Fractal Complexity in Mamokgethi Setati's Work on the Nexus between African Languages and Mathematics

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Introduction

That Mamokgethi Setati (née Mmutlana) has emerged as the preeminent scholar on the nexus between African languages and mathematics is hardly a matter of dispute. One need only do a Google search of the phrase "African languages and mathematics" to discover that the first name that comes up and also numerously is Setati's. It is therefore only fitting that when the Broken Hill Proprietary (BHP) selected Setati for a 2010-2011 National Science and Technology Forum (NSTF)-BHP Billiton Award in honor of her outstanding contributions to Science, Engineering, Technology and Innovation, it had the following to say: "…for her innovative, quality research on teaching and learning mathematics in multilingual classrooms" (www.nctfawards.org.za/).

From Setati's World Wide Web site, one also learns that, as of this writing, she has authored and coauthored 20 journal articles, four book chapters, four edited volumes, 24 conference publications, six research publications, and six publications in public print media (www.kgethi.com/). While my extensive search yielded approximately 8,030 citations of Setati's writings, I found no systematic analysis of them, even though such potential exists. This paper is an attempt to fill this void. Specifically, I employ the mathematical concept of Fractal Dimension and Complexity Theory to explore the idea of spectrum progressing from more orderly to less orderly or to pure disorder in the text. This called for the utilization of the Pluridisciplinary approach that helped me to mix linguistics and mathematical approaches—more precisely, Linguistic Presupposition and Fractal Methodology. Before discussing the results generated from the MATLAB computer runs, however, it makes sense to begin with an expose of the research methodology employed in this paper, followed by brief descriptions of the six solely authored journal articles that serve as the data sources for the analysis. A listing of the six articles and the justification for employing them appear in the first paragraph of the data analysis section.

Research Methodology

The major challenge for me was how to transform the linguistic pragmatic or deep-level meanings in the six journal articles examined for mathematical modeling. As I stated earlier, this called for the utilization of the Pluridisciplinary approach that helped me to mix linguistics and mathematical approaches: more precisely, Linguistic Presupposition and Fractal Methodology. Furthermore, it behooves me to state here that discussions of this methodology also appear in the following works: Abdul Karim Bangura (ed.), *Fractal Complexity in the Works of Major Black Thinkers, Volumes One and Two*, San Diego, CA: Cognella Press, 2013; Abdul Karim Bangura, "A Mathematical Exploration of Fractal Complexity among the Axioms on the African State in the *Journal of Third World Studies*: From John Mukum Mbaku to Pade Badru," *Journal of Third World Studies*, Vol. xxix, No. 2, Fall 2012:11-64; Abdul Karim Bangura, "Fractal Complexity in Cheikh Anta Diop's *Precolonial Black Africa*: A Pluridisciplinary Analysis," *CODESRIA Bulletin*, Nos. 1 & 2, 2012:10-19; and Abdul Karim Bangura, "Fractal Complexity in Mwalimu Chinua Achebe's *Things Fall Apart*: A Mathematical Exploration," *Critical Interventions*, Number 9/10, Spring 2012:106-121. The following is a discussion of these techniques.

Pluridiciplinary Methodology

Pluridisciplinary Methodology can be generally defined as the systematic utilization of two or more disciplines or branches of learning to investigate a phenomenon, thereby in turn contributing to those disciplines. Noting that Diop had called on African-centered researchers to become pluridisciplinarians, Clyde Ahmed Winters (1998) states that the Pluridisciplinary specialist is a person who is qualified to employ more than one discipline – for example, history, linguistics, etc. – when researching aspects of African history and Africology in general.

The history of the Pluridisciplinary Methodology can be traced back to the mid-1950s with the works of Diop and Jean Vercoutter. The approach was concretized by Alain Anselin and Clyde Ahmad Winters in the 1980s and early 1990s. A brief history of this development with brief backgrounds of these four pioneers is retold in the rest of this section.

G. Mokhtar in his book, *Ancient Civilizations of* Africa (1990), traces the development of Pluridisciplinary Methodology to the works of Diop and Vercoutter. Diop was born in Senegal on December 29, 1923 and died on February 7, 1986. He was a historian, anthropologist, physicist, and politician who investigated the origins of the human races and pre-colonial African culture. His education included African history, Egyptology, linguistics, anthropology, economics, and sociology. He is considered one of the greatest African intellectuals of the 20th Century. Jean Vercoutter was born in France on January 6, 1911 and died on July 6, 2000. He was a French Egyptologist.

According to Mokhtar, Diop and Vercoutter were in total agreement on the point that it is necessary to study as much detail as possible all the genes bordering on the Nile Valley which were likely to provide fresh information. Mokhtar notes that Vercoutter considered it necessary to give due weight to the palaeoecology of the Delta and to the vast region which had been termed by other researchers the Fertile African Crescent. Mokhtar points out that Diop advocated tracing the paths taken by peoples who migrated westwards from Dârfur, reaching the Atlantic seaboard by separate routes, to the south along the Zaïre Valley and to the north towards Senegal, on either side of the

Yoruba. He adds that Diop also pointed out how worthwhile it might be to study Egypt's relations with the rest of Africa in greater detail than had been done, and Diop further mentioned the discovery, in the province of Shaba, of a statuette of Osiris dating from the 7th Century before the Christian era. Similarly, argues Mokhtar, a general study might be made of the working hypothesis that the major events which affected the Nile, such as the sacking of Thebes by the Syrians, or the Persian invasion of -522, had far reaching repercussions on the African continent as a whole (Mokhtar 1990:55).

Furthermore, according to Winters, two major scholars who have advanced the Pluridisciplinary approach by combining anthropological, historical and linguistic methods to explain the heritage of African people, constituting a third school of Africancentric researchers (the first and second schools being the African American and the French-speaking African and African Caribbean, respectively), are Anselin and himself (Winters 1998). Anselin teaches ancient Egyptian linguistics at the University of Guyana Antilles. He is an anthropologist and also the founder of the *Journal of Caribbean Egyptology*. Winters is a lecturer at Governors State University at University Park in Illinois where he teaches curriculum design and research methods courses. He also is a 28-year teaching veteran of the Chicago Public Schools system.

Anselin is the author of three important Pluridisciplinary Africancentric books— (1) *Samba*, (2) *La Question Puele*, and (3) *Le Mythe d'Europe*—and numerous articles. In *Samba*, Anselin demonstrates how the corpus of Egyptian hieroglyphics explains both the Egyptian civilization and the entire world of the Paleo-Africans. He also makes it clear that Kemetic civilization originated in the Fertile African Crescent and that Black African and Kemetic civilization at its origination was unified from its foundations in the Sahara up to its contemporary manifestations in the languages and culture of Black Africans. In *La Question Puele*, Anselin examines the unity for Egyptian, West African and Dravidian languages, political traditions and culture. He also provides a detailed discussion of the "Black Ageans." The findings comprise a thorough representation of the affinities between the Agean and Dravidian civilizations (Winters, 1998).

Winters is the only African American that attempts to confirm Diop's theories in relation to the genetic unity of the Egyptian, Black African, Elamite, Sumerian and Dravidian languages. Winters is mainly concerned with the unity of the ancient and new worlds' Black civilizations and the decipherment of ancient Black writing systems used by these Africans. This interest had led him to learn many languages, including French, Tamil, Malinke/Bambara, Chinese, Arabic, Otomi, and more (Winters 1998).

