Published 2019 in Subramanian J (ed.) *Proceedings of the Tenth International Mathematics Education and Society Conference*. Hyderabad, India: University of Hyderabad.

DE/MATHEMATISING THE POLITICAL IN MATHEMATICS EDUCATION: *A DE/POSTCOLONIAL CRITIQUE*

Anna Chronaki[1,2] and Dalene Swanson[3]

[1]University of Thessaly & [2]University of Malmö, [3]University of Stirling

Abstract: Various interpretations have been given to the double gesture of de/mathematising in relation to a variety of social thematic contexts demarcating 'the political' in mathematics education. By way of theoretical intervention, we offer the beginnings of a de/postcolonial critique in response to such programmes of work, while recognising the important contributions they have made to advancing complex political approaches to mathematics education as a pedagogic praxis. Social thematic approaches of de/mathematising have promoted ways of envisioning mathematical activity and agency. Our critique is both celebration of these diverse initiatives, as well as, a way of moving these conversations forward in newer, alternative, politico-epistemological directions. In a dialogue amongst us, based on our previous works, we reconsider 'the political' in mathematics education through a de/postcolonial critique.

INTRODUCTION

Much has been said on the nature of mathematising and demathematising and their necessary underpinnings beyond a conception of 'horizontal and vertical mathematisation' (Gellert & Jablonka, 2007). In this respect, parallel working interpretations of mathematising can be defined as: *first,* a process that renders a set of activities increasingly mathematical, as well as, *second,* the increased political influence of the voice of mathematics and mathematics education (and STEM) in the social domain. Dialectically, demathematising would have the dual reverse effect of deminishing the mathematical effects or qualities in a set of activities, and/or its political diminishment. These multiple, dialectical understandings are constantly at play in the way in which they concomitantly and often contradictorily inform each other. An example of this may be mathematics and mathematics education's increasing technological and economic utilitarianism under global neoliberal governance, which has the dual effect of entrenching its perceived importance while in servitude to specific technoscientific and economic agendas (Skovsmose, 2006, Chronaki, 2009, 2010, 2011, Swanson, 2017a).

In this paper, we attempt to move beyond current understandings of what it means to mathematise in relation to varied social thematic contexts at the service of mathematics education. These social thematic contexts span from realistic mathematics education, to real world activity, critical mathematics education (CME), Ethnomathematics, arts or craft-based mathematics, playful contexts, media-based materials, pseudo-contexts based on word problems or varied themes of mathematics in action. By way of theoretical intervention, we offer an entrée to a de/postcolonial critique in response to such programmes of work, recognising the important contributions they have made to

advance complex didactic and socio-political approaches to mathematics education as praxis in relation to society, and the way in which they have promoted alternative ways of envisioning mathematical activity. They have encouraged us to think beyond the confines of school, classroom and curriculum as containers of knowledge and knowledge circulation, ways that envision mathematical pedagogy as relating to people and their histories in present complex societies. Nevertheless, we provide some distinction from these programmes of work by attempting to move these conversations forward in newer, alternative politico-epistemological directions, ones which more centrally consider critical de/postcolonial perspectives.

While socio-political projects are still relatively recent in mathematics education (Ernest, Sriraman & Ernest, 2016), there is a need to explore how a de/postcolonial critique might offer opportunities to centre ethical, democratic and (geo)political considerations in de/mathematising activity, while bringing forward concerns about social and economic development, culture, race, class, ability, gender, and global or local (in)justices to bear on arguments in relation to mathematics and mathematics education discourses. We suggest that a de/postcolonial critique can usefully provide theoretical concepts that enable us to speak of ontological and epistemic considerations *politically* in mathematics education in-between global and local contexts.

MATHEMATISING, DEMATHEMATISING AND THE POLITICAL

From the time of Galileo who argued that the book of nature is written in the language of mathematics, to Freudenthal who coined the word 'mathematising', a dominant conception of mathematics as the 'Queen of the Sciences' has pervaded discourses in the public domain, and these inheritances largely remain in educational contexts where mathematics is taught. Pervasively, in the school setting, pseudo contexts of 'real-life' have often served as exemplars of mathematising as if providing an easy straight-forward entry to 'the real'. In the many educational and social contexts, mathematics often has been divined as revealing Truth. Its reification within Enlightenment discourses has perpetuated such dominance (Swanson, 2005), thus giving rise to critical conversations about the potential benefits and dangers of de/mathematising within society in the context of a world structured according to socio-economic, epistemic, embodied and political hierarchies and widespread inequalities of every form (Ernest, Sriraman & Ernest, 2016).

