REHEARSING A MAROON MYTHOPOETICS IN MATHEMATICS EDUCATION THROUGH CONSIDERATION OF AN ARTEFACT OF MATHEMATICS POPULARIZATION (THE PEDAGOGICAL FILM ALL IS NUMBER)

by

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Abstract

In this transdisciplinary study I rehearse ideas of communication, discourse, identity, representation, ethics, and responsibility as they relate to mathematics education through critical engagement with the medium of a specific pedagogic film – *All is Number* – which was produced in the Caribbean and intended for Secondary School and non-specialist audiences. I argue that popularizations of science and mathematics, even as they work to interrupt particular limiting narratives, simultaneously participate in ideological, political moral and aesthetic economies and ecologies in which the discursive enactments of colonial power/knowledge are necessarily implicated and show that mathematics popularization has proselytizing and pedagogic functions.

I consider the film *All is Number* to be situated with/in the heteroglossia of broader cultural phenomena, viz. the ‘popularization’ of educational consumption, and most specifically, the popularization of mathematics. Specifically, I illustrate how the film constructs an idea of mathematical authority and mathematics that is simultaneously sensitive to concerns in the mathematics education literature about the representation of mathematical practitioners and mathematics yet insensitive to practices of Othering.

I argue that the film is an ethnomathematical artefact representing aspects of a particular culture of mathematics and that the mythopoetic tradition in Curriculum Studies might serve as a useful alloy for ethnomathematical studies. In addition, I contribute towards a language for Caribbean Curriculum Theorizing by arguing that the film and dissertation as anomalous places of learning can be construed as a maroon narrative. I introduce and rehearse the implications of my concept of intervulnerability where rehearsal is taken as being an ethically and epistemologically vigilant mode of dialogical inquiry, a demythologizing critique and recursive elaboration.
Preface

Fragments of the discussion of Dialogism in Chapter 1 are rehearsed in


The theoretical parts of Chapter 6 were rehearsed in


and

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“Once we agree that thinking is an individualized form of interpersonal communication, we must also concede that whatever one creates is a product of collective doing…full of ‘echoes and reverberations’” (Sfard, 2008, p.xxi)

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Dedication

This work is lovingly dedicated to

Clare Kathleen Khan (1956-2009)

and

Azamuddin Khan.

My Parents and First Teachers.
CHAPTER 1: UNFINISHED BEGINNINGS

Six years later it seems that I am not done playing with polyphony. In my previous work (Khan, 2006) I examined the polyphonic discourse in a beginning secondary school mathematics classroom in Trinidad. That study was grounded in the dialogical framework of Bakhtin (1981), socio-constructivist (e.g. Ernest, 1991) and socio-cultural (e.g. Boaler, 1999; van Oers, 2001) philosophies of mathematics education, and the learning of mathematics as learning to participate in a discourse (e.g. Sfard, 2001). This dissertation can be thought of as an extension and elaboration of some of the ideas that I explored in that (earlier) and in subsequent work, though, as I describe below, my preferred metaphor is rehearsal. In this present work I continue to examine ideas of communication, discourse, identity, representation, ethics, and responsibility as they relate to mathematics education. However here I have shifted my attention away from the day-to-day communicational activities that take place in, and thereby constitute, the discourse community of a mathematics classroom to another medium through which conceptions of mathematics are communicated – pedagogic film.

For the present purpose of this introduction I take film to mean any deliberately juxtaposed, reproducible sequences of moving images (with or without an accompanying soundtrack) that is (potentially) viewable by audiences and not merely the physical medium produced by chemical processes. It is not an exaggeration then to claim that ‘film’ is almost everywhere in many contemporary industrialized and surveilled societies. While it is possible to engage with and learn from visual stimuli to which we are able to consciously attend, for the purposes of this work, I delimit ‘pedagogic film’ as a category which refers to those films whose producers a priori intended some educational purpose within some discursive situation that might be described as having a didactic or pedagogical dimension.

Consider for example photographer Eadweard Muybridge’s scientific experiments which settled a vexing problem of 19th century animal locomotion studies: whether or not during full gallop there was ever a point in time at which none of a horse’s legs was in contact with the ground. These experiments took place in Palo Alto California and the photographs demonstrating that indeed such a point in time existed were published in 1878. These were shown to audiences in San Francisco (Art Association in 1879), Paris (laboratory of Dr. E J. Marey in 1881) and to the Royal Institution of Great Britain (in 1882) using Muybridge’s own invention, the
zoöpraxiscope\(^1\), to demonstrate “movements analytically photographed from life” (Muybridge, 1957, p.15). I would claim, it is at these multiple points – when the viewing of the moving sequence of images, in the specific situations and with/in the discourse communities (audiences) identified, together with the conscious knowledge of the viewers of the specific question(s) that motivated the inquiry – that the deliberately juxtaposed, reproducible sequences of moving images produced and projected by the zoöpraxiscope take on the characteristics of what I am calling pedagogic film. Notwithstanding that there is much more that could potentially be learnt from differently inflected studies of the specific set of static images and the projected moving ones – by taking them for instance as artistic, cultural, semiotic, or technological artifacts – it is the fact that the images were created for a very specific pedagogical purpose, to answer a specific question of scientific interest, and, significantly, in my opinion, that viewers’ attentions are consciously drawn to this question, and from there to the relation that exists between the question and the images that comprise part of a response, that makes their public presentation pedagogical.

Fast-forward – a significant and apt metaphor in itself – to the first half of the twentieth century with the birth, establishment and growth of motion-picture industries in various locations around the globe and one witnesses the simultaneous emergence of praise for and concerns with ‘new media’ and educational technology and its relation to societal well-being and educational effectiveness and skepticism, discourses that persist into the present (Snelson & Perkins, 2009). For example as a writer in the School and Society journal cautioned in 1918, “[t]he cinema exercises a powerful and far-reaching influence on our national life. It is an agency rich in possibilities for educational advancement and helpful recreation, but capable of being prostituted for ignoble purposes” (School & Society, 1918, p.55, italics added). More circumspect for example is Dale (1937) who offered that while, “[t]here is a danger that we may claim too much for the effect of the cinema... there is a greater danger... that we shall claim too little as the share of the cinema in this process of educating children (Dale, 1937, pp.698, italics added).

Educators were among the early adopters of film-as pedagogy (e.g. Hansen, 1933; Sumstine, 1918) to explore how the then new mass entertainment medium of motion-pictures could be effectively utilised, and instrumentalised in promoting learning, retention and later

\(^1\) Images of one of Muybridge’s zoopraxiscope discs and a video/animation of it in motion can be viewed at http://en.wikipedia.org/wiki/File:Zoopraxiscope_16485d.gif
transfer in school settings (Butler et al, 2009) as part of the growing movement towards the psychologisation of teaching-learning in the 20th century in North America and parts of Europe. Across all disciplines and perhaps loci of education it is not uncommon for teachers to have used film as a bribe, as a techno-aesthetic pacifier and as a highly successful strategy to create/consecrate time and space away from the daily physical and psychical tolls that teaching takes to complete other duties such as assessment, evaluation, and preparation. These constitute but one aspect of the early, enduring, and sometimes warranted characterization of film use in educational settings as “lazy teaching” (Butler et al, 2009, p.1161). Snelson and Perkins (2009), in a review of the history of educational motion-pictures up to and including the recent increase in online educational motion-pictures available through video-sharing sites like YoutubeTM, demonstrate how many of the tropes and concerns that that were articulated in the very early deployment of motion-pictures in education continue into the present.

In the present moment, many films, particularly those used in educational situations and discourse communities, explicitly adopt a pedagogic posture. The chief goal of any purposeful pedagogy, including that of film-as-pedagogy, is (student) learning. The basic premise is that viewing a film and reading related text(s) provide a greater number of opportunities for the learner to engage with and encode meaningful relations between the ‘material’ to be learned as presented in different contexts and media thus increasing the quantity of material learned and the quality of learning as measured by indices of retention and transfer (Butler et al. 2009). In addition films are frequently used as pedagogical aids to motivate learners (Butler et al. 2009, Metzger, 2010, Smith, 2009), assess learning (Dudley, 2010) and address social justice concerns (O’Neill & Wayne, 2007). This latter situation describes what I would call a ‘pedagogic use of film’. In this dissertation I am not concerned with the pedagogic use of film in this way in classrooms.

In addition there exists a significant corpus of films in which the focus is on individual teachers and their pedagogies and which logically might also be construed as pedagogic films. In this work however I make a distinction between these films about pedagogy and what I define as pedagogic film. Rather, my concern is with a very specific pedagogic film, All is Number, i.e. one where the producers specifically intend some educational purpose(s). This work also does not attend to the pedagogic use of this film in any classroom. However, I do attend to the “rich…possibilities” and the “danger[s]” of “claiming too much” or “claiming too little” in
analysing, interpreting and rehearsing some of the implications for (mathematics) education in considering this pedagogic film. One of my over-arching goals in this dissertation is to responsibly attend to and represent the polyphony in this work.

In this section I have given a provisional definition of one of the key terms that I intend to use throughout the dissertation, that of pedagogic film. I have suggested that the images recorded and projected by Muybridge in the specific contexts and audiences listed constituted one of the first pedagogic films. I illustrated that in very short order, as film grew from novel curiosity to a mass culture industry, concerns were raised about its educative dimension. I also distinguished a pedagogic use of film from what I am calling pedagogic film.

**Polyphony, Dialogism and Transdisciplinarity**

**Polyphony**

Polyphony is a curious word and an even more curious human phenomenon. Its linguistic components, ‘poly’ and ‘phony’, identify its literal meaning as “many voices or sounds.” As stated previously, my goal in this work is to responsibly attend to and represent an ongoing relationship with this curious concept. As part of attending to this responsibility, let me first introduce the concept by way of an analogy before proceeding to situate it within its historical and wider cultural dimensions.

Consider for a moment contemporary work being done on interpreting the ‘big data-sets’ generated by bioinformatics in studying the patterns of differential gene expression in diseases such as cancer at the Harvard Medical School (Akst, 2009). In this multidisciplinary work the component variables relating to gene expression are assigned different (musical) notes and different instruments. Akst (2009) reports that “[t]he team carefully chooses the notes such that normal gene expression patterns sound pleasantly in tune, while abnormal data yield discordant sounds”. The result is a way for scientists and medical professionals to listen for abnormalities in the overall pattern of gene expression by attending to those instances when the musical harmony is broken – when the sound noticeably shifts from polyphony to cacophony. What this example that marries medical science, mathematics, and music perhaps illustrates is that polyphony is one way to metaphorically describe dynamic patterns of relations: as the metaphorical description ‘music of the spheres’ was once given to describe the polyphony of the heavens, so too might

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2 Listen and watch an example at http://www.youtube.com/watch?v=ObTvZ6KCMsY&feature=player_embedded
musical motifs (metaphorically) allow us to hear the conversations of the universes unfolding within the cell.