Winters had used Diop's genetic model in his research by combining anthropological, linguistic and historical methods to confirm that the center for the rise of the originators of the Egyptian and Manding civilizations, the Magyar or Hungarian civilization, the Dravidian civilization, and the Sumerian and Elamite civilizations was the Fertile Crescent of the highland regions of Middle/Saharan Africa. He also explains how Blacks founded civilizations in the Americas and East and Southeast Asia. A major finding from Winters' work is that the ancestors of the Dravidian and Manding-speaking people seem to have left Africa at the same time around 2600 BC, and that these people founded civilizations in Europe, Elam, India and ancient China (Winters 1998).

Like Diop before him, Winters also discusses the African sub-stream in European languages, the conflict between African people and Indo-European-speaking people, and the loss of early African settlements in Europe to the contemporary European people due to natural catastrophes and wars around 1000 BC. Winters provides valuable source material for the elaboration of the African influence on European languages and those of East and Central Asia (Winters 1998).

Winters had discovered that the Proto-Saharan people used a common writing system. He also was able to read the ancient inscriptions left by these people in the Sahara dating to 3000 BC. He was able to confirm this development by comparing the Manding and the Elamite languages, and the Sumerian and Dravidian languages. The evidence of a genetic relationship between the Manding languages, which Winters used to decipher the earliest Proto-Saharan writings and other languages spoken by the founders of civilization in India and Mesopotamia, led him to hypothesize that

the writing systems used by these ancient founders of civilization could be deciphered. The utilization of Diop's linguistic constancy theory allowed Winters to confirm his own hypothesis and read the common signs used to write the Harapant, Minoan and Olmec scripts (Winters 1998).

Winters' most significant finding is the cognate language of Meroitic. By employing the evidence presented by the Classical sources that the Kushites ruled empires in Africa and Asia, Winters is able to show that the cognate language of Meroitic was the Tokharian language spoken by the Kushana people of Central Asia. He has been able to decipher many Meroitic inscriptions by using the Kushana/Tokharian language (Winters 1998).

According to Dani Nabudere (2003), Pluridisciplinary Methodology involves the use of open and resource-based techniques available in an actual situation. Thus, it has to draw upon the indigenous knowledge materials available in the locality and make maximum use of them. Indigenous languages are therefore at the center of the effective use of this methodology.

What all this suggests, according to Nabudere, is that the researcher must revisit the indigenous techniques that take into consideration the epistemological, cosmological and methodological challenges. The researcher must be culture-specific and knowledge-source-specific in his/her orientation. Thus, the process of redefining the boundaries between the different disciplines in our thought process is the same as that of reclaiming, reordering and, in some cases, reconnecting those ways of knowing, which were submerged, subverted, hidden or driven underground by colonialism and slavery. The research should therefore reflect the daily dealings of society and the challenges of the daily lives of the people.

Towards this end, following Nabudere, at least the following six major questions should guide Pluridisciplinary research (2003:13):

(1) How can the research increase indigenous knowledge in the general body of global human development?

(2) How can the research create linkages between the sources of indigenous knowledge and the centers of learning on the continent and in the Diaspora?

(3) How can centers of research in the communities ensure that these communities become "research societies"?

(4) How can the research be linked to the production needs of the communities?

(5) How can the research help to ensure that science and technology are generated in relevant ways to address problems of the rural communities where the majority of the people live and that this is done in indigenous languages?

(6) How can the research help to reduce the gap between the elite and the communities from which they come by ensuring that the research results are available to everyone and that such knowledge is drawn from the communities?

The truism that indigenous knowledge is critical to Africa's development prompted a workshop titled "Indigenous Knowledge Systems and Intellectual Property in the Twenty-First Century: Perspectives from Southern Africa" convened at the University of Botswana from November 26 to 28, 2003 which culminated into a book with the same title published in 2007 by the Council for the Development of Social Science Research in Africa (CODESRIA) based in Dakar, Senegal. The tenor of the workshop and subsequent book is that the twin themes of indigenous knowledge systems and intellectual property rights have moved to the center of academic discourse within the context of innovation and the commercialization of knowledge. This is because wealth is no longer reckoned in terms of physical assets alone. Unfortunately, the traditional imbalance between the North and the South, which has for long manifested itself mainly through trade, is replicated even in tapping intellectual property given to residents of the developing world who remain largely unable to define their property rights. Once again, the West exploits Africa and the rest of the developing world by expropriating indigenous knowledge systems and patenting them in the West (Mazonde and Thomas 2007).

Various scholars have suggested many major concepts to underlie the Pluridisciplinary Methodology, but it is Dan Nabudere (2003) who has provided the most succinct definitions and discussions for most of these concepts. They are as follows:

(a) *African Spirituality* refers to those aspects of people that have enabled them to survive as a human community throughout the centuries. It transcends European classical humanism with its class, socio-economic and geographical limitations based on Greece and the Athenian City-State, which is based on a system of slavery. African Spirituality leads to enlarged humanities and recaptures the original meaning of humanity which Western scholars, beginning with Plato, in their hollow and lopsided search for material progress, have abandoned (Nabudere 2003:3-4).

(b) *Contemporary African Philosophy* is a critique of the Eurocentric "idea" and "general philosophy" in its metaphysical perception that European humanism is superior to that of the African people. This falsehood, which has been perpetuated by Europe to this day, hinges upon the belief that the rest of humanity has to be *forced* to believe like Europe in order to be "humanized" into a singular humanity. Contemporary African Philosophy seeks to "de-structure" this European pretext and emphasize humankind's "shared humanity" (Nabudere 2003:4).

(c) *The African Renaissance* is the initiative to recapture the basic elements of African humanism (*ubuntu, eternal life*, and *immanent moral justice*) as the path to a new humanistic universalism. This initiative, according to Chancellor Williams, "is the spiritual and moral element, actualized in good will among men (and women), which Africa itself has preserved and can give to the world" (Nabudere 2003:4).

(d) *The Pan-Afrikan University* does not begin in a vacuum, for it has a deep heritage of culture and "civilizational" values that must inform its recreation (e.g., the Sankore University in Timbuktu). These institutions are to be found within Africa's ancient achievements. They must be unearthed and reclaimed. If the Pan-Afrikan University is to respond to this historic challenge and be a part of the correction of its historical distortion and theft of African heritages, it has to provide deeply thought out and well-conceived vision and mission, with a well articulated strategy to achieve its objectives. For it to be successful, it must be a part of the creation of a counter-hegemonic discourse which

can enable the "triple agenda of deconstruction, reconstruction, and regeneration" to be undertaken at the same time. Consequently, the Pan-Afrikan University must develop the University as a new institution of higher education, which can help in reshaping the direction of education on the continent toward a more culture-specific and culturally relevant curriculum and pedagogy of liberation. It must draw from those heritages and provide the students, adult learners and the communities with a space in which they can learn as well as carry out their research and be trained by their teachers, community experts, and consultants at the University campuses as well as in the community knowledge sites. Essentially, the Pan-Afrikan University must be people-centered and community-based in which everyone enjoys the freedom to learn and speak (Nabudere 2003:5-6, 14).

