unable to observe any attitude towards the formatting power of mathematics, nor any concern for developing a competence which reacts critically to applications of mathematics. In fact the interpretation and application of mathematics in different cultural contexts is itself not problematised. Mathematics is seen essentially as a tool that can be harnessed to improve life for all. It is exactly the notion of ‘techno-culture’ which is forgotten in the ethnomathematical discussion. ‘Culture’ needs to be thought of as containing conflicts and ‘antagonistic relations’. This becomes obvious when we have to do with not only ‘culture’ but also ‘techno-culture’. In general, ethnomathematics does not seem to have articulated how the development of a democracy can
be supported, a key consideration in many developing nations and much of Africa.

**‘ETHNOMATHEMATICS’ AND THE LEARNER**

In bringing the ethnomathematics of the children’s culture into the classroom, the concern has been primarily with featuring students’ cultural backgrounds centrally in the teaching and learning of mathematics. An ethnomathematical approach to school mathematics is characterised by Pompeu (1992) as one in which “mathematics lessons are based on knowledge which pupils bring from outside school” and in which “mathematical knowledge is developed from the pupils’ own situation” (p. 79). However, giving meaning to students’ social/cultural contexts in a mathematics classroom is not unproblematic. What could this focus on background mean in a classroom in South Africa with children from both the ‘suburb’ and the ‘squatter settlement’?

The way in which a teacher gives meaning in practice to an approach that focuses on the cultural background of their students hinges on many things, one of which is the teacher’s own understanding of the concept of culture and the reasons for focusing on learners’ cultural backgrounds. A focus on learners’ cultural background may be intended to provide a mathematics education for valuing cultural difference; or for cultural transformation; or for engaging in a political analysis of culture; or as an education for empowering students in their specific contestations (Moore, 1994). The question of how these approaches are translated into practice within classrooms remains. Teachers not only have to access, understand and accept their students’ social and cultural background knowledge, they need to be able to interpret these outside realities in terms of mathematics and transform them into curriculum experiences. But which aspects of reality have this potential? Whose reality, adults’ or children’s? Which adult or child’s reality? And what about teachers who do not share the cultural background of their students? These questions must be dealt with in any theory that puts students’ backgrounds in the centre of the discussion.

Clearly, students’ cultural backgrounds cannot be conceptualised in terms of neat categories into which any individual or group of students may be fitted. Any one learner’s background intersects with that of another in a myriad of different ways. Moreover, even when learners are seen as sharing a particular cultural background, the experiences and mathematical knowledge acquired by different learners from the same cultural context varies. In her study in a sugar cane farming community in Brazil, Guida Abreu has shown this to be the case in a context where children are engaging in the same social or cultural practice such as buying bread (see Abreu and
Bishop, 1993). The culture of any one group cannot be thought as being uniform.

Cultural approaches to education in multicultural societies often assume that cultures are compatible and in harmony within themselves and with each other. In so doing they render invisible any conflicts that can and do exist and hence preclude the development of strategies for coping with them. The consequence is that teachers who employ cultural approaches appear not to notice conflicts which do exist or in the face of conflicts simply stop using such approaches. In the South African context, Victor Amoah’s (1996) study points to some of this concern on the part of teachers about the use of ethnomathematics in classrooms. For instance, in a workshop for teachers which dealt with an example of using ‘South African rural architecture in a multiracial classroom’, a teacher asked: “How will you overcome student embarrassment?” Furthermore Amoah states: “Some teachers in Malamulele, a rural area in the Northern Province, pointed out that the materials developed were cultural biased.” (p. 52)

We do see a focus on cultural conflicts (see for example Bishop, 1994 and Abreu et al., 1992) but much of this analysis has been confined to cultural conflicts in the interaction between the culture of schools including school mathematics and that outside schools. Much less has been written about conflicts in classrooms related to the different backgrounds of students and how students value their own and others’ backgrounds. In South Africa bringing students’ backgrounds into the classroom could come to mean reproducing those inequalities in the classroom. The aspect of conflict must be elaborated in ethnomathematics, as it forces us to consider the question: does bringing cultural contexts into the curriculum reconcile or exacerbate differences and conflicts?