The work described above resonates with the earliest formal descriptions of polyphony. In Western (Euro-Judaeo-Christian) Church musical traditions polyphony is generally used to refer to works from the Baroque and Renaissance period such as the fugue. More recent multidisciplinary approaches to comparative ethnomusicology, which rely upon evolutionary arguments show that the necessary elements of polyphonic singing are found in animal vocalisation (van Silver, 2004) but note that while “different forms of dialogical singing (antiphonal and responsorial singing) [which] are directly connected to the origins of polyphony” (Jordania, 2002, p.85) are a “strong musical universal across…world musical cultures” (Jordania, 2002, p.85), few of the elements of vocal polyphony have been observed in approximately half of the world’s musical cultures (Jordania, 2002). Zemtsovsky (2002) takes (musical) polyphony as a necessary fundament of “musical hearing” which he sees as analogous to “musical thinking”. For Jordania (2002, 2004), the origins of polyphony are linked to the evolution of human language, the ability to ask questions, human cognitive development, and communicational complexity in human societies. This however does not imply that cultures in which polyphony has not been observed are in any way cognitively ‘underdeveloped’ or at some earlier stage of ‘development’, but rather the presence of vocal polyphony affords a culture access to engage with more diverse landscapes of observable communicational patterns.

**Polyphony in Bakhtin’s Dialogism.**

The musical concept of polyphony is extended and broadened by Russian literary theorist Mikhail Bakhtin in his study of the work of Dostoevsky (Bakhtin, 1984). In Bakhtin’s work polyphony is not simply multi-voicedness (Holquist, 2002) or the existence of a plurality of perspectives. For Bakhtin, polyphony is the result of what he conceives as the unfinalizability of the self that is due to the influence of others. It is not the ‘poly’ or the ‘many’ that is most necessary to characterize the concept, but the way these voices inter-relate, the way they shape each other, and continually form a self not in-itself-alone but always in and through dialogue. As in music and in the analogy from medical bioinformatics above, it is not merely the existence of

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3 Listen to a recording of, for example, a bar from J.S. Bach’s "Fugue No.17 in A flat", BWV 862, from Das Wohltemperierte Clavier (Part I) available at http://upload.wikimedia.org/wikipedia/en/d/de/BachFugueBar.mid which provides an example of contrapuntal polyphony. Also visit the website of the International Research Center for Traditional Polyphony, http://polyphony.ge/index.php, for a more global comparative discussion of polyphony in music.
the multiple sounds that makes a composition polyphonic, but how the musical ‘voices’ are inter-related and work, or are read, against, and with each other. Similar ideas are emerging to explain consciousness and the phenomenon of self-perception at the neuroanatomical level (D’Amasio, 2010)

Dialogism⁴ can be considered the philosophical framework in which polyphony is situated. Dialogism and dialogue are, as Linell (2005) describes them, ‘polysemous’ terms and that there are many forms of dialogue with varying concerns as Renshaw and van der Linden (2004) illustrate by drawing on Socrates, Freire and Bakhtin. However my focus is on a Bakhtinian understanding and application of Dialogism. Dialogism, according to Bakhtin scholar Holquist (1990), posits that “all meaning is relative in the sense that it comes about only as a result of the relation between two bodies occupying simultaneous but different space…” (p. 18). Indeed, whatever meaning is obtained from a dialogue “is shaped by the place from which it is perceived” (p. 21). A dialogic interaction for Bakhtin comprises a triad of utterance, reply and the relation between these. These relations and the meanings derived are always in a process of “being made or unmade” (Holquist, 1990, p. 29).

Linell (2005) drawing on a number of dialogical scholars including Bakhtin, defines Dialogism more extensively as “a general epistemological framework for sociocultural (human) phenomena: semiosis, cognition, communication, discourse, consciousness, i.e. for the social, cultural and human(istic) sciences (and arts)” (p. 16). For Linell (2005) it is the way in which we “in different capacities and at different levels…acquire knowledge about the world and ascribe meaning to the world” (p. 5). Within this broader conceptualization of dialogism as an epistemological framework the concept of polyphony remains relevant.

Polyphony is relevant to addressing and accommodating the tensions that arise when one attempts to simultaneously weave a path through, while working the insides, outsides, and in-betweens of what has been called the academy’s “two cultures” (Snow, 1965) – Science and the Humanities – or as more recently suggested, “three cultures” (Kagan, 2009) – Natural Sciences, Humanities, and Social Sciences. While these ‘cultures’ could, reasonably, be identified as ‘discourse communities’, this is not to conflate these two inter-related concepts. A functioning discourse community is a necessary fundament for a human culture.

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⁴ This and the subsequent paragraph on dialogism is reproduced with slight variation from Khan (2006).
In this work I am concerned both with practices of discourse across a variety of communities as well as staging dialogical encounters with the types of cultural artefacts that emerge out of those communities. In this dissertation the specific artefact is not only the short Caribbean film, *All is Number*, but also the literatures of mathematics education, curriculum studies, and post-colonial theory with which I engage in continuing this play with polyphony.

**Transdisciplinarity as Scholarly Polyphony**

At a meta-theoretical level, this work is informed and framed as a transdisciplinary study. Following Davis (2009), transphenomena are taken to be “forms [structures] or happenings [phenomena] [that emerge and evolve] and can only be understood, [albeit still only partially], by looking [considering simultaneously other relevant forms and happenings] across (multiple) levels of organization” (p.10). Consequently, transphenomena that emerge in the context(s) created by the (co-)actions of social agents in education, require more than an interdisciplinary or multidisciplinary approach to their study. Such phenomena often insist upon an emergent eclecticism or transdisciplinary approach as for example that advocated for and enacted in the scholarship of Cultural Studies theorist, Stuart Hall, who writes,

> [w]e do live in a period when many of the existing paradigms established and developed within the traditional intellectual disciplines either no longer in themselves adequately correspond to the problems that we have to resolve, or require supplementing from other disciplines with which they have not historically been directly connected (Hall, 2007, p.276).

Conceptually, transdisciplinary research (TDR) is related to but differentiated from interdisciplinary research (IDR) and multidisciplinary research. Mitchell and Willets (2009), for example, note that TDR involves

> going beyond IDR and questioning disciplinary knowledge, generating new methods and insights, and including a legitimacy of lay knowledge…[and is] based in collaborative generative processes in which values or ethical stances are made explicit (Mitchell & Willets, 2009, p.2).

Methodologically, they also note, transdisciplinary research necessitates an engagement with,

> a wide variety of disciplines and epistemological standpoints, as well as with the world at large…[in which] [e]ach discipline…[is] engaged with at a depth that, as a minimum, enables its artefacts (theoretical frameworks, methodologies, methods, analytical frameworks etc.) to be applied with integrity” (Mitchell & Willets, 2009, pp.9-10).

Methodologically and conceptually then, polyphony emerges as a necessary characteristic of transdisciplinary scholarship in that it requires a disposition which is attuned to generating...
responsible dialogues among different disciplines while attending to the congruencies, tensions, contradictions, and hostilities, that accompany differences in epistemological and/or ontological commitments.

With debts owed to, at a minimum, the concepts of dialogic polyphony (Bakhtin) and contrapuntal reading-writing strategies (Said, 1993) this dissertation attempts to responsibly address members in at least two different discourse communities, most notably, Mathematics Education and Curriculum Studies – my present disciplinary and departmental homes. By first attending to relevant conversations in these different fields, and inviting them into dialogue, this dissertation attempts to negotiate the tension among these disciplinary discourse communities (or academic cultures) and seeks to bring them into generative conversation around the particular artefact, the film All is Number.

As a film which takes mathematics as its main subject and which was produced in the Caribbean by university educators and distributed online and via television networks, All is Number, could justifiably be approached from within any one of the individual aforementioned disciplinary domains. The film, however, when taken together with its contexts of production and consumption as well as its intended and imagined audiences, is suggestive of an ontological complexity, i.e. it is an artefact that emerges from and speaks to, or addresses, at the minimum, mathematics educators, as well as postcolonial, curriculum and cultural theorists. As such, while it is possible to take single vectors as a basis into the analysis of the space of the film, if these vectors are ‘fixed’ in a single disciplinary domain, then this constrains forms of engagement to the limits of the parameters of the disciplinary discourse. If the chosen vectors however are capable of dissolution and resolution, assemblage and disassemblage, then this provides a means to bridge those constraints imposed by disciplinary insularities. A transdisciplinary approach, involving the disciplines identified above, offers such basis vectors for a polyphonic engagement with the space occupied by this film. The resultant of such transdisciplinary engagement is, in Klein’s (2004) words, the “elaboration of a new language, logic and concepts to permit genuine dialogue” (p. 516). Below, as a first attempt at elaborating such a new language, I engage with the concept of rehearsal as used by Wilson Harris (1999).
Rehearsal

Following Caribbean (Guyanese) mythopoet (Henry, 2000) and cultural theorist Wilson Harris’ use of the term, this project is conceptualized as a ‘rehearsal’. For Harris (1999) rehearsal entails,

a shift of emphasis in which [one] has to judge [oneself], [one] has to become profoundly aware of [ones] own position as someone who worked for the employer against whom [one] is rebelling. …[One] has to break the spell, the charisma, the enchantment which ruled [one’s] employer and the society to which [one’s] employer belongs. [One] has to break a certain kind of mould. [One] has to do more than protest against the society. [One] has to understand the society deeply enough to appreciate the kinds of psychological fallacies which have gripped those against whom [one] rebels…and in fact [one] is unable to do it by [oneself] (p.81).

‘Rehearsal’ can be thought of as being an ethically and epistemologically vigilant mode of dialogical inquiry into the aetiology of imagination’s sensational genealogies, a *kin*, perhaps, to Ellsworth’s (2005) description of “teaching and learning as always in the making…” (p.56) and related to the four moments described in the method of *currere* – viz. the regressive, progressive, analytic and synthetic as elaborated by Pinar (2012). Rehearsal, however, in the sense described above, is simultaneously critique *and* enacted polyphonic performance.

Given that the producers of this film, Dr. Shirin Haque and Dr. Leo Mosley, are both senior faculty members at the same regional institution where I lectured prior to commencing doctoral studies, albeit the latter is at another campus, at a literal level then, I am aware that they, and I, belong to the same society and have been employed by the same employer(s). However, it is not (only) the literal employer, nor the literal societies to which they and I belong that is the focus of my demythologizing critique, this polyphonic protest. Rather, it is the discursive devices that are employed/deployed in the film’s narrative, and the attendant “psychological fallacies” which sustain such discourses which I seek to understand and write against.

For educators, Harris’ concept directly addresses one of the persistent dilemmas in education’s imagination, one which has been repeatedly identified, for example by Freire (1970) and Ellsworth (1989), namely that while,

[i]t is easy for a society to overturn an oppressor…it is equally easy for those who overturned to become the oppressor in turn. If one polarizes the world dreadfully, the oppressor and the oppressed, then one is no longer in a position to understand who the oppressor is, how he relates to one, who the oppressed are, how the oppressed relate to one. To understand that, one has to *rehearse the implications* (Harris, 1999, p.85, italics added).
The particular emphasis that Harris places, not just on rehearsal, but specifically on rehearsing the *implications* of one’s actions and thinking is key to “breaking…certain kind of mould[s]” in educational theorizing, viz. Manichean thinking or what Harris might call ‘block’ functions. Obsessive attention to dichotomous categorizations, such as ‘oppressor and oppressed’, ‘colonizer and colonized’, ‘native and immigrant’, ‘teacher and student’, ‘the 1% and the 99%’, ‘employer/supervisor and employee/supervisee’, ‘tenured and adjunct’ etc., that too rigidly partition the world under consideration, obscuring the *implicatedness* of each in and as the other.