(e) *African Epistemology and Cosmology* imply the development of an all-inclusive approach which recognizes all sources of human knowledge as valid within their own contexts. This calls for the adoption of hermeneutic philosophy in its African essence. This African-based epistemological and cosmological foundation is the prerequisite for the production and development of knowledge (Nabudere 2003:6-7).

(f) *African Humanism/Ubuntu* is a concept from the Southern African Nguni language family (IsiNdebele, IsiSwati/ IsiSwazi, IsiXhosa and IsiZulu) meaning humanity or fellow feeling; kindness. *Ubuntu* serves as the spiritual foundation of African societies. It is a unifying vision or worldview enshrined in the maxim *umuntu ngumuntu ngabantu*: i.e. "a person is a person through other persons." This traditional African aphorism, which can be found in every corner of the continent, articulates a basic respect and compassion for others. It can be interpreted as both a factual description and a rule of conduct or social ethic. It both describes the human being as "being with others" and prescribes what that should be (Bangura 2005 & 2008).

(g) *African Languages* are at the center of developing the Pan-Afrikan University at all knowledge sites. Language, as Amilcar Cabral correctly pointed out, is at the center of articulating a people's culture. He stated that the

African revolution would have been impossible without Africans resorting to their cultures to resist domination. Thus, culture is a revolutionary force in society. It is because language has remained an "unresolved issue" in Africa's development that present day education has remained an alien system. As Frantz Fanon put it, "to speak a language is to assume its world and carry the weight of its civilization." Kwesi K. Prah has argued consistently that the absence of African languages in the curriculum has been the "key missing link" in the continent's development. Consequently, the Pan-Afrikan University must build its curriculum on the basis of promoting African languages at the sites of knowledge and at the same time try to build libraries at those sites in the languages of the people living there. They must be promoted as languages of science and technology. This calls for the complete revamping of the epistemological and cosmological worldview of the current discourse. It also calls for the application of different methodological and pedagogical approaches to learning and research in African conditions (Nabudere 2003:10).

(h) *New Humanities* is to serve as the core department in the division of the Pan-Afrikan University concerned with research and advanced studies. In the words of Chancellor Williams, the New Humanities "will have the task of enlisting the services of the world's best thinkers of the work of developing a science of humanity through studies expressly aimed at better human relations. It is to be at the heart of the entire education system and, therefore, the nation." Williams believes that the central idea in this philosophy is life. He argues that since neither Western science nor religion has provided satisfactory answers to three questions (From where do we come? Why? And where are we bound?), it is imperative for the Pan-Afrikan University to provide the space for discussing these eternal questions. This approach calls for the reorganization of the disciplines of the social and human sciences as well as the natural sciences into a holistic learning process. The reorganization should lead to a breaking down of the over-compartmentalization and over-fragmentation of faculties, departments, and branches of knowledge.

It should explore the reunification of allied disciplines (which have been subdivided into sub-disciplines) into unified fields of study (Nabudere 2003:14).

(i) *Hermeneutic Philosophy* recognizes the basic unity of human endeavor through "discourse" that expresses "the intelligibility of Being-in-the world" (Nabudere 2003:16).

(j) *Integrated and Synthesized Knowledge* is based on the notion that privileging African-centered curriculum must transcend a narrow conception of what is purely African to include such knowledge within the wider synthesized framework of global knowledge (Nabudere 2003:17).

(k) *Afrikan-based Pedagogy* draws inspiration and materials for learning from real life situations of the African people, especially in the rural areas, by adopting those pedagogical methods and techniques that inform their philosophy of life, their worldview, and their lived experiences and practices. The key to developing an Afrikan-based Pedagogy hinges upon the knowledge specific-sites where African experts of different branches of knowledge are located. These sites will inform both the content and the pedagogy. The pedagogy will incorporate "oracy," which contains forms of art and techniques to which they give expression, which is essential for adult learning. By mainstreaming this form of expression, its agents gain visibility and recognition in knowledge creation and production. This will enable indigenous tales, stories, proverbs, legends, myths, symbols and epics to be resuscitated, for these forms of knowledge incorporate people's philosophies of life, norms, values in a kind of "moving" and "living library" (Nabudere 2003:19).

(l) *Life Long Learning*, which has recently become a mantra of many developed countries and international organizations as a novel approach to learning in the 21st Century, is deeply embedded within African culture and epistemology. Learning and "culturalization" in African societies were considered continuing processes that "took place from birth until death with the family unit, extended family, the village and the entire community participating" (Nabudere 2003:19). Life Long Learning will bring

adult learners to formal institutions of learning and remove the division between informal, non-formal, and formal education in line with African traditions and culture. It will also provide for the coo-peration in research between the Pan-Afrikan University and the communities, in addition to providing for the recognition of learning out-comes gained through their own contexts outside the formal education system (Nabudere 2003:20).

(m) *Kemetic Civilization* is a Black African civilization whose origination in the Fertile African Crescent was unified from its foundations in the Sahara up to its contemporary manifestations in the languages and culture of Black Africans (Winters 1998).

The favored methodological approach for Pluridisciplinary studies is Hermeneutics, an open-ended approach that permits cross-cultural communication and exchange of ideas and opinions to promote understanding between all knowledge systems in their diversities. This African philosophical-pedagogic approach hinges upon the acceptance of pluralism and cultural diversity. It stresses the need for the "fusion of historical horizons" as the best way of transmitting understanding between different lived histories or experiences of different communities as the basis of their existence. It insists on both the cultural context and the historical contingencies of events as necessities for a true comprehension of the different lived experiences. Furthermore, the approach has its roots in the African/Egyptian mythical figure of Hermes, the messenger of knowledge from the gods to mortals and the interpreter of the divine message to humankind, and that is why Hermeneutics is named after Hermes (Nabudere 2003:7-8).

Hermeneutics is to be employed on the premises that encourage self-directed learning, which engages with the knowledge, interests, and real life situations that learners bring to their learning situations. This notion of site-specific knowledge attempts to offer a corrective to the Eurocentric tendency of universalizing knowledge around Occidental centers and sites of knowledge which are privileged to the disadvantage of others, claiming to be the only sites of "rationality" and "scientific knowledge." Recognizing the other sites and centers

leads to a truly multi-polar world of global knowledge culled from all sources of human endeavor (Nabudere 2003:8).

Linguistic Presupposition as the Unit of Analysis

As stated earlier, the unit of analysis for the present paper is linguistic presupposition, which can be defined as an implicit assumption about the world or background belief upon which the truth of a statement hinges. The linguistic presuppositions for this study are drawn out of the writer's (i.e. Setati's) topics in the texts examined. The writer's topics here are the a priori features, such as the clear and unquestionable change of subject focus, for defining types of linguistic presuppositions found in the texts examined. While there are many other formulations of 'topic' from which to chose, the writer's topics are employed for this paper because it is the writer of the texts who had topics, not the texts. The other formulations of 'topic' include sentential topics, discourse topics, presuppositional pools, relevance and speaking topically, topic boundary markers, paragraphs, paratones, representation of discourse content, position-based discourse content, and story. Thus, the notion of 'topic' in the present paper is considered as one related to representations of discourse content.