So, the first point in our comment on ethnomathematics and the learner is that the possible conflicting nature of culture in learners’ cultural backgrounds must be recognised. If not, the ‘appreciation of culture’ can become a conservative force and actually come to contradict the actual intentions of ethnomathematics.

While in the discussion above we have attended mainly to the concept of culture in the notion of ‘cultural background of learners’, we now turn our attention to the concept of background itself. The premise on which an ethnomathematical perspective rests is that students’ backgrounds are important in understanding their achievement, performance, attitudes and motivations. The concept of background may be understood as that socially constructed network of relationships and meanings which are the result of the learner’s lived past history (Skovsmose, 1994).
We assert, however, that of equal importance is the student’s foreground. Foreground may be described as the set of opportunities that the learner’s social context makes accessible to the learner to perceive as his or her possibilities for the future (Skovsmose, 1994). Both the background and foreground interact and are interpreted and organised by students in whatever meaning is given to school or classroom activities. It is by integrating the background and foreground that the performance and under-representation of various groups in mathematics such as ‘disadvantaged’ students or women, for instance, can be understood.

To show how ‘foreground’ comes to play an essential role in the interpretation of teaching-learning, we suggest that learning can be interpreted as (similar to) an action. Therefore, we take a look at the notions of: ‘disposition’, ‘intention of learning’, ‘learning as action’ and ‘meaning’ in learning and education.

Intentions of learning emerge out of dispositions. Dispositions are concerned with ‘background’ as well as ‘foreground’ and are revealed when the learner produces, creates or decides his or her intention. A situation which could raise intentions for learning does not automatically belong to the background of the student having to do with his or her situation and social or cultural heritage. It has just as much to do with the student’s possibilities in future life, not the objective possibilities but the possibilities as the student perceives them. The decision of the learner to act or learn therefore has a role to play when conditions for learning are created. The student has to be involved in the learning – should want to learn – if the learning activity is to become learning as action. Furthermore, the learning has to be performed by the learner if it is to include reflections and a critical awareness.

Epistemic development thus cannot be forced upon anybody. We cannot, as teachers or curriculum designers, implant goals or good reasons in a student. Goals and reasons have to be identified and accepted by the learner as being of importance. If not, they can never become the goals and reasons of a learner. Hence a condition for a productive teaching-learning process is that a situation is established where students are given opportunities to investigate reasons and goals for suggested teaching-learning processes, and by doing so, to incorporate some of them as part of their learning processes. Intentions in learning must be placed there by the learner himself or herself. The learner must own the process of learning, including the goals.

Meaning in learning is related to the intentions of the student. Could the student perceive meaning in this activity? Are they participating? Are they learning something? The connections are: If students should see meaning
in learning something, it should be possible for them to intend something. If it should make sense for the students to learn something, a situation must be brought about in which the students could see reasons to decide ‘to go for this’. They should be able to put their intentions into the learning activity. That something is seen as meaningful for the students means that they, with good reasons, could chose to perform a learning. Ethnomathematics is also concerned with meaning in education. The content of education should be meaningful to the students and, according to ethnomathematics, meaningfulness must be grounded in ‘cultural familiarity’. However, ‘meaningful’ does not only refer to the ‘background’ but also to the foreground of the students. When learning becomes interpreted as similar to an action, then meaningful education refers to situations where students choose to ‘perform their learning’ and see a purpose in the action. And providing purposes for what to do also refers to the ‘foreground’ of the person. Meaningful education therefore also relates to the foreground of the students. Instead of asking only, as ethnomathematics does: Where do the students come from? the question should also be: Where do the students want to go from here? Meaning in mathematics education refers to the opportunities which are part of the student’s perspective.

If learning has to do with action and is specified by intentions, it becomes important to interpret performance in school in terms of the students’ views of their future. Formal mathematics may seem hostile to many students, because it is difficult for them to locate themselves in a (future) situation in life, which they hope to get into, and in which formal mathematics met by them in school, plays a vital role. Therefore, it can be difficult for the students to identify any personal reasons, except instrumental ones, for learning abstract calculations. When we discuss a students’ performance in school, we do not (only) have to look at the students’ background, but at their foreground. The future gives reasons and dreams, or destroys them. Actions, and therefore epistemic development, are also oriented towards the person’s actual perception of the future.