The need to open up diverse meanings and spaces for conversations about the nature of de/mathematising has become ever more urgent in the face of the perpetuation of a widespread singular logic structured around a hyper-pragmatic, economically-informed 'reality' and pervasive neoliberal 'common sense' (Hall and O'Shea, 2013). In this light, we argue that there is a need to see de/mathematising as a broad processual, interactive and evocative space where discourse, power, and 'the body' come to influence ecologies of knowing and being by way of coming to know the world through mathematics (Swanson, 2013a; Chronaki, 2009, 2010, 2011). The process of mathematising is therefore unavoidably political, and cannot escape such influences and positionings through a call to objectivity and the lure of certainty (Swanson, 2005).

In another sense, the process of doing mathematics often works like religion, turning de/mathematization a matter of morals (Restivo, 2009).

De/mathematising's necessarily political nature is a condition we purposively embrace rather than attempt to render as neutral, which we argue acts as a political positioning in itself. Foregrounding the acknowledgement that mathematising activities are informed by relations of power and cultural-historiographical investments, it is in the understanding of this purposive political act that we bring critical de/postcolonial perspectives to bear on such conversations. We are not following an expected paradigm of academic engagement by offering 'solutions', but rather attempting to grapple with complexity in problematising the myriad of issues at hand and in opening up alternative conversations about what it means to mathematise and what are its many effects in contemporary society in this political moment. The effects of de/mathematising social activities can be traced to some degree through the effects of power in which mathematics education discourses and practices cohere, constructing particular 'regimes of truth' (Foucault, 1980), through the evocative power of context (Bernstein, 2000) and its politics. Yet, the ethical implications of power dynamics are often left unattended in the literature, with some attention being given to Levinasian perspectives for example (Maheux, Swanson & Khan, 2012), referencing structural exclusion (Swanson, Yu & Mouroutsou, 2017b; Jörgensen, Gates, & Roper, 2014), or exploring the affirmative potential of minor gestures (Chronaki, submitted).

The move to understand de/mathematisation is one which begins to frame mathematics education in its many socio-political contexts. Bringing 'the political' together with 'mathematics' or 'mathematics education' may seem a surprising, radical or even 'irresponsible' gesture, within the framework of modernist hegemony. Yet, there are multiple ways in which one might respond to the question of what it might mean to (de)politicize mathematics education, if taken within a wider conception of mathematics and mathematics education's role in contemporary global relations. One view would be a deconstructive move as an intervention to a dominant narrative of mathematics' claim to being able to objectively describe nature and the workings of the universe, which is itself a position that has had political effects in the way it has granted mathematics authority and power (Swanson, 2005). This authority has lent credence and power to mathematics education, extending its 'formatting power' (Skovsmose and Yasukawa, 2004) in advancing globalizing modernism through its practices. In the same vein, mathematics and hence mathematics education's claim to neutrality is a politicizing of mathematics, while claiming the opposite. But more importantly, the prevalence with which mathematics educational tasks have displayed an avoidance of contexts of an explicitly political nature, such as addressing issues around disenfranchisement of certain groups within the nation state, oppression of ethnic minorities or women, or controversies over climate change, amongst others, speaks to its always-already politicized nature. The political nature of mathematics is also internal to its structures and practices, and heated debates over 'grouping by

ability' and 'mixed ability grouping' (Swanson, Yu, & Mouroutsou, 2017b) are only one example of how fraught issues around exclusion and inequality in mathematics classrooms can be, let alone drawing political parallels to the ways in which these practices help undermine democracy in society. The poor attention given to issues of racism in mathematics education is a political issue desperately demanding attention, and the broader injustices of mathematics education in its implications to sustaining gender inequality as well as economic and social oppressions of the Global South require interrogation from feminist de/postcolonial positions (Chronaki, 2009, 2011). Not only is mathematics education already political by the nature of the power struggles in which it is embroiled, but in the sense of the injustices and absences discussed here, it can be argued that it owes a 'political responsibility' to the search for more viable, sustainable and more just alternative futures (Swanson, 2017).