In choosing the writer's topic as the recording unit, the ease of identifying topics and correspondence between them and the content categories were seriously considered. Guiding this choice was the awareness that if the recording unit is too small, such as a word, each case will be unlikely to possess any of the content categories. Furthermore, small recording units may obscure the context in which a particular content appears. On the other hand, a large recording unit, such as a paragraph, will make it difficult to isolate the single category of a content that it possesses. For the current paper, two methods were appropriate. First, there is the clear and uncontestable change of subject focus. Second, topicalization was found to have been used to introduce new characters, ideas, events, objects, etc.

Finally, in order to ascertain the reliability of the coding unit employed for the paper, attempts were made to show inter-coder reliability: that is, two or more analysts, using the same procedures and definitions, agree on the content categories applied to the material analyzed. Two individuals, who had extensive training in discourse analysis and especially topic identification, were given copies of the texts studied to identify what they perceived as topics, or more specifically, where one topic ends and another begins. Although there were no differences between the two individuals and I, the identified topics and the texts were also given to a linguist who has done a great deal of work on topic analysis for comments and suggestions. This approach was quite useful for increasing my confidence that the meaning of the content is not heavily dependent on my analysis alone.

After identifying the presuppositions in the texts studied in terms of the topics identified, these propositions were placed into two categories (*order* versus *disorder*) based on the bottom-up processing approach common in linguistic analysis for further examination. This involved working out the meanings of the propositions already processed and building up composite meanings for them.

Because the texts examined are a representation of discourse in texts, the level of analysis is naturally the written text. Text is used here as a technical term – in Gillian Brown and George Yule's conceptualization, "the verbal record of a communicative act" (1983:6).

In order to ascertain the presuppositions and in the texts examined, the test known as Constancy under Negation Rule was employed. This test is important because, following Gottlob Frege (1892/1952) and Peter Strawson (1952), presuppositions are preserved in negative statements or sentences. A researcher can therefore simply take a sentence, negate it, and see what inferences survive: that is, are shared by both positive and negative forms of the sentence. But because, as Stephen Levinson (1983:185) is quite correct in pointing out, "constancy under negation is not in fact a rich enough definition to pick out a coherent, homogenous set of inferences," the tests for presuppositional defeasibility (the notion that presuppositions are liable to evaporate in certain contexts) and the projection problem of presuppositions (i.e. the behavior of presuppositions in complex sentences) were also employed.

Consequently, in order not to necessarily presume the conclusions to be drawn, cues to the intent of the author of the texts examined are 'deconstructed.' How, then, are these cues mapped out for the present paper? According to Herbert Paul Grice's (1975) characterization of meaning or non-natural meaning (which is equivalent to the notion of intentional communication), intent is achieved or satisfied by being recognized. A sender's communicative intent becomes mutual knowledge to sender and receiver: that is, S knows that H knows that S knows that H knows (and so ad infinitum) that S has this particular intention. So following Roger Shuy (1982), it is necessary to begin by asking "What did the writer do"? Thus, it is clearly necessary to look at specific topics developed by the author of the texts analyzed. This is particularly true because, according to Wallace Chafe (1972) and Carol Kates (1980), the structure of intentions can neither be defined by the grammatical relations of the terms, nor the semantic structure of a text. Therefore, mapping out the cues to the intent of the author contained in the texts analyzed called for: (a) identifying communicative functions, (b) using general socio-cultural knowledge, and (c) determining the inferences made.

Fractal Methodology

It is only logical to begin any discussion of Fractal Methodology with a definition of what a fractal is. As I state in my book, *Chaos Theory and African Fractals* (Bangura 2000:6), the concept of fractal remains inexplicably defined. This shortcoming is pointed out by Philip Davis as follows, albeit he himself does not provide and explicit definition: "I consulted three books on fractals. Though there were pictures, there was no definition" (1993:22). The following is a small sample of the various ways the concept of fractal has been described as provided by Lynn Steen:

> The concept of fractional dimension, or fractals, was developed in order to describe the shapes of natural objects….An interesting property of fractal objects is that as we magnify a figure, more details appear but the basic shape of the figure remains intact (1988:409).

In addition, according to Steen,

> The word fractal – coined by (Benoit B.) Mandelbrot – is related to the Latin verb *frangere*, which means "to break." The ancient Romans who used *frangere* may have been thinking about the breaking of a stone, since the adjective derived from this action combines the two most obvious properties of broken stones – irregularity and fragmentation. The adjectival form is *fractus*, which Mandelbrot says led him to fractal (1988:420).

Furthermore, as Steen points out, "Fractal dimension (is) a measurement of the jaggedness of an object" (1988:413).

Keith Weeks (in Hargittai and Pickover, 1992) states:

> [J. E.] Hutchinson laid the foundations of a certain concept of self-similarity, the basic notion being that of the object made up of a number of smaller images of the original object, and so on ad infinitum, typically resulting in detail at all levels of magnification, a trait commonly associated with objects referred to as *fractals* (1992:107).

From the preceding descriptions, I venture to offer a general definition of a *fractal* as a self-similar pattern: that is, a pattern that repeats itself on an ever diminishing scale.

As for Fractal Methodology, more popularly referred to as Fractal Analysis, itself, with its applications in the social sciences, Clifford Brown and Larry Liebovitch in their recent work appropriately titled *Fractal Analysis* (2010) published as part of the Sage Publications Quantitative Analysis of the Social Sciences series have a succinct exposé on the subject. The rest of the discussion in this section is based on their work.

Brown and Liebovitch begin by stating that several early applications of fractal mathematics emerged in the social sciences. These works include Vilfredo Pareto's 1897 study of the distribution of wealth; Lewis Fry Richardson's 1948 and 1960, but published posthumously, study of the intensity of wars; and George Zipf's 1949 studies of the distributions of word frequencies and city sizes. Brown and Liebovitch argue that while these ideas were known by experts in the field, they were isolated, quirky concepts until Mandelbrot developed the unifying idea of fractals in the 1970s and 1980s. Since that time, however, in spite of the fact that Zipf and Pareto distributions represent fractal distribution, social scientists have lagged behind the physical and natural sciences in utilizing fractal mathematics in their works (Brown and Liebovitch 2010:ix).

Brown and Liebovitch observe, however, that in recent years, the application of fractal mathematics by social scientists in their studies has grown exponentially. Their variety, they note, has expanded as rapidly as their numbers. They cite the examples that fractal analysis had been employed by criminologists to investigate the timing of calls for assistance to police, by sociologists to investigate gender divisions in the labor force, and by actuaries to study disasters. The surprising range of fractal phenomena in the social sciences led Brown and Liebovitch to call for a comprehensive survey that would investigate the common threads that unite them, thereby leading to a broader understanding of their causes and occurrences (Brown and Liebovitch 2010:ix).

According to Brown and Liebovitch, if a researcher has rough data, strongly nonlinear data, irregular data, or data that display complex patterns that seem to defy conventional statistical analysis, then fractal analysis might be the solution to the researcher. They posit that the non-normal and irregularity of so much of social science data apparently are the result of the complexity of social dynamics. Thus, for them, fractal analysis offers an approach for analyzing many of these awkward data sets. And more important, they note, the method also offers a rational and parsimonious explanation for the irregularity and complexity of such data. They insist that the data are not behaving badly; instead, they are simply obeying unexpected but common rules of which we are unaware (Brown and Liebovitch 2010:1).