In a study examining the social construction of their realities, Suchitra Singh (1994) shows that the under-representation of ‘Indian’ women students in South Africa in science related careers may be related to both background and foreground (even though they may have performed well in mathematics and science at school). The study demonstrates how perceptions about their future, experiences in school and the home together may explain why the majority of these students chose not to enter a computer-related career.

The students’ perception of a subject is partly determined by the their perceptions of their opportunities in society. If the students do not see any
career-possibilities' available in which a competency in mathematics plays a significant role, then it becomes difficult for the students to 'decide' to get into this subject. The different social groupings in society are provided with different opportunities for work and career. Some societies discriminate according to colour of skin, some according to gender, others according to 'class' – and some societies apply all these sources for discrimination. The opportunities which the student can identify are determined by society's way of distributing opportunities according to 'race', 'class' and 'gender'. The achievements in school are determined by how the student interprets these opportunities. Achievements are therefore determined by the way society handles its 'social groupings'. The study by Singh exemplifies this phenomenon.

The point is that the (low) achievement in school of children with a 'poor' background is not only to be explained by reference to their background (meaning that those children, because of their 'weak concepts', etc, need to have some 'special training'). Their (low) achievements also have to be explained in terms of the 'poor' foreground which society reveals for these students. By understanding achievement also as a consequence of the students' interpretations of their actual foreground, the social and political nature of differences in achievements is opened.

So while the first critique of ethnomathematics, having to do with the learner, is that the conflicting nature of the students' cultural background is not reflected, the second is for paying too much attention to this background. These two critiques may appear to pull in different directions, so a further remark is necessary. It is also essential to pay attention to the possible actual conflicting structures in the foreground of the students. The foreground cannot be expected to be in any more harmonious state than the background. For instance, a conflict in foreground may arise from tensions experienced in opportunities perceived towards a 'traditional' versus a 'modern' future life – for e.g. staying in a rural area or seeking a future in the city; becoming a wife and mother or choosing a career that seems to preclude the former.

A key question arising out of this discussion is what is the nature of the foreground of a South African child and what could it mean to pay attention to both his or her foreground and background in the classroom. The opportunities made available in school/life are essential for how the child conceives of the learning situation. In some of the very diverse (culturally, socially, politically and economically) classrooms in South Africa, and given its history, a focus on foreground, a common shared future, may be preferred by learners while a focus on background, on difference, may be resisted. Rather than only looking back, it has been
argued that a curriculum needs to equally reflect the diversity of a changing South Africa where new possibilities are made visible and available and where cultural richness and variety is critiqued, challenged and extended in the classroom (Samuel, 1994).

**‘Ethnomathematics’ and its Self-Protection**

Ethnomathematics (and critical mathematics education) have provided new insights and directions in mathematics education. They have emerged, in part, through a critique of other positions, especially traditional or conventional approaches. However, there is a need, equally, to turn that critique inward. Michael Apple (1995) refers to this as being “reflexive about our own critical approaches . . . a double reflexivity is needed – one that is critical of dominant approaches and agendas, and another that is constantly self-critical of the alternatives we propose” (p 341).

What are the means for developing such a double reflexivity or self-critique? How can opportunities be created, not only for those who put forward these alternatives, but for anyone, to engage in that critique? The issues here are that of providing a strategy for setting up a critique and that of opening up and giving access to a wider audience to critique positions put forward.

With respect to a theoretical position in mathematical education, what can the source of a critique be? One is of particular importance: a detailed description of an educational practice. We shall not try to establish criteria for such a detailed description, but the basic idea is that a description of an educational teaching-learning process can make it possible to criticise a theoretical position in mathematics education.