To this end, I take the injunction to “rehearse the implications” to be similar to Seymour Papert’s (2006) call for “properly *disciplined* thought experiments” (p. 582, italics added) in education. For Harris however this might involve mythopoetic dreamwork, and rehearsals, “always preparatory but never definitive” (Harris, 1999, p.139) in order to develop more complex consciousness and conscientiousness.

Similar to Bakhtin’s foregrounding the impossibility of dialogic closure and the unfinalizability of the self, Harris foregrounds the necessity of “infinite rehearsal”. But this is not a Sisyphean nightmare, i.e. repetition without transformation. The purpose of this understanding of “infinite”, “unfinished” rehearsal, in Harris’ thought, is to enable a “complex dialogue” (p.83) out of which individual and civilizational “literac[ies] of the imagination” (p.84) can be developed, “obsessional codes” (p.84) broken and “block functions” (p.77, p.84) escaped, i.e. cultural autopoeisis.

‘Rehearsal’ then, as used in this dissertation, is more than simple recursion. It is more a kin to the concept of “recursive elaboration” (Davis & Simmt, 2003) in which what was learnt in/from earlier ‘performances’ have become embodied and enacted, incorporated in(to) an iteratively unfolding situated performance. And, indeed, fragments of the ideas developed in this dissertation have been rehearsed elsewhere (e.g. Khan, 2008a, b, 2010, 2011). What is new, perhaps, are the particular assemblages that I have chosen to be engaged with/by here and the particular discursive assemblage that is a dissertation.

Conceptually, while Bakhtin’s notion of the unfinalizable self resonates with Harris’ notion of Infinite Rehearsal, Bakhtin’s concern can be said to be at the level of the individual self/consciousness while Harris’ concern is at the level of a culture/society. The method of *currere* too is addressed to individual transformation through academic study and autobiography, though the more recent formulation in which it is aligned with allegory (Pinar, 2012) is a turn
towards the cultural dimension, its understanding, interruption and ultimately transformation that are Harris’ concern. The work in this dissertation by drawing on these traditions, rehearses some implications, both for myself and for the communities I have identified previously and with whom I seek to engage in dialogue.

In the remainder of this chapter I describe the context, rationale, significance, goals and preliminary questions of the research project, and provide an overview of the subsequent chapters.

**Contexts**

The film, *All is Number*, the primary ‘object’ with which I am engaged, is a mathematics film produced in the Caribbean and intended for a non-specialist or popular audience. It is an example of what could be called ‘mathematics popularization artefacts’. Increasing attempts to popularize mathematics and mathematicians (both as individuals and as career category) as cultural phenomena are situated within more general trends of the popularization of and concern with representations of science and scientists. This is situated within a context of individual, national and multinational anxieties, inadequacies, inequalities, insecurities, insufficiencies and lack of competitiveness, associated with mathematics and science education in schools, colleges, universities and social life and which includes the (Anglophone) Caribbean, Trinidad and Tobago, in particular, where demonstrated levels of mathematics proficiency at the end of Secondary School as assessed by regional examinations are viewed as being unacceptable (Antigua Observer, 2011; Stabroek Editor, 2011; The Jamaica Gleaner, 2011). In the section below I contextualize some aspects of mathematics education in Latin America and the Caribbean before narrowing to the Anglophone Caribbean.

**Mathematics Education in Latin America and the Caribbean**

The Inter-American Bank Education Division’s Technical Notes, *The State of Numeracy in Latin America and the Caribbean*⁵ (Valverde & Näslund-Hadley, 2010), states that numeracy abilities and skills have not received the same degree of attention as literacy skills and

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⁵ The countries that are listed in the report are Argentina, Brazil, Chile, Colombia, Cuba, Dominican Republic, El Salvador, Guatemala, Haiti, Mexico, Panama, Paraguay, Peru, Uruguay. Some attention is given to the Anglophone Caribbean via the CSEC reports where the writers note that “country differences are significant” (p.17) and some phenomena e.g. numeracy, gender (really sex) gap favouring males over females is reversed in some Anglophone Caribbean countries compared to Latin American countries.
competencies. However, performance on regional and international standardized tests\(^6\), studies that demonstrate a lack of adequate numbers of researchers in the region’s workforce, a critical lack of quality” (p.14) in the region’s educational system and the recognition by policy-makers that “interest in mathematics and science [are] necessary to ensure that all students develop the general numeracy skills important for every citizen” (p.2) have contributed to a shift in which increasing emphasis is being placed on numeracy education\(^7\). Limited engagement with “disciplinary rigor or research evidence, giving precedence to the philosophical and/or ideological choices made by policy makers…little discussion…of the array of numeracy skills and knowledge necessary for the conduct of personal, social, and economic life” (p.9), a “static” lower-secondary curriculum in which “considerable instructional resources [are devoted to] arithmetic topics that are introduced and covered extensively in primary school” (p.10), and using, “curricula that do not meet international standards of clarity, alignment and rigor” (p.10, italics in original) are identified as factors contributing to the “troubling picture” of numeracy education in this region.

Valverde and Näslund-Hadley (2010) describe the heteroglossic environment in which educational policy generation occurs. They state,

> [t]he generation of new policy documents is often an act of political expediency, directed at a myriad of disparate actors and agencies in the educational system… (often external consultants) who usually do not write such instruments of curriculum policy [and who] typically lack effective mechanisms to guarantee that they are aligned with one another [thus producing] a sort of “tower of Babel” effect in which curricula, programs of study, learning indicators, test frameworks and other instruments, rather than forming a strong cohesive architecture of complementary policies, constitute a cacophony of confusing and contradictory directives (p.10).

\(^6\)These tests include those carried out by UNESCO’s Regional Bureau for Education in Latin America and the Caribbean (OREALC), the Organization for Economic Cooperation and Development’s (OECD) PISA, the Caribbean Examinations Council’s (CXC) CSECs, and the International Association for Evaluation of Educational Achievement’s (IEA) TIMMS (p.15).

\(^7\)Valverde and Näslund-Hadley (2010) note that while the specific term ‘numeracy education’ is relatively new, its concerns with the acquisition, relevance and impact of mathematics and science skills during early childhood through secondary school are not. The working definition proposes that,

> numeracy education includes both aspects of mathematics and science education. It represents education that seeks to develop students’ abilities to use quantitative, spatial, probabilistic, relations, empirical, and experimental reasoning skills; it denotes the knowledge and understanding of mathematical and scientific concepts and processes of inquiry (focusing especially on evidence, and the use of evidence to substantiate claims, to distinguish testable explanations from other types of explanations) to successfully carry out tasks of personal decision making, and participation in civic, social, cultural, and economic affairs (p.4).
This description resonates strongly with my direct experiences as a classroom teacher, a mathematics curriculum writer on the Secondary Education Modernisation Programme, a lecturer at a regional University and as the Chair for the Caribbean Examinations Council (CXC) Secondary Education Certificate’s (CSEC) curriculum ‘renewal’ process – cacophony and not polyphony are more often than not defining features of the working environment of education in Trinidad and Tobago. Another recent report, this one produced by the International Council for Science (ICSU) Regional Office for Latin America and the Caribbean, *Mathematics Education in Latin America and the Caribbean: a reality to be transformed* (ICSU, 2009) closes by describing the state of mathematics education and the need to act in this region as “URGENT; something must be done” (p.18).

**A view of mathematics results in the Anglophone Caribbean**

Another way of describing the context of mathematics education in the Anglophone Caribbean territories is through numerical statistics. In Table 1 below I aggregate the Regional results for mathematics of the Caribbean Secondary Education Certification Examinations (CSEC) administered by the Caribbean Examinations Council (CXC) which occur in January and May/June. The first examinations of a revised syllabus took place in May/June 2010 and January 2011. For the period examined in Table 1, a Grade of I, II, or III indicated a ‘Pass’ in the examination. In 2008, data on Trinidad and Tobago’s performance was disaggregated from the Rest of the Region (RoR) due to an incident affecting test-integrity and which resulted in students in Trinidad & Tobago having to write an alternative examination.

<table>
<thead>
<tr>
<th>Year/Month</th>
<th>Approx. No. of candidates</th>
<th>% Pass (Gr. I, II, III)</th>
<th>Approx. No. NOT Passing</th>
<th>% Scoring at least 50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-January</td>
<td>11 672</td>
<td>57</td>
<td>5 019</td>
<td></td>
</tr>
<tr>
<td>2004-May/June</td>
<td>84 786</td>
<td>35</td>
<td>55 119</td>
<td></td>
</tr>
<tr>
<td>2005-May/June</td>
<td>88 559</td>
<td>39</td>
<td>54 021</td>
<td></td>
</tr>
<tr>
<td>2006- May/June</td>
<td>86 479</td>
<td>35</td>
<td>56 211</td>
<td>26</td>
</tr>
<tr>
<td>2007- January</td>
<td>12 650</td>
<td>44</td>
<td>7 084</td>
<td>26</td>
</tr>
<tr>
<td>2007- May/June</td>
<td>86 835</td>
<td>34</td>
<td>57 311</td>
<td>23</td>
</tr>
<tr>
<td>2008- January</td>
<td>14 800</td>
<td>57</td>
<td>6 364</td>
<td></td>
</tr>
<tr>
<td>2008- May/June RoR</td>
<td>57 000</td>
<td>37</td>
<td>35 910</td>
<td>28</td>
</tr>
<tr>
<td>2008- May/June T&amp;T</td>
<td>20 000</td>
<td>47</td>
<td>10 600</td>
<td>40</td>
</tr>
</tbody>
</table>

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8 By way of full disclosure, I served as the Chairperson of the committee that prepared the revised syllabus for use from May/June 2010. Some of my thoughts on that process are described in Khan (2010).
<table>
<thead>
<tr>
<th>Year/Month</th>
<th>Approx. No. of candidates</th>
<th>% Pass (Gr. I, II, III)</th>
<th>Approx. No. NOT Passing</th>
<th>% Scoring at least 50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009 – January</td>
<td>15 300</td>
<td>49</td>
<td>7 803</td>
<td></td>
</tr>
<tr>
<td>2009 -May/June</td>
<td>91 370</td>
<td>41</td>
<td>53 908</td>
<td></td>
</tr>
<tr>
<td>2010 -May/June</td>
<td>88 400</td>
<td>41</td>
<td>52 156</td>
<td>24</td>
</tr>
<tr>
<td>2011 – January</td>
<td>13 760</td>
<td>37</td>
<td>8 668</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>671,611</strong></td>
<td></td>
<td><strong>410,167</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Based on CXC, 2004a, b, 2005, 2006, 2007a,b, 2008a,b,c, 2009a,b, 2010, 2011). Note that the cut-score for passing is not 50% but varies. Grades I, II and III constitute a ‘Pass’

In terms of the regional context of mathematics education what I wish to highlight from Table 1 is the situation where over the last seven years, of the over half a million candidates who have taken this exam, approximately three-fifths or over 400,000 entrants failed to pass Mathematics at this level of proficiency and with only a small percentage scoring more than 50% of the available marks. In the year for which Trinidad & Tobago’s data is disaggregated from the Rest of the Region it can be seen that while the pass rate and percentage of students scoring more than half of the marks is greater in Trinidad and Tobago than the rest of the region, the overall performance suggests an underlying problem.

While these numbers do not provide direct evidence of how individuals perceive mathematics, in the region, they do offer as a starting point, that one of the most direct experiences of many students and individuals in the region is a lack of success with mathematics on terminal examinations.