Brown and Liebovitch go on to conceptualize fractals as *"sets* defined by the three related principles of *self-similarity*, *scale invariance*, and *power law relations*." They postulate that when these principles converge, fractal patterns form. They note that the statistic called *fractal dimension* is employed to capture the essential characteristics of fractal patterns. They add that much empirical work in fractal analysis focuses on two tasks: (1) showing that fractal characteristics are present in a particular data set and (2) estimating the fractal dimension of the data set. They also mention that there are various techniques for implementing these two tasks (Brown and Liebovitch 2010:2), the discussion of which is beyond the scope of the present paper. Nonetheless, it is necessary to provide brief definitions of the preceding five italicized concepts based on Brown and Liebovitch's work for the sake of clarity. The significant fact about *sets* is that almost all data sets can be fractal: that is, points, lines, surfaces, multidimensional data, and time series. Since fractals occur in different types of sets, various procedures are required to identify and analyze them, with the approach hinging upon the kind of data (Brown and Liebovitch 2010:2-3).

Brown and Liebovitch define *self-similarity* as a characteristic of an object when it is composed of smaller copies of itself, and each of the smaller copies in turn are made up of yet smaller copies of the whole, and so on, *ad infinitum.* The word *similar* connotes a geometrical meaning: that is, objects that have the same form but may be different in size (Brown and Liebovitch 2010:3).

Scale invariance for Brown and Liebovitch refers to a thing that has the same characteristics at every scale of observation. Thus, when one zooms on a fractal object, observing it at ever-increasing scale of magnification, it will still look the same (Brown and Liebovitvh 2010:5).

According to Brown and Liebovitch, *power law relations* denote the rule that for a set to achieve the complexity and irregularity of a fractal, the number of self-similar pieces must be related to their size by a power law. Power law dristributions are scale invariant because the shape of the function is the same at every magnitude (Brown and Liebovitch 2010:5).

Finally, Brown and Liebovitch characterize *fractal dimension* as the invariant parameter that characterizes a fractal set. An analyst uses the fractal dimension to describe the distribution of the data. It is akin to having a "normal" set of data and using the mean and variance to describe the location and dispersion of the data (Brown and Liebovitch 2010:15).

Brief Descriptions of the Texts Analyzed

As mentioned earlier, six of Setati's solely authored journal articles serve as the basis for the analysis that follows this section. Journal articles, especially when they are refereed, represent critical scholarly expertise and are reviewed by experts. And when such articles are solely authored, they mostly represent that writer's thoughts alone, as opposed to coauthored articles which represent more than one writer's thoughts. The six articles are briefly described in the chronological order in which they were published in the paragraphs that follow.

First, Setati in her article, "Code-switching in a Senior Primary Class of Second-language Mathematics Learners" (1998), probes the various ways a senior primary mathematics teacher employed code-switching when instructing mathematics to second-language learners with who she shared a first language. Setati points out that since linguistic diversity is a conspicuous aspect of South African society, it creates a number of educational challenges, particularly in the employment of languages in multilingual classrooms. Consequently, she notes, there has emerged considerable debate about this matter in the South African media. The discourse, she adds, has led to two opposing perspectives that are undergirded by identity and access to economic and political power. One postulate is that English is a viable language of wider communication in a multilingual society like South Africa. The other perspective is that schools should encourage the use of African languages in order to nurture and promote those languages.

Second, in her article titled "Researching Mathematics Education and Language in Multilingual South Africa" (2002), Setati analyzes policy, practice and research issues that are germane to the learning and teaching of mathematics in South Africa's multilingual classrooms. She begins with a brief history of language-in-education policy in South Africa to demonstrate how the stratagem is directed by both political and educational interests. She therefore proffers the argument that "Language-use in a multilingual educational context like South Africa is as much, if not more, a function of politics as it is of communication and thinking" (2002:6). By considering the nexus between language and mathe-matical learning from a myriad points of view and culling from many studies in the field not limited to South Africa, Setati pays greater attention to code-switching because it is a topic that has received considerable attention in the country. Her substantive findings affirm that language has tremendous power in mathematics education settings. She therefore calls for more research on the connection between language and the learning and teaching of mathematics from a political point of view.

Third, writing on "'Re'-presenting Qualitative Data from Multilingual Mathematics Classrooms" (2003), Setati excogitates the notion of 're'-presenting qualitative data from multilingual mathematics classrooms. She draws upon a study on language practices in multilingual mathematics classrooms to investigate the different levels involved in 're'-presenting such data. She then employs the data to demonstrate that 're'-presenting multilingual data is more than just talk written down, as the process is influenced by the theory selected, the research questions probed, the analytical tools employed, and the aspirations for 're'-presenting the data.

Fourth, using data she gleaned from one lesson in a multilingual primary mathematics classroom in South Africa taught by a copiously qualified and experienced teacher, Setati examines in her article titled "Teaching Mathematics in a Primary Multilingual Classroom" (2005a) the complex link between language and mathematics education in multilingual classrooms in the society. Two major findings emerged from this investigation. The first finding is that since English was the dominant language in the classroom, its ascendancy was privileged by procedural mathematics discourse. The second finding is that while English functioned as the medium of mathematics, authority, and assessment, the learners' mother tongue functioned mainly as an instrument of solidarity. Setati therefore sounds the trumpet for researchers to espy and comprehend the political role of language when investigating the nexus between language and mathematics education in multilingual classrooms.

Fifth, in the article titled "Researching Teaching and Learning in School from "with" *or* "on" Teachers to "with" *and* "on" Teachers" (2005b), Setati discusses a number of issues concerning the ethical and political aspects of investigating learning and teaching in schools. She points out that the precepts of working "with" instead of "on" teachers have become the focal point of the ethical and educational issues dealing with the relationship between researchers and teachers within educational research. She then challenges the practice of dissecting conducting research "on" and conducting research "with" teachers because of its undergirding tenet that power is unidirectional. She therefore advocates for a corresponding power relationship between researchers and teachers.

Finally, in her essay titled "Access to Mathematics versus Access to the Language of Power: The Struggle in Multilingual Mathematics Classrooms" (2008), Setati examines the manner in which learners and teachers situate themselves vis-à-vis the use of language(s) in multilingual mathematics classrooms in South Africa. The results from the investigation led to several conclusions. To begin with, learners and teachers who privilege English are concerned with access to the social goods that the language provides. Next, these learners and teachers do not focus on epistemological access but insist on English being the language of learning and teaching. In contrast, learners and teachers who support the use of their mother tongues position themselves in relation to mathematics and, concomitant-ly, epistemological access, thereby reverberating more antithetical discourses.

Indeed, the preceding texts comprise a closed set of statements within which it is easier to guess how and why new insights emerged, and what was overlooked. Occasionally, they show 'new' ideas are rediscoveries. But since today's studies about the nexus between language and mathematics are in process, to understand, let alone to evaluate them, is more difficult. Analysts abandon or redefine traditional terms and produce such a welter of innovations that it is not easy to find a neutral framework within which they can be compared.

What unifies the texts can appear rather banal. But many linguistic and mathematical insights are so obvious, so fundamental, that they are difficult to absorb, appreciate, and express with fresh clarity. Thus, the originality of the following analysis hinges upon the clarity with which familiar but uncontested facts about the texts analyzed are marshaled

into a simpler, linguistically and mathematically satisfying unity.