One of the difficulties in understanding the precise nature of ethnomathematics as an educational practice is the lack of adequate detailed descriptions of such practices. However, examining practices can give meaning (or otherwise) to the notions that ethnomathematics embeds. We talk about a description and not just about observations, as the person who launches a critique cannot be expected to have been present in the educational situation. A description of an educational practice which makes it possible for an outsider to make a critique of a certain theoretical position in mathematics education we call a crucial description.\(^{14}\) It must be emphasised that a crucial description can both support and weaken a theoretical position. Critique does not simply mean negative critique.

Ethnomathematics provides a perspective on mathematics education. However, nowhere in the ethnomathematical literature (in English) do we find a crucial description of an educational practice. A theoretical position which has not provided any crucial description cannot be serious-
ly challenged, and it becomes in this sense dogmatic. For the moment, ethnomathematics appears in this dogmatic form and to that extent it is self-protecting.

We do not say that we cannot find any references to classroom situations. For instance, in his investigation of Pythagoras' theorem, Gerdes (1988) incorporates references to the quadratic button made in Mozambique and he refers to remarks from students. But these references only indicate what takes place. They do not provide any means for an outsider to observe or develop a critique of the theoretical part of ethnomathematics. Such descriptions provide illustrations of ethnomathematical notions, but the descriptions are not crucial.¹⁵

What then should be included in such a description? They have, at least, to reveal the nature of the interactions in the teaching-learing situation: the interaction between teacher and students, and the interaction between students and the topic. A crucial description cannot be based on descriptions of the intentions of an educational perspective but must reveal what is actually happening when an attempt is made to realise this perspective in an educational setting.

This methodological critique of ethnomathematics is important but it can be solved. We must also emphasise that in this respect critical mathematics education is not much better off. Some descriptions of education practices are found in Skovsmose (1994). However, the function of these descriptions is not to provide an empirical basis for a critique of critical mathematics education. They serve the more limited purpose of illustrating an educational meaning of some of the notions by which critical mathematics education is described. A step further has to be taken, and in Christiansen (1995) a detailed empirical investigation is found which reveals difficulties and conceptual gaps in some of the notions of critical mathematics education. This description then becomes a crucial description.

These remarks show that the resistance towards critique is not a specific phenomena of ethnomathematics, but it is important if a theoretical development should be continued that ethnomathematics (and critical mathematics education as well) provides crucial descriptions.

Theory building and theory critique are not discrete activities but rather mutually dependent. Critique is essential not only to the generation of new and alternate theoretical positions; but also in changing directions, weakening, strengthening or sharpening focusses in existing positions. Therefore, it does not make sense to assert that a critique of a particular theory can be premature if that theory is in its infancy.¹⁶ Educational theories must not only allow or create spaces for critique but also present opportunities for critique.
CONCLUSION

We share the intentions and general concerns built into the ethnomathematical movement, and agree with D’Ambrosio when he writes:

“In the last 100 years, we have seen enormous advances on our knowledge of nature and in the development of new technologies. . . And yet, this same century has shown us a despicable human behaviour. Unprecedented means of mass destruction, of insecurity, new terrible diseases, unjustified famine, drug abuse, and moral decay are matched only by an irreversible destruction of the environment. Much of this paradox has to do with the absence of reflections and consideration in values in academics, particularly in the scientific disciplines, both in research and in education. Most of the means to achieve these wonders and also these horrors of science and technology have to do with advances in mathematics.”
(D’Ambrosio, 1994a, p. 443)

It is exactly this observation which is also the starting point for critical mathematics education. Nevertheless, we find that the notion of ‘ethnomathematics’ just simply cannot survive the meeting with the new situation in South Africa, where all the questions for modernisation theory will be played off once more. ‘Ethnomathematics’ emerged as a term representing an oppositional stance. It has achieved that purpose. It has established an understanding of mathematics and mathematics education as culturally and socially negotiated. But the concept ‘ethnomathematics’ is itself problematic. And it is not innocent.