**All is Number**

It is in this milieu of ongoing educational concern about mathematical competencies that physicists Dr. Shirin Haque and Professor Leo Mosley of the University of the West Indies (U.W.I.) (St. Augustine and Cave Hill campuses respectively) produced the mathematics documentary *All is Number* (2010) with funding from the Peter Moores Trust of Barbados. The film is available online and has been broadcast on Trinidadian and regional television stations. The film, to my knowledge, stands as the first and perhaps only regionally produced mathematics documentary meant for a ‘popular’ audience and has not received ‘critical’ attention from
educators (neither within nor outside of the region) thus far. Given that representations of the Caribbean and its peoples in the colonial and post-colonial periods are heavily inflected with a “tourist gaze” the region and its inhabitants are not often thought of as being or represented as scientific’ or ‘mathematical’. This film thus presents a pedagogical occasion that seeks to challenge an ‘absent’ or under-represented but socially and economically valuable cultural identity while utilizing aspects of the economy of looking and consuming of the tourist gaze (Urry, 2002) to create access for both local and global audiences.

The lack of critical attention to ‘popular’ mathematics artefacts such as mathematics documentaries by educators however is not a unique phenomenon⁹. Such artefacts may not be seen as being of sufficient scholarly significance to warrant the investment of time and resources by researchers in mathematics or mathematics education. In addition there may be complex intersections between individual beliefs about and histories with mathematics education that make it challenging to engage the cultural and epistemological authority that mathematics, mathematicians, and mathematical practitioners are given in some cultures. There is also the belief that these artefacts are likely to ‘do no harm’ or that the ratio of potential harms to potential benefits by viewers is sufficiently small as to not be a significant concern. In this work I have undertaken to trouble these notions.

**Rationale**

Pedagogical objects, events, spaces and occasions that can potentially affect learning are deserving of attention and deep, prolonged engagement by educational researchers (Ellsworth, 2005). The wide availability and ease of access to pedagogical objects such as short film via distributed electronic networks increases the demand and necessity of being critical as to what types of ideas and ideologies might be communicated to audiences and through what representations.

The particular film that is the object of study in this research project has been endorsed by powerfully and influentially placed stakeholders – university professors, a university and a regional funding agency. This context makes examining the film’s content, structure, aesthetics, epistemology, and visual rhetoric important from a political and cultural perspective. More particularly, *this* film brings together issues of interest relating to mathematics education,

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9 Amsden (1951) for example discusses the use of a pedagogical film for helping students to make the move from concrete to abstract in early arithmetic. Much of the early work in this area sought to adopt a scientific approach in creating films for classrooms, eg. Price (1954), Allan (1951), Wells (1959) and Lyden (1959).
mathematics popularization, representations of the Caribbean including the touristic gaze, as well as gender issues. The film thus functions as an inter-cultural ‘contact zone’, an assemblage, a holding-area for constructing meaning and negotiating complex identities and that presents an opportunity to follow several strands of theoretical interest and practical value to multiple discourse communities.

**Research Goals**

“Caribbean people…/ I can’t solve your problems…/ but I can make you some music…” (Rudder, 2010, Coke)

In this research project I critically analyse and interpret one artefact of mathematics popularization – the short film/documentary *All is Number* (Haque & Mosley, 2010). Through extended, repeated and recursively elaborative looking, listening, and mindfully attending to the aesthetics of this case I raise:

- **critical** concerns regarding representations of mathematics and mathematicians in visual media;
- **curricular and pedagogical** concerns regarding the teaching and learning of mathematics from pedagogical film and
- **political** concerns regarding the work of ideology in attempts at mathematics popularization via the medium of pedagogic film

as I assemble and stage a series of encounters at the individual and socio-cultural levels. It should be noted that my goal has not been to solve a ‘problem’, but to, metaphorically, “make some music”, by attending to the polyphonic resonances at my levels of enquiry.

In this work I argue that popularizations (and popularisers) of science and mathematics, even as they work to interrupt particular limiting narratives, simultaneously participate in ideological, political moral and aesthetic economies and ecologies in which the discursive enactments of colonial power/knowledge are necessarily implicated. I demonstrate how this is accomplished in the film *All is Number* and present a case for mindful attention and greater awareness on the part of popularisers to relevant research in mathematics education, curriculum studies, and media/film studies.

In acknowledging and responding to the challenge issued by Earl McKenzie (2009) for Caribbean philosophers to formulate “our own aims for education” (p.122), a concurrent goal through this work is to contribute to developing a language and vocabulary for talking about
education in the Caribbean. Analysing and responding to this film from multiple perspectives provides one means of doing that. In particular I theorize, develop and illustrate some concepts for thinking about education in the Caribbean and distinguish, connect and relate these to analogous concepts in North American and international Curriculum scholarship where they exist.

**Significance**

The work will likely contribute to and have implications for educators and scholars across a wide spectrum of fields/disciplines, including but not restricted to, Caribbean Studies, Culture Studies, Educational Studies, Film/Media/Visual Culture Studies, Postcolonial Studies, and in particular Mathematics Education. Among the latter population I expect this research to be of interest to researchers whose concerns include mathematics and aesthetics, mathematics and culture, ethnomathematics, the socio-political dimensions of mathematics education, mathematics and gender, mathematics and race, mathematics and ethics, and producers/funders and communicators of mathematics popularizations. The intended audience for this work includes colleagues in mathematics education both internationally and regionally as well as those in other disciplines with a focus on Caribbean cultures.

On a personal level the film is situated at the nexus of several areas that I care about – mathematics, education, aesthetics, popularization and the Caribbean. The film then is tied up with my own identity as a Caribbean person and mathematics educator. Additionally, at the level of disciplines and domains of scholarly inquiry, the film makes for an interesting case on several levels that appeal to scientific, critical and mythopoetic curriculum scholars. *All is Number* raises issues related to gender, representation, identity, power/knowledge and illustrates a struggle for recognition that mathematics educators must face.

**The Long Shot**

In the language of film and photography, I describe the ‘framing’ and goal of the chapters in this dissertation as a “long shot”. In film, the long shot is used to establish a context and situate the individual subject that is the focus in relation to features of the general environment. For example, in the first part of the short documentary film, *Powers of Ten*, written and directed by Ray and Charles Eames (1968), the camera pulls back slowly (by an order of ten every ten seconds) and continuously from an opening scene of a couple picnicking in a Chicago lakeside park through an expanding field of view to the edges of the Universe. Each of the screen-
captures below in Figure 1 could be considered a long-shot for different subjects. As a consequence two things happen: a larger area is included in the frame but there is a simultaneous loss of visible detail.

![Screen captures from the film Powers of Ten (Eames, 1968).](image)

Figure 1: Screen captures from the film *Powers of Ten* (Eames, 1968). (Images reproduced courtesy and © 2012 Eames Office, LLC ([eamesoffice.com](http://eamesoffice.com))\(^{10}\)

If we were to consider the first screen capture in Figure 1 above, the one taken from one metre away, the specific film, *All is Number*, could, without loss of generality, be likened to a single item such as those on the plate in the upper right quadrant. The description in Chapter 4 and the analysis in Chapter 5 could be considered as work presented at this level. To extend the analogy further, the blanket and everything on it could be likened to the field of mathematics popularization and the wider vicinity of ‘the park’ (screen capture 2) might then be considered as the proximal part of the field of mathematics education in which mathematics popularization is situated\(^{11}\) as I demonstrate in Chapter 2. In chapters 6 and 7 I zoom further out to consider the film *All is Number* within the broad theoretical frames of ethnomathematics, mythopoetic curriculum and maroon narratives.

I have also used the metaphor of the ‘long-shot’ to structure the material in some of the chapters as for example the moving across scales in Chapter 2. However, it is necessary to draw attention to an uncomfortable fact that in visual anthropological field work this framing strategy has sometimes served to, “erase [the ethnographer’s] own presence in the field, thereby establishing the “ecological distance” required to sustain [the ethnographer’s] own authority” (Poole, 2005, p.166). Where and how I am positioned, with what authority and where I position myself in the frame are questions that also must be attended to and I do so in Chapter 8. There, I ‘zoom’ even further out with the effect that the film as object of analysis is no longer ‘in focus’.

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\(^{10}\) In *Powers of Ten*, the long shot is also used to illustrate the concept of the film itself – differing orders of magnitude.

\(^{11}\) Other blankets then might be considered some of these other sub-fields/disciplines.
Rather, the focus shifts to representing my own positioning and authority as well as articulating the type of relationship that this dissertation seeks to enact. Zooming out even further, the final chapter rehearses the implications of the concepts and analyses developed in previous chapters for mathematics education.

Colloquially, the expression and metaphor of a ‘long-shot’ has come to signify the mathematical/statistical idea of a highly improbable outcome – a risk or gamble – though its origin is in ballistic warfare (also another venue in which mathematics continues to play an important role). Using this metaphor, perhaps any metaphor, always involves some risk. The risk, mostly epistemological in this case, is a consequence of the limitations and limits on what can (and cannot) be attended to given certain constraints, informational attrition and memory-loss, as well as the values and moral economies in which one is invested. Attending to polyphony, however, actively seeking out and mindfully listening to more voices, in particular those which operate in a different register from one’s own is one means to negotiate this riskiness.

Overview of Subsequent Chapters

In the following chapters I present a series of independent but related engagements with a short pedagogical film, *All is Number*. The experiment undertaken in this dissertation involves multiple readings of this artefact through different theoretical frameworks. But this dissertation is not really about this film. Rather, I use the film *All is Number*, as a case to engage with questions of discourse and the implications of power-knowledge in mathematics education. The particular film serves as a suitable vehicle to bring ideas from diverse fields into productive conversation.

In Chapter 2 I trace an etymology of the term ‘popular’ before surveying the literature or mathematical popularization efforts and highlight some of the inter-related issues that accompany attempts at mathematics popularization. I suggest that two major conceptions – the transgressive political power and the economic power of the pursuit of leisure and pleasure through consumption – have come to be joined closely in the 20th century and are discernible in contemporary popularization efforts for mathematics and mathematicians.

In Chapter 3 I elaborate a conception of film as a transphenomenon and describe the methodological approaches upon which the analyses are based. These include compositional interpretation, anthropological approaches, and ideological analysis. I also lay out the framework
for my own reflexivity as an audience member who is simultaneously an insider and outsider with respect to the viewing of the film.

In Chapter 4 I present a visual and narrative synopsis of the film in the form of a side-by-side narrative transcription and screen captures of appropriate scenes using a particular partitioning strategy. I also give a brief background to the film and its producers. The purpose of this chapter is the set a stage for the analytic chapters which follow.

Chapter 5 is divided into two parts. In part one I engage with the question of how mathematics is represented in this film. Specifically I attend to the ways in which mathematical authority is represented and constructed and how this authority interacts with the aural and visual modalities through which mathematics is represented in the film. In part two I introduce and utilise Ellsworth’s (2005) concept of anomalous places of learning and the idea of the ‘pedagogic hinge’ with respect to the film.

In Chapter 6 I engage with the film as an ethnomathematical artefact, not simply because it has emerged from the Caribbean, but in the context of a particular culture of mathematics which it attempts to communicate. I also argue that mythopoetic curriculum offers a useful alloy for ethnomathematical studies.