Data Analysis

Before engaging in the fractal analysis of the data generated from the six texts described in the preceding section, I will begin with a discussion of the descriptive and inferential statistics employed to analyze them first. Before computing the univariate and bivariate statistics to do the descriptive and inferential analyses of the data teased out of the six texts, a two-dimensional ad hoc classificatory system was developed within which the data were categorized. The first of these categories entails the presuppositions of *order*: that is, presuppositions that suggest a condition of logical or comprehensible arrangement among the separate elements of a group. This type of presupposition is triggered by presuppositional discourse stretches such as "Linguistic diversity is an important feature of the South African nation," "One view is that in a multilingual country like South Africa, English is a viable language of wider communication," and "The other view is that there is a need to develop and promote African languages and one way of doing this is to encourage their use in schools" (these examples are from Setati 1998:34). The second category encompasses presuppositions of *disorder*: that is, presuppositions that suggest a condition or place of confusion, mess, disturbance, disarray, or muddle. This type of presupposition is triggered by presuppositional discourse stretches such as "Separating learners according to their first languages may be perceived as bringing apartheid back, whilst choosing one of the languages as a medium and not the others may also be interpreted as favouring one group over the others," "…at senior primary levels pupils are far less capable of handling content subjects through English than through their mother tongue," "…the language transition is not only the pupils' problem. It affects teachers and their methods, orientations and resources," and "It can, however, be predicted that most schools will not opt for mother tongue learning, since among speakers of African languages, mother-tongue policy has a bad image" (these examples are also from Setati 1998:34).

After computing the descriptive and inferential statistics, the data were then plotted for oscillations between *order* and *disorder* in the six texts. This technique made it possible to show visually the attractor reconstruction for the various major themes in the texts.

As shown in Table 1, a total of 1,456 topic entries were teased out of the text. Of these, I categorize 864 or 59 percent as presuppositions of *order* and 592 or 41 percent as presuppositions of *disorder*. The mean for the *order* category is about 22 presuppositions, with a standard deviation of approximately 19 presuppositions; the mean for the *disorder* category is 15 presuppositions, with a standard deviation of approximately 14 propositions. The range for the *order* category is 72 presuppositions and that for the *disorder* category is 57 presuppositions, while the variance for *order* is about 349 presuppositions and that for *disorder* is approximately 209. This means that there are more, and statistically significant, topic entries for presuppositions of *order* than there are of those for *disorder*. Moreover there are significant variations among the themes for each category in terms of topic entries, as can be gleaned from the ranges.

The preceding results make it axiomatic to assert that Setati's treatise on the nexus between African languages and mathematics is gnoseologic. According to Guinean President Ahmed Sékou Touré, in his essay, "A Dialectical Approach to Culture," Gnoseology refers to the positive-intuitive thinking that is driven by the African's spiritual mind (1989:7). Indeed, Touré considers Black revolutionaries to have promoted an evolution of progressive qualification of reason that privileges gnoseology, which facilitates "the transition from ignorance to an increasingly deeper and more exact degree of knowledge" (1989:14). Thus, Touré argues that "Any anthology of African culture tending to situate it outside the realm of reason, of rational thought, of the law and of gnoseology tends to down-grade it and deviate it from its true end, which is to qualify mankind, and sacrifices it to the myth of singularity and specificity" (1989:14).

Yet still, given the significant number of presuppositions of *disorder* in the text, it is not tenable to assert that Setati engaged in either "romanticizing" about South African languages, as some critics like Stephen Howe (1999) and Tunde Adeleke

(2009) tend to say about Africans who write about the African condition, or the wholesale bashing of African leaders, as scholars such as George Ayittey (1993, 1999, 2011) tend to do. In essence, Setati is more optimistic than pessimistic about the role of languages in South Africa's mathematics education, albeit not uncritical about its politics.

A similar sentiment is echoed by Amilcar Cabral in his "Identity and Dignity in the Context of National Liberation Struggle" when he asserts that one of the essential characteristics of contemporary history is the people's struggle for national liberation and independence from imperialist rule. This struggle, he contends, hinges upon "returning to the source" and of identity and dignity in the context of the national liberation movement (Cabral 1995:73-74).

From Chief Albert John Luthuli, the President-General of the African National Congress from 1952 to 1957, we also get the following:

> Who will deny that thirty years of my life have been spent knocking in vain, patiently, moderately, and modestly as a closed and barred door? What have been the fruits of moderation? The past thirty years have seen the greatest number of laws restricting our rights and progress, until today we have reached a stage where we have almost no rights at all. It is with this background and with a full sense of responsibility that, under the auspices of the African National Congress, I have joined my people in the new spirit that moves them today, the spirit that revolts openly and boldly against injustice and expresses itself in a determined and non-violent manner. What the future has in store for me I do not know. It might be ridicule, imprisonment, concentration camp, flogging, banishment, and even death. I only pray to the Almighty to strengthen my resolve so that none of these grim possibilities may deter me from striving, for the sake of the good name of our beloved country, the Union of South Africa, to make it a true democracy and a true nation, in form and spirit, of all the communities in the land (Luthuli Museum 1952 speech:
>
> http://www.luthulimuseum.org.za/luthulis-life-/speeches).

Table 1: Univariate Statistics by Types of Presuppositions in the Texts

Sections/Themes in Texts	Number of Topic Entries for Presuppositions of Order		Number of TopicEntries for Presuppositions of Disorder	
	N	%	N	%
1. Code-switching…(1998)				
Introduction	26	2	10	28
What exactly is code-switching?	9	69	4	31
The source of the data?	27	71	4	31
How often and why code-switching occur?	22	71	11	29
Types of switching	57	86	9	14
Discussion and notes	8	73	3	27
2. Researching Mathematics…(2002)				
Introduction	3	75	1	25
The history of language-in-education…	45	59	31	41
The school mathematics curriculum…	20	83	4	17
The relationship between language...	30	43	40	57
Teaching and learning mathematics…	8	50	58	50
The political role of language…	40	70	17	30
Conclusion	2	40	3	60
3. 'Re'-presenting Qualitative…(2003)				
ZDM-classification: D20	2	79	6	21
Researching multilingualism…	11	42	15	58
From the actual experience…	20	50	20	50
From transcription to translation	13	43	17	57
From translation to interpretation	31	60	21	40
Suggestion for a way forward	8	67	4	33
4. Teaching Mathematics…(2005a)				
Introduction	7	54	6	46
What do I mean by discourse?	18	58	13	42
The political role of language	27	59	19	41
Analysis of language(s) used, discourses…	74	64	41	36
Languages, discourses, and cultural…	3	25	9	75
Implications for curriculum, assessment…	11	58	8	42
Conclusion	7	54	6	46
5. Researching Teaching…(2005b)				
Introduction	8	43	24	57
Negotiating access	65	54	55	46
Providing feedback on analysis of data…	28	82	6	18
The nature of teachers' involvement…	62	44	27	38
Conclusion	2	66	1	34

Table 1: Univariate Statistics by Types of Presuppositions in the Texts (continued)