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NOTES

1 For a clarification of the notion ‘critical mathematics education’, see Skovsmose (1994).
2 The critique which follows reflects and is shaped by the diverse contexts in which we live and work: Ole Skovsmose in Denmark and Renuka Vithal in South Africa.
4 The notion of ‘lifeworld’ has been used by Habermas (1984, 1987). The question Habermas discusses is the degree to which the ‘lifeworld’ becomes structured and ‘systematised’.
5 It should be noted that while some writers and researchers in this area refer to their work as ethnomathematical e.g. Ubiratan D'Ambrosio (1985, 1989, 1990, 1991, 1992), Paulus Gerdes (1986, 1988a, 1988b, 1988c, 1990, 1991a, 1991b, 1994, 1995), Marcia Ascher (1991), Marcelo Borba (1990) and Geraldo Pompeu (1992), others such as Munir Fasheh (1982, 1988) and Alan Bishop (1988), for instance, also explore this connection but do not specifically refer to their work as ethnomathematics. Yet their writings are often grouped with and discussed in relation to ethnomathematics. We concede also as a shortcoming of this paper, that some of the key proponents of ethnomathematics who have elaborated their ideas in other languages, e.g. Portuguese, have not been considered. Often English translations are essentially extended summaries of ideas presented elsewhere and read as secondary sources. Our critique is based on available literature in English (see references).

6 For a more detailed discussion see Vithal (1992) and also Bishop (1994).


8 In Basil Moore's (1994) interviews with Michael Cross and Joe Muller.

9 For example, for D'Ambrosio (1985), ethnomathematics is the mathematical practices of culturally identifiable groups, that is "...culturally identifiable groups with their jargons, codes, symbols, myths, and even specific ways of reasoning and inferring... Associated with these we have practices such as ciphering and counting, measuring, classifying, ordering, inferring, modelling and so on which constitute ethnomathematics" (p. 45–46). See also D'Ambrosio, 1994b, p. 237.

10 Giroux (1981) makes the following remark about such a notion of culture: "Culture, in this sense, would be defined not simply as lived experiences functioning within the context of historically located structures and social formations but as 'lived antagonistic relations' situated within a complex of socio-political institutions and social forms that limit as well as enable human actions." (p. 26)

11 For a further discussion of the formatting power of mathematics, see Skovsmose (1994).

12 This silence is also present in the parallel activity of bringing ethnomathematics into mathematics education. The importation of aspects of a culture into a mathematics curriculum has not been discussed in relation to the people whose culture a particular practice or artifact belongs. Barton (1993) raises two issues in this regard: "For example, in Maori bilingual classes in New Zealand, there has been discomfort with the way in which culture is incorporated into the mathematics programme... for example the issue of European teachers introducing Maori culture to Maori children. Another source of uncertainty is the use of cultural items to introduce mathematical ideas which are clearly not from that culture, for example using Maori rafter patterns to teach transformation geometry. Teachers are aware that the rafter pattern is being isolated from its context in a way which might not be approved of by the Maori artist, nor by the wider Maori community." (p. 3)

13 The consequences considered from an "optimistic" interpretation (the one usually put forward) is that having identified the mathematics it could be beneficial to the practitioners, say enabling weavers to develop more efficient weaving techniques which then enhances their situation. There is equally a "pessimistic" interpretation to be considered where interpreting an activity in terms of mathematical abstractions is seen to be disempowering rather than empowering for the people whose activity is being mathematically interrogated, rendering the activity less accessible to weavers or potential weavers. Through the formalisation of language and actions, mathemati-
sation can create real objects which interact with reality and which could be useful or
dangerous and used not only for explaining but also prescribing.

14 This idea is found in Nielsen and Simont (1994).
15 These remarks about the self-protection of ethnomathematics are naturally not dev-
astating. It concerns the actual situation, not an internal feature of ethnomathematics,
but in order to further develop the notions of ethnomathematics it is essential that
the crucial descriptions become accessible.
16 This point of view was expressed by Paulus Gerdes in a panel discussion on eth-
nomathematics at the First National Conference of the Association of Mathematics
Education for South Africa, Wits University, 4–7 July 1994 and in a discussion with
Renuka Vithal. Gerdes argued that ethnomathematics was still in development and
used the analogy of ‘a baby’ that should be spared from critique for now as one does
not critique a growing baby.

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