Mathematics education's disavowal of becoming implicated in the singular logic of global modernist hegemony, needs undoing through a dual approach: First, by making its always-already political nature explicit; and second by politicising it in a way that holds it responsible for the current global condition. The way in which we engage the political counts however, and approaches that afford a deeper critical sociology of mathematics education in respect of global/local relations and becomes increasingly urgent given the crisis of global social and ecological instability. This opens up a space for de/postcolonial critique that may attend to the localizing issues of oppression with a view to its global effects, as well as, the global effects that impact on local conditions and communities, and with a focus on their intricate interconnectedness. Here, arguments related to mathematics education's political implications in global structural injustices can advance the argument for political accountability through a language of ethics and democracy, whether pertaining to the social, economic or ecological and ethical discourses.

ETHICS OF MATHEMATISING AND DEMOCRACY

Considering ethics in terms of rights and democracy, many areas of theoretical interest to mathematising as social processes often see the advocacy of mathematics as an automatic good (Swanson, 2013a), albeit that the manner and nature of mathematising and pedagogy count. Within these terms, the effects on people's lives and ecology are understated. Here, much advocacy of mathematising from these perspectives leaves fundamental assumptions unquestioned and unquestionable. A critical relationship with democracy for mathematics education (Skovsmose & Valero, 2001) involves an active (re)direction of its intents and purposes. What is seldom asked, however, is the question of whether choosing *not* to participate in experiences of mathematics education or its (re)direction were itself also a critical relationship with mathematics education. Seldom is the view held that the refusal and disobedience to the evocative power of mathematics is also a democratic action. Swanson & Appelbaum (2012) argue that mathematics education for democracy and development must take seriously specific acts of refusal that directly confront the construction of inequality common in most development contexts. They argue that globalisation and development discourses,

via citizenship and nationalism, construct oppressive relationships with learners and mathematics education. Such relationships are coercive and based on assumptions of the inherent goodness of learning mathematics and of mathematising as a virtue or the right to mathematics education is one and the same as the expectation to do so, for the person and/or society's own good. In a similar vein, Chronaki & Kollosche (2018) discuss the case of a female student in a secondary school who opts towards refusing mathematics as an act of opposing a process of being schooled in an austere context. However, seldom is the action of refusal to participate in mathematising activities understood in the light of a refusal to participate in mathematics education's colonising and/or globalising neo-liberal gaze.

Bringing Jacques Rancière's (2009) notion of 'radical equality' to mathematics education theory helps to advance the ethical and emancipatory position of intentional disregard for ideological narratives such as the ones produced by dominant development mathematics education discourses (Swanson, 2013b). Consequently, by reconsidering the assumptions behind mathematics education in its global development context, one can reframe refusal, disengagement, disobedience or resistance not as deficit or failure but as a critical position of radical equality in relation to arguments on mathematising, access and choice (Swanson and Appelbaum, 2012, Chronaki, submitted). This brings us back to the issue of a politics of mathematics education, where mathematics education is recognised as operating within a geography of global relations. Mathematics education is, of course, a contested terrain with competing values, ideals, and intentions attributed to it, but its general role in advancing economic development within a frame of globalising modernism speaks to a particular ensemble of discourses that have political effect in the global social domain, construing particular relations of power that operate on micro, meso, and macro levels. We argue that a feminist de/postcolonial framing could provide insights and interventions in coming to understand how such power dynamics operate on a global scale, with particular implications for 'the local' that may act as forms of symbolic violence against communities (Bourdieu, 1990).

DE/POSTCOLONIALITY AND MATHEMATICS EDUCATION

The origins of postcolonial studies in the field of science and technology, as Harding explains (1998), can be traced back to the 1940s when a West Indian historian looked at how the immense profits from Caribbean plantations had played such a crucial role in making European industrialisation possible. This early investigation revealed how the British had intentionally destroyed the Indian textile industry in order to create a market for imported British textiles. Postcolonial studies have helped to reveal that imperial control has driven the politics of scientific knowledge historically, likewise postcolonial scholars have undermined the assumption of a single universally-valid scientific and technological tradition by offering evidence of alternate, localised ways of knowing scientifically. Furthermore, they have documented how the modern European 'utopia' of a perfectly coherent account of nature's regularity and order is beginning to take on the character of 'tragedy of the commons' (Lloyd, 1833; Hardin,