6. Access to Mathematics…(2008)				
Introduction	10	53	9	47
The political role of language and its use…	8	50	8	50
Theoretical framework	9	82	2	18
Data collection and procedure	7	70	3	30
Teachers' language choices	24	44	31	56
Learners' language choices	41	58	30	42
What does this mean for research…	6	43	8	57
Conclusion	3	50	3	50
Totals Scores & Mean Percents = 1,456 or 100	64	59	592	41
Mean	22.15		15.18	
Standard Deviation	18.687		14.469	
Range	72		57	
Variance	349.186		209.362	

Source: Self-generated data from the texts and computed using MATLAB

Table 2: T-Test: Paired Samples–Test and Correlation

Pair 1: Order-Disorder	Paired Differences
Mean	6.97
Standard Deviation	11.474
Standard Error Mean	1.837
95% Confidence Interval of the Difference	
Lower	3.25
Upper	10.69
t-Statistic	3.796
Degrees of Freedom	38
Significance (2-tailed)	0.001
Pair 1: Order and Disorder	**Paired Samples Correlation**
Correlation	0.789
Significance	0.0001

Source: Self-generated data from the texts and computed using MATLAB

Essential dignity of Blacks is also expressed in poetic forms such as in President of Senegal and father of *Negritude* Léopold Sédar Senghor's "For Khalan" (a guitar with three strings):

We delighted, my friend, in an African presence:

    Furniture, from Guinea and the Congo, heavy and polished, dark and light.

    Primitive and pure masks on distant walls yet so near.

Tabourets of honour for the hereditary hosts, the princes from the High-country.

Wild and proud perfumes from the thick tresses of silence,

Cushions of shadow and leisure like quiet well running.

Eternal words and the distant alternating chant as in the loin-cloths from the Sudan.

But then the friendly light of your blue kindness will soften the obsession of this presence in

Black, white and red, O red like the soil of Africa

(*www.disa.ukzn.ac.za/webpages/DC/asjul58.22/asjul58.22.pdf)*.

Indeed, Setati is quite unapologetic in advocating that the Essential Dignity of African languages be elevated and employed in learning and teaching

mathematics in South African schools, despite the dominance of English in the endeavor. As she puts it,

> …the power of mathematics and English can work together in multilingual mathematics classrooms to reduce the mathematical opportunities for procedural discourse. Further, it appears that for substantial teaching and learning and engagement in conceptual discourse to occur, the learners' main languages are required. However, given the master model of *English is Inter-national*, it is not always possible to fulfill this requirement. The issue is not only that additional language learners learn mathematics in a language that is not their main one, but that the various languages used will privilege different discourses of mathematics (Setati 2002:18).

Setati also asserts that

> The extensive use of Tswana may not be allowed, but it seems that it is the best means available to teachers to foster mathematical under-standing in their pupils. Apart from being an educational resource, the use of the learners' first language is also a key to the world and culture of the learners

involved. It enables the participants to make relevant connections with their lives beyond the school (Setati 1998:40).

Setati further insists that

> …in addition to encouraging the use of the learners' home language, there is also a need to consider multilingual assessment practices, where test items can be given in the LoLT [language of learning and teaching – i.e. English] and in the learners' home language(s) and learners can respond to the questions in a language they prefer. For this to happen, school language policies need to be more flexible to give teachers the freedom to assess in multiple languages…For learners in these [i.e. multilingual] classrooms to be successful in a reform curriculum it is important that their home languages be used as legitimate language(s) of interaction in a range of mathematical Discourses (Setati, 2005a:463-464).

Also, as can be seen in Figure 1, the data are plotted in a phase space. The plot is neither an orderly periodic oscillation, nor is it simply a random scattering. There is structure here, suggesting that this could be a slice through a higher dimensional attractor. Would this higher-dimensional

attractor correspond to a cognitive structure in the mind of Setati? Or, since I was the "signal director" for these data, would it be better to think of them as a "socio-cognitive" structure created through the interaction between the Setati and her targeted audience.

> Furthermore, Figure 2 is the log-log plot (or log-log graph) generated to represent the observed units described by the two-dimensional variable encompassing *order* (y) and *disorder* (x) as a scatter plot/graph. The two axes display the logarithm of values of the two dimensions, not the values themselves. If the relationship between x and y is described by a power law,

$$y = x^a;$$

then the (x, y) points on the log-log plot form a line with the slope equal to a. Log-log plots are widely used to represent data that are expected to be scale-invariant or fractal because, as stated before, fractal data usually follow a power law.

A logarithm is an exponent. It is illustrated in the following definition:

> For $b > 0$, $b \neq 1$ and for $x > 0$,
>
> $y = \log_b x$ if and only if $b^y = x$

Figure 1: Phase Space Portrait Mapping Presuppositions of Order and Disorder
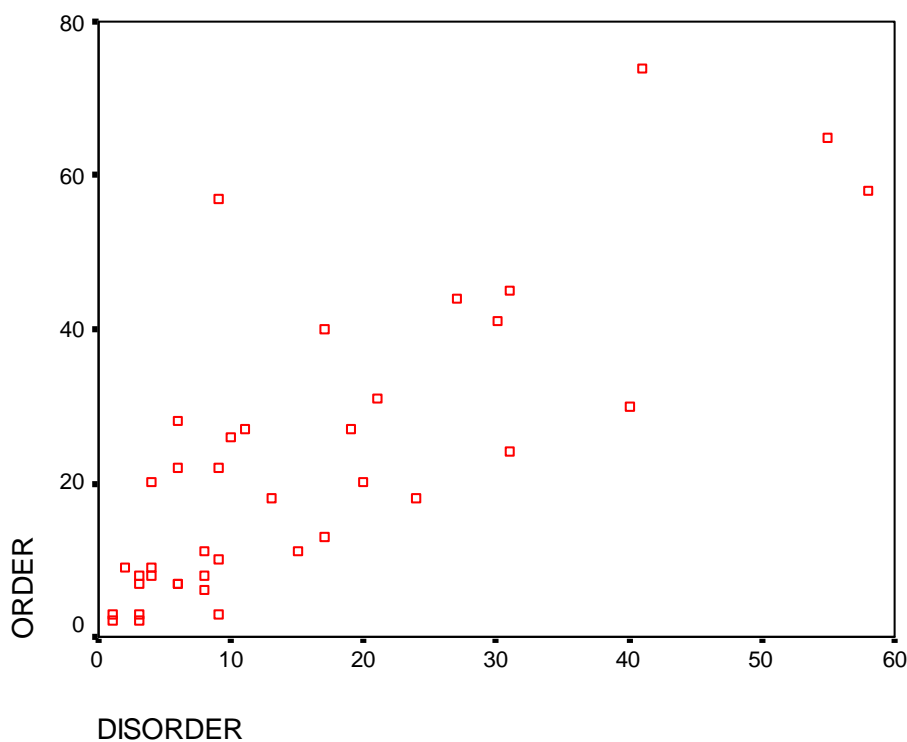
Source: Self-generated data from the texts and computed using MATLAB

Thus, since a logarithm is an exponent, it is easy to use exponent laws to establish mathematical generalizations.