In Chapter 7 I introduce the concept of the maroon narrative as part of developing a language for curriculum theorizing in the Caribbean and make a case for considering the film *All is Number* as a maroon narrative. I also claim that mathematics education is a marooning activity.

In Chapter 8 I represent myself mythopoetically and introduce the concepts of the kumbla and intervulnerability. This chapter is perhaps the most unlike those that have preceded it, in that it is written very much in my developing mythopoetic voice in order to illustrate one way of ‘doing’ mythopoetic work in mathematics education. This chapter is meant to serve as the ‘pedagogic hinge’ in this dissertation.

Chapter 9, the final chapter in the dissertation, brings together the ideas and analyses developed in the earlier chapters. Specifically I argue that mathematics education is a discipline that is divided to the vein.
CHAPTER 2: DISCOURSES OF MATHEMATICS POPULARIZATION

*All is Number*, the pedagogic film that is the sustained object of interest/analysis in this dissertation, is one among an increasing number of differentiated types of artefacts of mathematics popularization. In this chapter I attend not only to the field of mathematics popularization but also seek to present some of the underlying motivations for such activity. The purpose of this chapter is to establish a context for the film *All is Number* as situated with/in the heteroglossia of a set of a broader cultural phenomenon – the ‘popularization’ of educational consumption, and most specifically, the popularization of mathematics (and mathematicians). I begin by tracing an etymology of the term ‘popular’. Next I briefly survey efforts at mathematics popularization before attending to some of the inter-related issues that accompany attempts at popularization.

**Etymological Survey of ‘Popular’**

In this section I examine the etymology of the word ‘popular’ in relation to my intent to critically examine the space(s) in which ‘the popularization of mathematics’ moves. I am interested in the palimpsestic accretions, ‘fossilized traces’ (Harris, 1974)\(^\text{12}\) and ligatures of the referent ‘popular’ and the polyphonic resonances of its historical trajectories that continue to be embodied and enacted in the present. In particular I trace a network of contradictory and problematic associations that I argue ought not to be ignored or assumed in attempts to ‘popularize’ any discipline, mathematics specifically.

While the ‘popular’ is polysemous, throughout history it is used to brand, to signify that which is ‘other’ than the phyla of the privileged\(^\text{13}\). Rooted in the Latin, *popularis*, meaning, “of or belonging to the people as a whole, belonging to or used by ordinary people, available to the whole community, of the common people, supporting or professing to support the interests of the common people, [and] liked or admired by many people” (Oxford English Dictionary, n.d.) the popular marked and set the “ordinary” and “common” in contradistinction to more exclusive

\(^{12}\) Ashcroft, Griffiths and Tiffin (2000) describe Harris’ metaphor as evoking a palimpsestic motif. Khan, (Shalini) (2010) however notes that, “unlike the metaphor of the palimpsest…in which the image of overwritten text is important, Harris’ metaphor of fossilisation does not privilege a linguistic based understanding of colonial experience and points towards a more complex and complete enmeshment of past and present traces such that it is impossible to identify any point of origin” (p.119).

\(^{13}\) In the context of its historical trajectory, the course of the popular is implicated in discourses and practices related to health, medicine and disease, colonization, slavery, capitalism, rebellion, democracy, education, fashion, commodification, mediation, and the economics of modern (and post-modern) attention and consumption.
groups – the elect, the elevated, the special, and the noble – differentiated by special privileges not enjoyed by all. Earliest references to the idea of ‘popular’ as an adjective occur in Old and Middle French (c.1200, c.1330), Italian (popolare, late 13th century), Spanish and Catalan (late 14th century) and Portuguese (14th century) and are connected to this Latin root popularis. A concurrent development is its association with the sense of ‘crowding’ and of being ‘heavily inhabited’ (see for e.g. Bauman, 2004). This feature of the popular as an indistinguishable group evolved to include ideas of suspect genealogy and ‘impure’ or ‘unrefined’ cultures and peoples. Indeed, this latter sense is acutely emphasized in the conflation of ‘popular’ with ‘vulgar’ and ill-bred in the 16th and 17th centuries.

During the 18th and 19th centuries the term ‘popular’ further evolved to accommodate political dimensions associated with the power of aggregates of people. The move towards popular democracy in Europe, for example, was strongly associated with mass rebellion against the (oppressive) nobility - as exemplified in the French Revolution - and the eventual establishment of democratic principles of government – vox populi. Alongside this political dimension, the popular also came to be associated with education, marketing and early consumerism during the same period. The 18th and 19th centuries saw the specific production of affordable, ‘popular’ artefacts for consumption by a ‘general’ audience – a market of and for leisure/pleasure. These artefacts included works of literature, art, science and mathematical recreations, primarily intended to entertain and enrich. The concepts of popularization, “to make a complex topic intelligible to the people” that is associated with ‘popular culture’ are attributable to this period and are relevant to my discussions of mathematics popularization.

Hall (2009a, cited in Storey, 2009, p.4), claiming that popular culture is a site where “collective social understandings are created”: a terrain on which ‘the politics of signification’ are played out in attempts to win people to particular ways of seeing the world (122–23)”, argues that, “[e]verybody now inhabits the popular, whether they like it or not” (Hall, 1992, cited in Giroux, 2000, p. 163). The concept of ‘popular’ as ‘fashionable’ in the sense of an ephemeral temporal link, quick to turn, is a more recent invention/innovation of those forms of capitalism

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14 Other early deployments of the term “popular” include the description of epidemics and cures, as demonstrated in the term maladie populaire or popular sickenesse. This invocation of popular for biological disease also developed a moral dimension as demonstrated in a seventeenth century sermon which asks the rhetorical question “Does not God plant remedies there where the diseases are most popular?” as well as beliefs (popular errors, opinions and speech).

15 Storey (2009) notes that the term ‘popular culture’ may very well be an “empty conceptual category” (p.1) for some researchers and cultural theorists.
which have emphasised speed, efficiency, novelty, and profitability. Reynolds’ (2004) argument that ‘brands’ – the icons of the popular – are re-positioning themselves as not only aids to living but as routes to meaning and spiritual fulfillment, finds resonance and purchase in, for example, the words of Kevin Roberts, CEO of global advertising/marketing corporation, Saatchi & Saatchi, who, in an address to the International Advertising World Congress (2000) described the situation and goals in the marketing industry as moving, “[f]rom rational benefits to emotional responses…to seduce our audience, one by one, lean right in close and touch them, literally, actually feel their spirit”, in order to “sell them more stuff”.

In the present moment we are perhaps witnessing another turn in the evolution of ‘popular’ as branded goods/corporations and iconic individuals come to be associated with spiritual values, sustainability practices, and well-being at individual through ecological scales of being. For example, reports (e.g. Pearce, 2011) that Facebook founder Mark Zuckerberg, “kills his own meat” deploys the popularity and global influence of the social-networking platform and its creator/founder towards implicitly modeling a type of ecological and social awareness.

Two major conceptions – the transgressive political power and the economic power of the pursuit of leisure and pleasure through consumption – came to be joined closely in the 20th century and are discernible in contemporary popularization efforts for mathematics and mathematicians, as I demonstrate in the next section. As Storey (2009) has argued there is an implied otherness that is always absent/present” when the term popular culture is deployed that needs to be mindfully attended to and that, “whichever conceptual category is deployed as popular culture’s absent other, it will always powerfully affect the connotations brought into play” (p.1). However, as hinted at by marketers and cultural theorists, the ecological, mythological and spiritual might now be considered the fertile terrain on which, “the politics of signification,…[continue to be] played out in attempts to win people to particular ways of seeing the world” (Hall, 2009a, cited in Storey, 2009, p.4). A summary of the evolutionary etymology of popular is provided in Figure 2 below.
Figure 2: A temporal unfolding and nesting of networks of associations of the concept ‘popular’.

At present the literature from the sociology of science broadly identifies two models for the popularization of science – the traditional model and the new model. According to Miller (2009), the traditional model rests on three assumptions: that there exists something like “pure genuine scientific knowledge; that it contrasts with popularized knowledge”; that popularization is a second-order activity left to non-scientists that is “external to [internal processes of scientific] knowledge production and validation”; and, that audiences are isolated, passive, blank-slate “assimilators of information” (p.260). In the philosophy of mathematics (and mathematics education), this world view would be described as Platonic, that is, mathematical objects are abstract and have an existence independent of humans, language and culture.

The new model of popularization of science emphasizes the social nature of the processes of knowledge construction, production and dissemination and questions the three assumptions associated with the traditional model. In contrast to the Platonic “pure genuine decontextualized knowledge”, the new model is more socio-constructivist/socio-culturally based, in that (scientific) knowledge is viewed as being dependent upon “social processes of negotiations” (p.261), and in particular the epistemic standards used by different communities. In the new model, popularization is seen not as a second-order activity, but as “an active part in the process
of producing and generating knowledge...in order to gain general support from society and lay-decision makers...” (p.260). In the new model the relationship between scientists, popularisers and media is seen as reciprocal and generative in that popularizations may feed back into the scientific community and provides a means for the community to “legitimize them as good science” (p.260). Finally, the new model recognizes audiences as diverse and actively “construct[ing] different self-perceptions of their interest in and knowledge of science as part of their social identity... [and who] treat popularized scientific knowledge differently” (p.260).

A Brief Survey of Mathematics Popularization

Popular’ treatments of mathematical ideas are not new [however] the proliferation of mathematically related books, plays, novels and movies in the past decade and a half, is, in its scale alone, without precedent (Higginson, 2006, p.136, italics added).

It is clear...that today we are facing a much larger production in the field of maths communication-popularization, compared with what happened 15 years ago. Today I am often overfilled by books of this type...today there is a higher quality level of popularization and it is common to publish books also concerning very sophisticated matters (Umberto Bottazzino quoted in Di Santo, 2007, p.41)

The 20th century is not without reason called, ‘the Mathematical Century’. As British mathematician Ian Stewart (2006) notes, more new mathematics was created in the 20th century than in all of the centuries prior. Perhaps it is no coincidence then (and more than an interesting correlation) that the 20th century is the one in which mathematics became both a respectable and desirable – one might even say ‘popular’ – profession. Taking the sense of popular as ‘common’ or ‘widely occurring’, one might conclude that there already exists a popular form of mathematics, viz. School Mathematics which became a ‘popular’ discipline in the period between the late 19th and early 20th century, in that it became a feature of perhaps every institutionalized educational system across the globe. However, as Higginson (among others) has noted, this particular genre of popular mathematics remains overwhelmingly ‘unpopular’ – in the general sense of not well-liked – among the large majority of those upon whom it has left a distasteful if not damning sometimes damaging impression. As will be discussed below, one of the prime motivations and self-referential justifications of projects which self-describe as being an attempt at Popularization of Mathematics (PoM) is the largely agreed upon failure of the current genre of mass mathematics popularization that occurs via schools and curriculum and the need to ameliorate and remedy this pathology (Howson & Kahane,1990b; Manaresi, 2007).
Howson and Kahane (1990b), in the only ICMI\textsuperscript{16} (International Commission on Mathematics Instruction) volume to date dedicated specifically to mathematics popularization, trace a long history of attempts to make mathematics more accessible to others, citing Archimedes’ \textit{Sand Reckoner} as “an early example of an author attempting to demonstrate to his ruler and others in ‘high places’ the power of mathematics…” (p.18, italics added). Making a convincing case or justification to powerful authorities is a recurrent theme in the popularization literature, one that sits, at times uncomfortably, with its more altruistic sentiments. The authors (1990b) also point to financier and merchant Sir Thomas Greshom’s endowment of a series of public lectures in London during the 1590s to increase awareness of developments which “might bring added power to London’s merchants, navigators and others” (p.19). Technological developments across the centuries have afforded later mathematicians opportunities to reach ever larger audiences. Stewart (2006) notes, for example, that towards the end of the 19\textsuperscript{th} century professional mathematicians like Felix Klein and Henri Poincaré engaged the public through books, the popular medium of the day while German mathematician David Hilbert, on the other hand, utilised radio broadcast for a 1930 lecture on the future of mathematics.