1968, for a review see Chronaki, 2009). In other ways, Swanson (2013a) has noted how the promotion of the study of mathematics and science has been touted as necessary in the modernist call to 'fix Africa', thus not only contributing to ongoing deficit views of the continent, but advancing the colonialist project in that context rather than undoing it. Under this mantra, mathematical and scientific discourses not only "enclose an African commons but (they) reproduce a colonized Other under the auspices of benevolence" (p, 337). In referencing Neil Turok's message that "the next Einstein will be African", a particular postcolonial patronage is produced towards the African continent through the authority vested in Western science and mathematics:

'In his TED broadcast, Turok (2008) promotes the mathematical sciences for "talented young Africans" as a panacea to all Africa's 'ills' and claims that "by unlocking and nurturing the continent's creative potential, we can create a change in Africa's future".[i] *Here 'Africa's future' depends on access to Western-endorsed mathematics.*[ii] *Mathematics has the power to 'know' what is best for Africa. If more 'talented young Africans' (and here 'talent' assumes exclusively 'mathematical talent', reifying this form over others) succeeded at mathematics, then Africa might be "fixed". For Africa to be awarded a construct of 'success', and only in Western-European terms, it must produce an Einstein. In other words, talented Africans must mimic Western scientific heroes. They need to emulate Western-European scientific discourses that have sole currency in the global modernization project. There is no other way to be 'successful' other than in these terms and judged from the dominant Western-European gaze'.* (Swanson, 2013a, p. 338)

Throughout the years, the categories of 'woman' or 'black' have become the subject of an extensive literature mainly through the accounts of travellers, missionaries and colonial officials. Chronaki (2009) discusses how Andrea Cornwall (2005), in her review of postcolonial feminist studies in Africa during the last three decades, explains that efforts to 'read' women range from studies that tend to define women as invisible, weak, and powerless to studies that challenge stereotypical assumptions about women's ability to participate in economics, mathematics and politics. Such representations are often firmly— but tacitly—located in a Western feminist perspective and evoke contradictory images, while their relevance and utility have been increasingly questioned by activists and academics. Postcolonial feminisms differ from the liberal, radical or socialist feminisms as they focus mainly on conceiving gendered and power relations within global political, economic and social programmes. They interrogate the assumption that the liberal pursuit of progress, development and colonialism are distinct and dominant projects. Thus, the question is how the distinctive concerns of postcolonial feminisms call for distinctive approaches to questions of science and technology, and call for a revisiting of children and adults' relation to mathematising via a feminist de/postcolonial lens (a discussion considering Spivak, Harding and Haraway can be located in Chronaki, 2009, 2011).

While anticolonialism has been touted as having some relevance to mathematics

education discourses, there has been little attention given to postcolonial and decolonial thinking in the ways in which it can offer an epistemic critique in relation to the nature of mathematical knowledge and the process of mathematising, informed by colonial relations and politics of knowing. Institutional neo-liberal demands for fulfilling modernisation agendas have set the terms for global economies by increasing, in analogy, the monitoring and regulating of individuals, groups and targeted communities. Such measures serve to perpetuate the global neo-colonial project.

The current conception of societal development, framed as 'economic progress' within the neo-colonial project, has excluded a range of other possible meanings and ways of engagement. This has been the experience of mathematics education in its increasing standardisation across the globe in assessment regimes, curricula, and pedagogy. This 'standardisation' has been invested in power, suppressing the cultural and localised ways of knowing in majority world contexts or global South via 'development' agendas, while installing the values, codes and epistemic relations of the minority world or global North 'as universal'. Development as a concept presumes a *need* for development on the part of the targeted communities and the individual through adequate pedagogy (Chronaki, 2011). In this sense, any development programme situates the subjects and the communities that are ostensibly aided as 'lacking' and in need of assistance. At the same time, political discourses within developing countries often frame the needs of their (often black and/or female) citizens in terms of deficit and economic lack, blaming their citizens for their own and the country's economic 'failures' for which national school mathematics results become the weapon (Chronaki, 2011, Swanson, 2013b; Swanson & Appelbaum, 2012).