Figure 2 illustrates the fractal dimension of the two-dimensionality of the variable. The binary logistic statistics reveal that the relationship between the two dimensions is statistically significant at the 0.0001 level. Visually, the text essentially moves halfway across the spectrum – it typically moves from periodic fractal, rather than stretching all the way to pure order or disorder. Thus, the results generated after the MATLAB computer runs suggest that the combination of negative and positive feedback loops, which form the basis of several African knowledge systems – as Ron Eglash (1999:173-4) suggests, also form a key mechanism of general self-organizing systems discussed in Setati's texts. Indeed, Setati's framing of the issue in her texts is reminiscent of African ways: i.e. despite the challenges and hardship, their thought processes never become completely chaotic.

In sum, there are at least two levels in which order and disorder are contrasted here. Within the statements of Setati, orderly and disorderly events come and go. But there is a higher level of "orchestration" in which Setati produces meaning

Conclusion

The data gleaned from Setati's texts made it possible to explore a phase space created by two dimensions: (1) *presuppositions of order* and (2) *presuppositions of disorder*. This was done to investigate the possibility that a fractal structure could exist in the literary dynamics that drive the narratives, similar to the ways that fractal structure exist in attractors for certain nonlinear physical systems. The substantive findings, as stated earlier, reveal that it is indeed possible to generate a phase space portrait in which data are mapped to a structure that has the kind of mix between periodic and random variation that we would expect from chaotic dynamics. This is not conclusive proof by any means – a full experiment would need to compare the results from several readers, examine such data in closer detail (for example, perhaps, scoring every page rather than every thematic section), and look at other such presuppositions. But it does suggest that this kind of analysis could be extended further to investigations of literary dynamics.

If my speculation concerning this phase space portrait is correct – if there is indeed an underlying structure that could be characterized by fractal variation, this is noteworthy in that it could be a commonality within at least some bodies of African literature. Further experiments would be needed to test this hypothesis. Nonetheless, as Kofi Nyidevu Awoonor (1990) and I (Bangura, 2002) posit, the African life concept is holistic – i.e. it is based on an integrative world view. All life to the African is total; all human activities are closely interrelated. This has as its underlying principle the sanctity of the person, her/his spirituality and essentiality. This essentialist view of the person confers value to her/his personhood. All else – her/his labor and achievements – flow from this value system. Even personal shortcomings cannot invalidate it. This salubriousness is evident in Setati's work which emphasizes the fact that politics shepherds the labyrinthine nexus between language and mathematics in South Africa's educational system. As she puts it succinctly,

> My own experience as a multilingual teacher and researcher in multilingual mathematics classrooms suggests that we cannot describe

Figure 2: Log-log Plot Order vs Disorder in the Texts
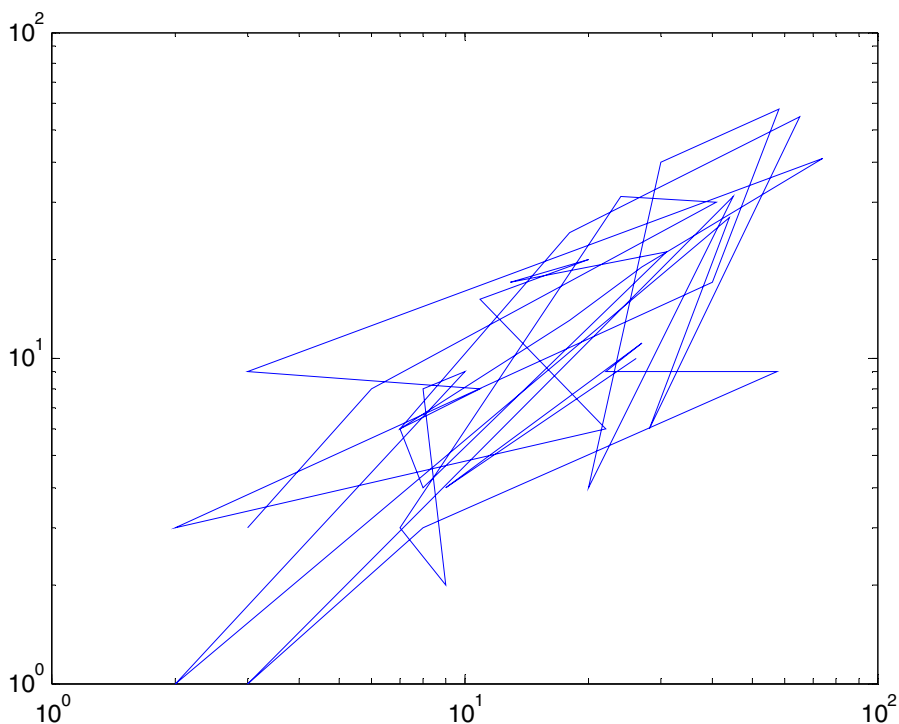
Binary Logistic: $y = 1.020 + 0.130$
$R^2 = 0.623$; $p = 0.0001$

Source: Self-generated data from the texts and computed by using MATLAB

and explain language practices in a coherent and comprehensive way if we stop at the cognitive and the pedagogic aspects. We have to go beyond these aspects and explore the political aspects of language use in multilingual mathematics classrooms (Setati 2002:15).

Indubitably, in order for Setati to capture the essentiality of the nexus between African languages and mathematics, she had to attune herself extensively not only with the scholarly literature and media discourses on mathematics education, her field of expertise, but also with those on linguistics and political science.

In addition, Awoonor (1990) and I (Bangura, 2002) point out that for Africans, politics defines duties and responsibilities alongside obligations and rights. All these relate to the various activities that have to do with survival. The survival concept is continuing, dynamic and dialectical. The fundamental principle that is at the basis of this conception is a moral one. Moreover, the African moral order never defined rigid frontiers of good and evil, which exist in the same continuum. Whatever is good, by the very nature of its goodness, harbors a grain of evil. This is a guarantee against any exaggerated sense of moral superiority which goodness by itself may entail. The notion of perfection, therefore, is alien to African thought. Perfection in itself constitutes a temptation to danger, an invitation to arrogance and self-glorification. The principle of balance defines the relationship between good and evil. As life operates in a dialectics of struggle, so also does good balance evil and vice versa.

Thus, the essence of an African-centered approach is that it is imperative and urgent for Africans to be concerned about broader development and the linguistic-mathematical nexus as well as approaches to these phenomena that are undergirded by humanity or fellow feeling toward others. When African-centeredness is considered along with the idea of the socialization effects of developmental environments and the possibilities of a reinforcement of these notions and contexts, the implications for African development, linguistic and mathematical processes appear vital.

Although compassion, warmth, understanding, caring, sharing, humanness, etc. are underscored by all the major world orientations, African-centered thought

serves as a *distinctly African rationale* for these ways of relating to others. African-centeredness gives a distinctly African meaning to, and a reason or motivation for, a positive attitude towards the other. In light of the calls for an African Renaissance, African-centeredness urges Africans to be true to their promotion of good governance, democracy, peaceful relations and conflict resolution, educational and other developmental aspirations.
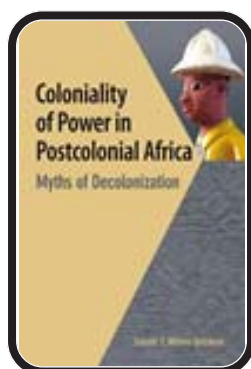
We ought never to falsify the cultural reality (life, art, literature) which is the goal of African-centeredness. Thus, we would have to oppose all sorts of simplified or supposedly simplified approaches and stress instead the methods which will achieve the best possible access to real life, language and philosophy.

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