Despite these and other such attempts at mathematics popularization however, the early 20\textsuperscript{th} century would witness the simultaneous flowering and fruition of a rhizomatically spreading tree of mathematical knowledge and its applications with a suspicion, bordering on disdain – perhaps a Hardyian melancholy\textsuperscript{17} – for the mathematician turned populariser (see for e.g. Bottazzini, in Di Santo, 2007). As recently as the 1980s many popular purveyors of mathematics ran the risk of being pigeonholed as mere ‘popularisers’ engaging in “less academically respectable activities” which cast doubt upon the quality of their work as professional mathematicians (Devlin, 1995).

This disdain for mathematics popularization, however, would begin to wane and even reverse in the 1950s aided by its own offspring – information technologies, numerical computation and computer graphics – which has now given birth to an exuberant ‘carnival’ of popular mathematical artefacts. Stewart (2006) describes the changes in the 20\textsuperscript{th} century among

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\textsuperscript{16} In its welcome message on its webpage (http://www.mathunion.org/icmi/home/), ICMI describes its history and mission as, “Founded in 1908 to foster efforts to improve worldwide the quality of mathematics teaching and learning, the International Commission on Mathematical Instruction fulfils its mission through international programmes of activities and publications that promote reflection, collaboration, exchange and dissemination of ideas and information on all aspects of the theory and practice of contemporary mathematical education.”

\textsuperscript{17} In the popular mathematician’s autobiography, \textit{A Mathematician’s Apology} (1940/2000) Hardy writes, “It is a melancholy experience for a professional mathematician to find himself writing about mathematics” (italics added).
\end{footnotesize}
mathematicians as “distaste for mere vulgarization giving way to grudging acceptance of its occasional necessity, and this in turn giving way to active encouragement and approval” (p.1632).

Miller (2009) in discussing a specific case of science popularization identifies three possible explanations as to why scientists might choose to engage the public directly through the media. These are increasing visibility and exposure of research results, establishing priority where peer review is slow and the field is rapidly developing and, consequently, increased recognition within and outside the community with tangible benefits such as increased citations and award of prizes. He also notes that in cases where different communities use different, independent and varying degrees of adherence to ‘strict’ epistemic standards to evaluate research and media reports the reputational cost to potential benefits ratio is negligible. In such cases it is possible for researchers to achieve, “maximal exposure without risking their scientific reputation” (p.272).

Italian researchers Francaviglia, Lorenzi and Pantano’s (2008) make a stronger claim in arguing that popularizing mathematics is an “urgent necessity” for today’s society. Their explicit aim and goal is to “revitalize the understanding of the central role that mathematics plays in everyday life starting from…the emotional and aesthetic side of our consciousness and perception...” (p.273). Their belief that such visualizations will result in “a diminishment of all the difficulties that are related to the transmission of an exact scientific message that might be abstract and rather far from common experience” (p.268) is oversimplified and does not take into account the new difficulties that arise in successfully orienting students’ attention to the necessary qualities and features of an artefact in a different medium.

One of the rationales underlying some projects to popularise mathematics is connected to increasing the participation of a much wider demographic of individuals in mathematics. Knight (1990), for example, is one of the few who writes about mathematics popularization in cultures outside of the Western mainstream. Considering factors affecting popularization among the Maori of New Zealand, Knight argues that because of their cultural alienation, popularization attempts must do more than merely bring elements of Maori culture into traditional presentations of mathematics. For Knight, as others, the aim of popularization is one of changing or influencing the perceptions that people have of the discipline. The nuances of the Maori culture with which Knight engages, however, are a reminder that mathematical cultures are not all
equally privileged and that the lingering legacy of colonial occupation, exploitation and/or neglect adds further dimensions to the complexity of discussions in mathematics popularization that have not hitherto been considered in great detail.

Esty and Schneider (1990) discuss the 1980’s Children’s Television Workshop (CTW) mathematically themed after-school series *Square One TV* which utilized a magazine format and was aimed at 8-12 year old children. They identified three explicit goals of *Square One TV* programming, “to show” the utility, beauty, power, applicability and accessibility of mathematics; “to model good problem-solving behaviour” and “to present” an enlarged conception of mathematics (p.106). They also identify the importance and influence of attracting an audience in a highly competitive television market on the way the mathematics gets presented.

In addition to pedagogic film other types within the discursive genre of mathematics popularization include cinematic film, erotic film, stage-plays, television series, radio broadcasts, video-games, comics, fiction and non-fiction books, graphic novels, newspaper and magazine columns, mathematically or numerically themed puzzles, commercial and private tutoring services as well as mathematically themed merchandising travelling exhibitions, painting, sculpture, music, and more recently, the first permanent North American Museum of Mathematics (MoMath). In contemporary society, the mathematical is now not only popular but also profitable. I do not attempt in this dissertation to engage with all of these different types, occasions or venues of mathematical popularization, nor is it possible within a single type, pedagogic film for example, to engage with even a modest fraction of the work put out in, say, a given year. It is not the goal of this dissertation to trace all the variations of popularizations of mathematics.

At the end of the first decade of the 21st century, one is witness to a number of growing spheres of mathematics popularization beyond the realm of education and schooling in the deployment of unused processing power of distributed but interconnected computing resources to perform brute force examinations in both classical areas of mathematics (number theory, e.g. search for large primes) and its applications (e.g. astronomy, SETI) as well as more modern mathematics (e.g. mathematical biology, protein-folding problem with links to origami and knot

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18 ‘Education’ however remains one of the chief markets for some types of popularizations, for example biographies (Hersh & John-Steiner, 2010).
theory). While this can be described as ‘popularization of mathematics through ‘passive’ participation’, it also illustrates a shift in (some areas of) modern (academic) mathematics towards large diverse problem-solving groups and renders visible the palpable reality that mathematics as a form of life and way of living is dependent on the membership of its social networks.

Higginson (2006) drawing on Whitehead (1948) and Bateson and heavily influenced by philosopher Dissanayake and neuro-physiologist Ramachandran among others, outlines a cultural evolutionary explanation for this phenomenon of proliferating popularizations. He emphasizes works emerging from artistic communities, and argues that, “artists are doing what artists are supposed to do, namely identifying key contemporary issues and exploring new ways of seeing the world…playing with the central construct of human sensitivity to pattern and form and their abstract extensions…” (p.138).

Taking a more transcendental or perhaps emergentist view, mathematician turned storyteller Apostolos Doxiadis (2003) suggests that the phenomenon of increased mathematical narratives, might herald the nativity/natality of an as yet un-named and not-yet-well-defined but “desperately needed” new branch or discipline running alongside that of mathematics that he calls paramathematics which “transcend[s] mere exposition or, that terrible world[sic], ‘popularization’. (p.6). The emergence of paramathematical narratives he suggests, “point to a new and original way of looking at mathematics itself… [are] inspired…by a rebel spirit” and he

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19 What these have in common is an active and ongoing invitation and the ability to opt-in and out at will. The passivity refers to the ‘action’ of ‘doing’ mathematics but even this is a problematic construction as indeed some modern mathematical problems/disciplines depend heavily if not extensively on iterative and distributed computer programming tasks. What I mean then is passivity in terms of engaging in the tasks directly related to solving the problem, such as designing the algorithm, chunking the problem etc.

20 See Whitehead’s Harvard public lecture, “Mathematics and the Good” where he connects ‘pattern’, ‘mathematics’ and ‘human civilization’ (the good of the title). Whitehead writes, “The notion of pattern is as old as civilization itself. Every art is founded on the study of pattern…Mathematics is the most powerful technique for the understanding of pattern and for the analysis of relationships of patterns.

21 Doxiadis’ (2003) framing of ‘paramathematics’ as a field that lies, “literally, on the side of mathematics… [That] will of necessity be cross- and inter-disciplinary, drawing on mathematics itself but also on logic, philosophy, epistemology, the history of ideas, cognitive psychology, sociology, anthropology, education theory. And of course mathematics education.” (p.17, italics added) is perhaps better framed as a transdisciplinary project. The purpose of paramathematics he offers is, to “provide mathematics…with context and thus meaning, extra-mathematical meaning…integration with thought, history and society” (p.17) or, alternatively to give mathematics (and by extension mathematicians) a language with which to “reflect on its[their] own nature” (p.17), while its goal he says “must be to construct complex, causality-driven, linear narratives, that enrich mathematics by understanding it is context, historical, philosophical, cognitive, utilitarian, intra-scientific, aesthetic – or combinations of the above” (p.18).
believes that it is an opportune time for “this rebel spirit begin to infest mathematics education” (p.6, italics added)22.

Complementary perspectives on popularization as exemplified by the positions of Higginson and Doxiadis can perhaps be unified by a consideration of the constructal law for flow systems as described by Bejan and Zane (2012). Posited as being at the same first principle theoretical level as the two fundamental laws of thermodynamics, as well as a way of seeing, the constructal law purports to offer an explanation for the necessary emergence of design, i.e. “macroscopic shape and structure” (p.14), in any evolutionary system at every scale in which something ‘moves’. In its simplest version the constructal law is described as follows: within the given constraints of a given system, “for a finite-size flow system to persist in time (to live) its configuration must evolve in such a way that provides easier access to the currents that flow through it” (p.3, italics added). The self-similarity of ‘branching’ structures seen in trees, deltas, blood vessels, neuronal dendrites and alveoli, for example emerge as a consequence of this tree-like structure being, “an effective design for facilitating point-to-area and area-to-point flows” (p.4).

In using this analogy, mathematical ideas, concepts, techniques, individuals and ideologies are taken to be the entities that ‘flow’ in and ‘stir up’ the local and global currents of communication, economic, and labor systems from their sites of production (departments and

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22 Doxiadis outlines a four-point proposal or working hypothesis for what pursuing paramathematics in education would entail:

1. “Mathematical narrative must enter the school curriculum in both primary and secondary education. The aim is:
   a. to increase the appeal of the subject,
   b. to give it a sense of intellectual, historical and social relevance and a place in our culture,
   c. to give students a better sense of the scope of the field…” (p.20)

2. “Mathematical narrative must supplement and interact with technical mathematics teaching. But a substantial amount of time now given to technical mathematics…should, according to the age and the level of the students, be taken over by narrative mathematics” (p.20).

3. In the early years of schooling (5-6), “…create storied environments for mathematics, global as well as local, to ease the transition into abstraction.” (p.20)… “Use what storytellers know about good stories and mathematicians about good proofs…to best advantage” (p.21).