Considering the global social imaginary of the current neoliberal world, it may be timely to bring some de/postcolonial theoretical concepts to bear on mathematics education in global development contexts in providing a geo-political focus that more centrally considers the role of the nation-state, the geo-political imaginaries of empire and the broader neocolonial/neoliberal global(ising) condition in respect of mathematics education in global context. For example, in a study with Roma young girls aged 10 to 12, it was noted how the context of selling and buying goods as a thematic approach for arithmetic became an explicit colonial act (Chronaki, 2005, 2011a). A preliminary analysis of episodes of Roma girls' interaction with the teacher revealed how gendered and racial discourses became instrumental in valorising the importance of those girls' engagement with the arithmetic task. Specifically, the teacher comments on how learning certain arithmetic operations well will protect them from thieves, and on how the process of learning such operations requires a certain disciplining of the body and mind and avoiding a focus on beauty, eating or chatting. Whilst the girls laughed at these comments, from a feminist postcolonial viewpoint, one may critique how the teacher so easily employ certain racialised (i.e. Roma people are thieves) or gendered (i.e. Roma girls think of marriage and not work) stereotypes

in order to convince them of the necessity of doing mathematics. Through this, such arguments turn, easily, into colonializing assaults on Roma girls' identities.

Some post/decolonial ideas valuable to move forward a critique in mathematics education are inscribed around such foci as (for example): centre-periphery discourses, loss and exile, disavowal and dispossession, epistemic violence, epistemic hegemony, epistemic suppression, epistemic racism, abyssal thinking, representation and voice in geo-political context, othering and exoticism, global social and ecological injustices, discourses on dominance and the subaltern, benevolence and salvationist discourses, global/local a/symmetrical relations, cultural imperialism; and the problem of 'dividing the world' into distinct categories or dichotomies (East/West; South/North; developing/developed; margins/centre; majority world/minority world). These can offer opportunities to provide frames of reference with which to converse with mathematics education from a wider geo-political and global justice-oriented perspectives that pave the ground for both a process of decoloniality and postcolonial critique (Chronaki, 2008; 2011, Swanson, 2013a,b; 2017).

CONCLUSION

As already mentioned, mathematising and demathematising have been given some attention in relation to social processes of mathematics education via such work programmes as ethnomathematics, critical mathematics education, or, realistic mathematics amongst many others. They have done much to underscore an interpretation of mathematics as being invested in cultural, historical, economic and social norms and values. Critical mathematics education, in particular, has pushed the conversation forward in considering mathematics in its broader political enterprise, but the theoretical concepts borne from de/postcolonial thought situate conversations on mathematics education in terms of contestations between global political imaginaries, whilst bringing into play the epistemic and ontological implications of such political considerations in the local contexts. A de/postcolonial critique begins to reverse the symbolic violence of Northern -emanating discourses within the mathematics education field, by introducing the thought of theorists, such as Spivak, Harding, Haraway, Mignolo, and Quijani, that hail from the global South. It opens up the opportunity to consider global ethics and democracy in relation to mathematising activities and discourses. As such, it also brings in the sphere of the geo-political while attending to the local or individual level when considering culture, gender, socio-economics and class, amongst other difference discourses, in historical and political contexts and their investments in global social relations of power.

REFERENCES

Chronaki, A. (2005). Learning about 'learning identities" in the school arithmetic practice: The experience of two young minority Gypsy girls in the Greek context of education. In the *European Journal of Psychology of Education:* Special Issue on "The Social Mediation of Learning in Multiethnic Classrooms" Guest Editors: Guida de Abreu and Ed Elbers. Vol. XX, no 1, pp. 61-74.

Chronaki, A. (2008). Technoscience in the 'body' of Education: Knowledge and Gender politics, In A. Chronaki. (Ed). *Mathematics, Technologies, Education: The gender perspective.* Thessaly: University of Thessaly Press, pp. 7-27.

Chronaki, A. (2010). Racism as Gazing Bodies: From 'body-color' epistemology to epistemic violence: *A response to: Not-so-strange bedfellows: Racial projects and the mathematics education enterprise.* MES 6 Proceedings, Berlin.

Chronaki, A. (2011). Disrupting development as the quality/equity discourse: Cyborgs and subalterns in school technoscience. In B. Atweh, M. Graven, W. Secada and P. Valero (Eds.). *Mapping equity and quality in mathematics education.* Dordrecht: Springer, pp. 3-21.

Chronaki, A. (in press). Affective Bodying of Concepts, Children and Diversity: Choreographing the political as a minor affirmative gesture in early mathematics education. Special Issue on Body and Mathematics Education. ZDM. Springer Journals.

Chronaki, A. & Kollosche, D. (in press) Refusing mathematics: A discourse theory approach on the politics of identity work. Special Issue on Identities in Mathematics Education. ZDM. Springer Journals.