4. “Introduce mathematical biography and history in the syllabus…Through the teaching of mathematical biography and history with a paramathematical slant, students can
   a. Identify with the human context of mathematical research and thus be better motivated for learning,
   b. a lot of the relevant technical mathematical material can be integrated in ways which…can smoothen and motivate the transitions, from person to idea to problem to person,
   c. Provide and help students find a context for mathematics and through it a sense of real purpose…

   By integrating biography with the history of mathematics, from a paramathematical viewpoint, as a form of fascinating intellectual history of ideas, the technical knowledge taught to students can acquire a true context…Let us endow through stories, our teaching of mathematics with both the problems that generated it and the goals to which it’s oriented. (pp.22-23).
institutes of mathematics research, research journals, etc.) to the sites of everyday consumption (educational venues, schools, and media/popular culture). The explosion in popularization artifacts and outlets, then, is a perceptible (quantifiable as well as qualitative) change in the configuration of the channels of communication for the flow of mathematical ideas such that, as in other anastomosing vascular networks, individuals (in some societies) are always and everywhere in proximity (in terms of geographical and temporal distance) to some mathematical idea. In this framing, as a cultural phenomenon, an increase in the number of popular culture artifacts is emergent and understandable. What is also predictable, is that these popular communication channels should become better over time at ‘moving’ and ‘stirring up’ mathematical ideas as new forms of institutions arise and new types of mathematical communicators arise.

Following the sequence laid out in Figure 2 an implication for future unfolding conversation(s) among mathematics (as a representative for the disciplines) and popularizations may be towards more ecological, cosmological, mythological, spiritual and mindful approaches to mathematics and mathematics education. One notes for examples several recent examples of these, (e.g. Barton, 2009; Deitel, 2011; Gerofsky, 2011; Renert, 2011) as well as D’Ambrosio’s (2010) challenge directed to the field of ethnomathematics specifically, but also mathematics educators more generally, to engage more fully with a growing mandate, not only to demythologize but, perhaps more importantly in the present moment (and for there to be hope for a future-with-dignity) to remythologize mathematics (education) through “open[ing] space[s] for the complex realit[ies] and…unrestricted imagination[s] resulting from fantastic visionary fiction” (p.16) (see also Khan, 2011).

Caution is also warranted in taking the concept of ‘popularization’ as an unproblematised universal across cultures. For example, that some mathematical puzzles occur in the *Kama Sutra* (see for e.g. Padula, 2005, Williams & Barton, 2003), a text that is popular at this time in some parts of the West, does not make it possible to claim it as an instantiation of mathematics popularization in Indian or Hindu culture in its own time. Nor is it possible here to engage in the substantial debate about what (and consequently who) counts or should count as mathematics (or mathematician) or what it means to ‘do’ mathematics, though these are nevertheless important questions. The perspective I adopt is an evolutionary and ‘anthropocentric’ one in which I view concerns for and interest in ‘popularizing’ mathematics and science not as cultural universals,
but rather as a recursively elaborative coherent discursive structure that has emerged in specific cultures with distinct but inter-related histories at particular times and for particular purposes.

Potential directions for developing and pursuing more novel forms of popularization of mathematics might be inferred by examining the ongoing differentiation of the various ‘markets’ and ‘niches’ for such popularizations. In such an examination, for example, one might encounter the recent erotic film, *Rites of Love and Math*, written by and starring mathematician Edward Frenkel (Graves & Frenkel, 2009). My point in highlighting the Frenkel film is that it illustrates why such artefacts must become objects of sustained attention and inquiry. They present opportunities to engage in critical investigation of the discursive practices and the work that they perform in the genre of popularization of mathematics beyond considerations of novelty and gimmick to get more people to attend to mathematics.

This section can be read as having described an appropriate level of detail to discern some of the shape, design, contours, patterns of the blanket of mathematics popularization as well as some of what lies on the blanket. But this is an insufficient reading. We must also attend to the ground upon which this blanket rests, that which it obscures by its presence.

**Inter-related Issues in Mathematics Popularization**

In some (Western) societies, mathematics, school mathematics in particular, has an image-problem (e.g. Brown, Brown & Bibby, 2008; Nardi & Steward, 2003). It is not well liked. Overwhelmingly, popularisers of mathematics describe one of their main aims as transforming the public perception of mathematics and mathematicians (e.g. Howson & Kahane, 1990b; Stewart, 2006). Such aims are often couched in difficult to argue against logic and language of benefit through better understanding or ability to (democratically) participate in an increasingly mathematically structured or “formatted” (Skovsmose, 1994) world. Steen (1990) for example states that the long term goal of mathematics popularization is to convey the idea of mathematics

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23 The authors quoting Roger Ascham a 16th century educator and tutor to Queen Elizabeth I of England whose description shows early association with some unflattering features of mathematical minds. He writes, “Mark all mathematical heads which be wholly and only bent on these sciences, how solitary they be themselves, how unfit to live with others, how unapt to serve the world” (p.3).

24 Eg. Stewart (2006) uses the by now ubiquitous justification that, “popularization of mathematics also benefits the populace…because we live in an increasingly technological world that cannot function effectively without substantial input from mathematics and mathematicians”. Also Howson and Kahane (1990b) argue that, “…a bad image of mathematics may result in enormous national loss…a good or improved image may prove immensely beneficial to any nation” (p.4).
as an “active, interesting field of significance to society” (p.185) while Stewart (2006) argues that one of the main aims of mathematics popularization is redressing the conception that ‘school mathematics’ is all there is to mathematics. Indeed, Stewart (2006) suggests that the goal of popularization is, “to convey significant ideas from or about mathematics to intelligent, mostly sympathetic non-specialists, in a manner that avoids scaring them silly and exploits whatever interests them” (p.1633). Mathematician and film-maker Michele Emmer for example has suggested that while, “…decrease[s] in the enrolment of maths students doesn’t depend on good popularization…universities are the best place to practise popularization” (quoted in Di Santo, 2007, p.45). That is popularizations will not be sufficient to change enrolment patterns in mathematics, but are necessary and important in university settings.

A substantial part of the literature on mathematics popularizations describes and reports on individual experiments in undergraduate classrooms as many popularisers are also teachers of mathematics at colleges and universities. These experiments have employed a variety of strategies in attempting to make their classes more enjoyable and to improve learning. Greenwald and Nestler (2004a), in the introduction to the first special section of PRIMUS25 devoted to looking at mathematics and popular culture note the motivation to use popular culture among educators to “enhance teaching and learning of mathematics” (p.1) especially for struggling students. Barnes (2007) for example has written a fairy-tale to teach the definitions of real-analysis to undergraduates, Hopkins (2004) has used the Kevin Bacon Game to introduce and explore ideas related to graph theory and Melendez and Williams (2007) have used a modified popular competitive game show environment, Mathematical Idol, in an undergraduate calculus course both to engage students and develop co-operative work habits as well as improved self-regulation of learning. The latter’s outcomes included increased confidence in problem-solving abilities and improved competency in communicating mathematical reasoning26. Greenwald and Nestler (2004b) report on using the rich mathematical content of the animated series, The Simpsons, to encourage mathematical scepticism, to motivate mathematical

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25 PRIMUS = Problems, Resources, and Issues in Undergraduate Mathematics Studies, is “refereed journal devoted to dialogue and exchange of ideas among those interested in teaching undergraduate mathematics” (http://www.tandf.co.uk/journals/titles/10511970.asp) published by Taylor and Francis, 8 times per year.  
26 Hatch and Shiu (1990) identify five elements that they suggest successful popularizations utilizing a workshop format might have in common, namely, an element of choice, occasions for positive affect, activities, opportunities to share and a suitable level of challenge. These sentiments are echoed by Larsen (1990) among others.
explorations and proof and to increase enjoyment. Mortimer and Poland (1990) describe a personal account of a failure to successfully popularize mathematics in the context of an undergraduate course while Hillyard (2007) utilized popular culture artefacts to teach quantitative reasoning to junior-level university students arguing that, “it provides a wealth of opportunities to explore mathematical concepts…[and]is the ideal context for motivating and teaching QR” (p.40).

There exist then at least two explicit dimensions to mathematics popularization as a phenomenon. These we can term its proselytizing function – which refers to the explicit desire to transform public perception and reception of mathematics – and its pedagogic function, in summary, to (p)reach and teach. While ‘fun’, ‘pleasure’, or positive ‘affect’ are essential dimensions for individuals in terms of popularity and learning, van Bendegem (1996) cautions that popular efforts should inspire ‘investigation’ not ‘awe’ of mathematics. Likewise, the study of mathematics popularization artefacts should do more than simply celebrate or condemn/criticize the mathematical ideas presented or the artefact itself. The study of mathematics popularizations requires a polyphonic engagement that attends to the complexity and inter-relatedness of the issues raised by the ideologies and enactments of mathematics popularization itself.

**Education, Entertainment…?**

The (incomplete) set of shifting significations and associations outlined in an earlier section that are evoked when the ‘popular’ is invoked alongside contemporary discussions of the popularization of science and mathematics render readings that construct such popularization projects as unquestionably benign or beneficial, intensely problematic. Popularizations (and popularisers) of science and mathematics participate in ideological, political moral as well as aesthetic economies and ecologies in which the discursive enactments and enchantments of power are necessarily implicated and whose loci of influence run through the medicalization, pathologization, colonization, carceralization and commodification of all spheres of public and private life, including education.

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27 My use of the term “carceralization” is connected to Foucault’s (1997) deployment of the term “carceral” in *Discipline and Punish*.
In this section I raise some issues and concerns that arise from a critical consideration of mathematics popularization as a cultural phenomenon. I do not claim that this presentation is an exhaustive treatment of all of the issues that might arise from the variety of Critical perspectives in education. But that these are relevant to the work in the future chapters of the dissertation.

**Simplification = Distortion?**

I do popularize and simplify, that's my goal...I see my mission as taking ideas that are complicated ideas that reside in the academic world and repackaging them in a way that makes them accessible to a general audience, to everyone else, to people like me...In the process of doing that, do I have to simplify the ideas? Yes, I have to. That's how you bring it to a wider audience -- you have to make some sacrifices along the way (Gladwell, 2011, italics added)

The most frequently raised and debated issue in the literature on PoM (and the Popularization of Science) relates to finding, developing and managing the appropriate tension between adapting the message for the medium and audience, and concerns by mathematicians and mathematics educators with the distortion of mathematical ‘truths’ to such an extent that it might interfere with future learning of mathematics. In other words there is a concern for the quality and accuracy of representations of mathematical cultures. Devlin (1995), for example, advocates that,

[i]n writing for the popular market, you have to be prepared to be loose with the truth – sometimes very loose. You have to paint a big picture using a very broad brush, and to hell with the details and the precision. This requires that you make judgment calls as to how far you can go. The decision you make depends on the audience you are trying to reach (italics added).