Cornwall, A. (2005). *Readings in Gender in Africa*, Bloomington & Indianapolis: Indiana University Press.

Ernest, P., Sriraman, B. & Ernest, N. (2016), (Eds.) *Critical Mathematics Education: Theory, Praxis and Reality.* Charlotte: IAP.

Foucault, M. (1980). *Power/knowledge: Selected interviews and other writings 1972-1977*, C. Gordon (Ed.). New York: Pantheon Books.

Gellert, U. & Jablonka, E. (2007), (Eds.). *Mathematisation and Demathematisation: Social, Philosophical and Educational Ramifications,* Rotterdam: Sense Publishers.

Hall, S and O'Shea, A. (2013). Common-sense neoliberalism. *Soundings (55).* Available: https://www.lwbooks.co.uk/soundings/55/common-sense-neoliberalism

Hardin, G (1968). *The Tragedy of the Commons. Science, 162 (3859): 1243–1248.*

Harding, S. (1998). *Is science multicultural? Post-colonialisms, Feminisms and Epistemologies*, Bloomington and Indianapolois: Indiana University Press.

Jörgensen, R., Gates, P., & Roper, V. (2014). Structural exclusion through school mathematics: Using Bourdieu to understand mathematics as a social practice. *Educational Studies in Mathematics, 87,* 221–239.

Lloyd, W.F. (1833). *Two lectures on the checks to population.* Oxford: Oxford University. Retrieved 2016-03-13.

Maheux J., Swanson D.M. & Khan S. (2012). From Text to Pretext: An Ethical Turn in Curriculum Work. In: Mason TC, Helfenbein RJ (ed.). *Ethics and International Curriculum Work: The Challenges of Culture and Context,* Charlotte, NC: Information Age, pp. 143-172.

Rancière, J. (2009). The method of equality: An answer to some questions. In G. Rockhill, & P. Watts (Eds.), *Jacques Rancière: History, politics, aesthetics* (pp. 273−788). Durham, NC: Duke University Press.

Skovsmose, O., & Valero, P. (2001). Breaking political neutrality: The critical engagement of mathematics education with democracy. In B. Atweh, H. Forgasz, & B. Nebres (Eds.), *Sociocultural research on mathematics education: An international perspective* (pp. 37–55). Mahwah, NJ: Erlbaum.

Swanson, D.M. (2017). Mathematics Education and the Problem of Political Forgetting: In Search of Research Methodologies for Global Crisis, *Journal of Urban Mathematics Education*, 10 (1), pp. 7-15.

Swanson, D.M., Yu, H. & Mouroutsou, S. (2017). Inclusion as Ethics, Equity and/or Human Rights? Spotlighting School Mathematics Practices in Scotland, *Social Inclusion*, 5 (3), pp. 172-182.

Swanson, D.M. (2013a). The owl spreads its wings: global and international education within the local from critical perspectives. In: Hebert Y, Abdi AA (ed.). *Critical Perspectives on International Education*. Comparative and International Education: A Diversity of Voices, 15, Rotterdam: Sense, pp. 333-348.

Swanson, D.M. (2013b). Neoliberalism, education and citizenship rights of unemployed youth in post-apartheid South Africa, *Sisyphus - Journal of Education*, 1 (2), pp. 194-212.

Swanson, D.M. & Appelbaum P. (2012). Refusal as Democratic Catalyst for Mathematics Education Development, Pythagoras, 33 (2), Art. No.:189

Swanson, D.M. (2010). Paradox and politics of disadvantage: Narratizing critical moments of discourse and mathematics pedagogy within the "glocal". In M. Walshaw (Ed.), *Unpacking pedagogy: New perspectives for mathematics* (pp. 245–263). Greenwich, CT: Information Age Publishing.

Swanson, D.M. (2005). School Mathematics: Discourse and the Politics of Context. In: Chronaki A, Christiansen IM (ed.). *Challenging Perspectives on Mathematics Classroom Communication*. International Perspectives on Mathematics Education - Cognition, Equity & Society, Greenwich, CT: Information Age, pp. 261-294.

[i] See Dowling's 1998 critique of Paulus Gerdes' assumptions in the use of such ethno-mathematical language applied to another mathematical and African cultural context.

[ii] See Bishop, 1990, on mathematics as a form of Western imperialism.