The organizers of the ICMI study make a similar point that popularisers, “cannot tell the whole truth, but what they tell should be part of the truth” (Howson & Kahane, 1990b, p.14). Steen (1990) identifies several pitfalls in addition to the concern with distortion in tracing the media flow of a story which he originally reported. He notes, “as the story progressed from mathematically trained writers to generalists, the border between innocuous simplifications and

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28 Claims of distortion in re-presentations meant for a ‘popular’ or mass ‘public’ or ‘audience’ or ‘consumer’ are not restricted to the mathematics popularization literature. Indeed it could be argued that ‘distortion’ or errors in fidelity are inevitable in the translation of any academic/scientific/discursive field to larger audiences than the original (discourse) community for whom it was originally intended. For example in education claims of ‘distortion’ could be made about attempts to ‘translate’, in the sense of ‘move’ from one context to another, literary, cultural and other theory, eg. complexity theory, without sufficient attention to the appropriateness of the translation for the audience, or distortion of what was originally said. To take an analogy derived from topology, a doughnut and a coffee-cup (with a handle) can both be seen as being ‘distortions’ [contortions might be a better word, transformations would be the mathematical one] of a rubber sheet with a single hole through it, i.e. they are topologically equivalent. What I am after in this dissertation then is not really about distortion, the nature of the transformation, but to ask after, using another important and powerful mathematical idea what remains invariant under the deformation of translation?
dangerous distortion was crossed by writers and editors who did not know enough mathematics to understand the story” (p.183). It absolutely matters then which part of the truth is told, how it is told, and by whom. Howson and Kahane (1990b) point out that popularizations should not entail having individuals *unlearn* something that they saw or heard before they can go further.

In addition to care in selecting subject matter when making math-movies, Emmer (1990) emphasizes that the facts and images need to be derived from the same source and that one should “avoid being *over-precise* while still aiming for the right degree of *exactness*” (p.100, italics added). His assumptions are that the audience, similar to Gladwell, is largely ‘lacking’ in elementary mathematical knowledge which will have to be provided but are intelligent and familiar with the language of cinema. However, whether or not the audience has critical cinema literacies is not discussed. He suggests that math movies should not merely be “a lesson with pictures” but should strive to create, “a *new language* that integrates the two ingredients” (p.96, italics added) while maintaining a successful balance between entertainment and information such that one does not dominate the other. Returning to the metaphor introduced in the previous chapter, his is a suggestion for polyphony.

**Stereotypes**

Stereotypical representations are specific types of distortions. Richard Dyer (2002) drawing on Walter Lippman (1956) offers that stereotypes, especially those associated with visual images, function simultaneously as, “(i) an ordering process, (ii) a ‘short cut’, (iii) refer[ence] to the ‘world’, and (iv) express[ions of] our values and beliefs” (p.11). It is this fourth function of stereotypes that most concerns the work in this section. Dyer (2002) elaborates, “[t]he role of stereotypes is to make visible the invisible…and to make fast, firm and separate what is in reality fluid and much closer to the norm than the dominant value system cares to admit” (p.16). In simplifying mathematics for a ‘popular’ audience, popularisers sometimes resort to stereotypes. Such stereotyping however may also come into conflict with another major goal of popularizations, viz. to interrupt and challenge negative stereotypes associated with mathematics and mathematicians.

For example, there has been much concern in the mathematics education community about the stereotypical representations and associations of mathematics and gender. UK researchers Mendick, Moreau and Hollingsworth (2008) in their report on representations of mathematics and mathematicians in popular culture (films, websites, books, radio, television)
examine both how these representations are gendered and how the effects on learners are also
gendered. Their main findings are as follows: that representations of mathematics are both
invisible and ubiquitous in popular culture; that describing something as ‘mathematical’ is
dependent upon who the viewer is, their relationship with mathematics and ability to decode
cultural tropes as well as the context in which the representation occurs; and that the majority of
popular culture texts, despite an emerging corpus of texts featuring women mathematicians,
strongly supported oppositional associations and privileged framings of mathematics with
masculinity, Whiteness, middle-class privilege and heterosexuality.

Arguing from the position that, “popular mathematicians and mathematics can provide a
resource for developing positive relationships with mathematics” (p. iv) for learners, they
recommend that producers of popular culture develop,

more representations of women doing mathematics and particularly more adult women whose abilities are
independent of the men in their lives; representations of women doing mathematics who are classically
attractive, feminine and engaged in heterosexual relationships and of those who are not; a greater diversity
of people doing mathematics, in particular, people from different ethnicities, nationalities, sexualities, ages,
social class backgrounds and with different bodies…[particularly] ones that go against the clichés; a range
of ways of engaging with mathematics happily and successfully, including presenting mathematics as a
hobby…incidental…occupational…so that mathematics can be seen as part of someone’s life rather than as
all consuming; representations…that present it as accessible to all and that do not obscure the mathematics;
and representations of the process of doing mathematics that present effort as part of ability and show the
process as creative and collaborative (p. iv).

They do acknowledge however, the difficulty for many producers and popularisers in attempting
to alter the production of popular culture artefacts given that these are often generated in North
America for a diverse global marketplace.

For practitioners and policymakers in mathematics education Mendick, Moreau and
Hollingsworth (2008) advocate for explicit attention to the question “What is Mathematics?”
within the UK National Curriculum and examination syllabuses as well as changes to teaching
materials and teacher training and development; making mathematics more visible in other
subjects especially in the humanities and social sciences; teaching and assessing mathematics
through activities which remove some of the oppositions; presenting mathematics as a human

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29 Evans, Tsatsaroni and Staub (2007) duplicate this finding in their report of an analysis of advertisements in the
UK press which examined the images of mathematics presented. They found that few advertisements explicitly
contained mathematics. This is part of the invisibility-ubiquity paradox of mathematics.
activity that is subject to politics and individual biography; providing opportunities to present “a range of ways of identifying with mathematics”, “to create space within the curriculum for looking critically at representations of mathematicians in popular culture” (p.v) and to develop pedagogies that utilize popular culture resources.

Greenwald and Thomley (2007) working in a North American context acknowledge that there has been an increase in the number of fictional representations of women mathematicians in film and television. They discuss aspects of how mathematically talented women are represented in Hollywood. They make the important point, which many other researchers, including Mendick et al. above, avoid, namely, that merely decreasing the frequency of negative representations and increasing the quantity of positive, realistic ones will likely result in an increase in students choosing to continue with or pursue mathematics. As Goff and Greenwald (2007) point out whether or not stereotypical representations in popular media actually have an effect on students is yet to be determined. However they fail to take into account the large literature from educational psychology on stereotype threat which provides evidence documenting precisely this effect (e.g. Schmader, Johns & Barquissau, 2004; Spencer, Steele & Quinn, 1999). Indeed, Hillyard (2007) offers cautions about using popular culture in mathematics as it can reinforce stereotypes and myths/beliefs as well as the fact that some students may treat popular culture indifferently or not take it seriously and the fact that what counts as popular culture is not universal.

**Awareness of Medium affordances and audience/genre appropriateness**

The issues of distortion, simplification, reliance on stereotypical representation, or merely (im)‘partial’ truth telling’ arise from the needs to employ different popular media and to account for a greater diversity of audience characteristics and individual motivations than one might typically find in a school, university or college classroom. For example, as Ian Stewart notes, the main concern for individuals seeking to popularize mathematics is audience appropriateness. He notes that “the main pitfall that I have found is not so much negative comments from colleagues, but a serious failure by some mathematicians to appreciate the difference between journalism and writing a math paper for a journal” (in Devlin, 1995, italics added).

This idea of genre suitability is repeated by the majority of popularisers. Stewart notes, for example that one of the first considerations in preparing an article for a newspaper or magazine is actually getting published. Unlike a mathematics journal article, such efforts must
explicitly tell a story, be timely and have ‘a hook’. In short it must utilize the resources and recognizable genre appropriate devices that would make the subject matter palatable to a general audience. As Miller (2009) describes, scientific stories, especially mathematical ones, lack news value: “they usually happen on a small scale; they touch on aspects that are foreign to people’s lives; stories about scientific discoveries are usually not exclusive; their immediate negative or positive impact is not clear; and they are often universal and not local” (p.273), as such, if scientists and mathematicians have an interest in having their work covered by the mass-media, “they must cooperate with the media’s epistemic standards” (p.273). Steen (1990) also notes that many mathematicians do not communicate well with the public, have little experience promoting stories and show little interest in doing so. This may be why individuals like Stewart with journalistic sensibilities stand out. More recently, similar sentiments have been echoed by Orsi (in Di Santo, 2007).

Emmer (2002) has also expressed his belief that some types of popularization attempts – he refers to these as “scientific commercials” (p.121, italics added) – which are “made to illustrate theorems or results of plane geometry or similar topics….are very boring and not very useful, not even for teaching mathematics at any level” (Emmer, 2002, p.121). Further, in a statement addressed directly to those who perhaps over-state the pedagogical usefulness of mathematical films, he notes that often, “[a] film is not the best tool to explain and to learn [mathematics]. A film can, in a short amount of time, give ideas, suggestions, stimuli, emotions. A film can generate interest, even enthusiasm. Looking at an interesting, pleasant film can stimulate the audience to learn more…” (2002, p.125).

Attending to the more overtly political dimension of the work of mathematics popularization Stewart (2006) draws attention to the fact that in the present, “it is not so much the medium as such that is responsible…the responsibility lies with the officials who commission television shows, and the companies who make them” (p.1641, italics added). In particular he is concerned with the replacement of competent and knowledgeable production companies with cheaper ones with the concomitant result of, at times, a lower quality product and the possible impact this might have on the quality and effectiveness of mathematics learning.

The Need for Public Communicators

Dunham (quoted in Devlin, 1995) notes that, “mathematicians must do a better job at reaching out to the wider public” a lamentable fact reiterated more recently by Arnold (2008) but
which requires perhaps a wider and deeper skill set than many mathematicians or mathematics educators possess. Italian researchers Francaviglia et al (2008) address the concern that Stewart and Dunham have raised regarding the producers of mathematics popularizations by proposing the need for developing specialist individual communicators of science and mathematics. They describe such a person as, “an intellectual figure who is not lost in the complexity of Science, of Society and of their growing copenetration…able to…master the fast and evolving means of Mass Communication” (p.268). They also propose a collective “task-force” of such specialists who not only have a profound understanding of the disciplines of mathematical knowledge as well as being capable of “promoting the dissemination of [mathematical culture] with the aid of well-designed and at the same time rigorously constructed and artistically valid multi-media presentations that can attract an audience toward a deeper immersion in the discipline itself” (p.268) – in short mathematical specialists, communicators, designers and marketing experts.

Pauwels (2008), in discussing the development of ‘visual competence’ for scientists and science communicators, argues that, “a serious effort should…be made to provide a unifying framework whereby each contributor should develop a knowledge about and sensitivity for the bigger whole. What they should not do is lock themselves up in their own area of expertise…” (p.160). This is yet another call for inter- and trans-disciplinary work – for polyphony.

Thinking through this proposal further suggests that the preparation of such a task-force requires rethinking the nature and purposes of mathematics education throughout the educational system. It is an attempt at repurposing of the system of school mathematics education/curriculum which extends all the way through universities, albeit one that appears naïve to the political, social, economic, ideological and cultural forces which have dominated its ossification in the 20th century and limited by the many politics of educational transformation. Successful popularization, however, will always involve the complexity of negotiating the polylogical relations and competing agendas among a diverse set of players.

In this context of ‘declaring’ an urgent need for mathematics and scientific communicators, mathematics popularization borrows from justifications derived from mathematics education in situating itself as part of a public service narrative, in which popularisers position themselves as intermediaries between mathematicians – the makers and interpreters of mathematical knowledge – and the lay public – the direct or indirect beneficiaries of this knowledge in much the same way that ‘teachers’ of mathematics continue to be
constructed in the present. An important part of this construction of a climate of crisis is the ongoing framing of ‘popularizations’ as oppositional to ‘school’ mathematics or educational systems. Van Bunge (1996) suggests that perhaps this might be due to a conflict between two seemingly incommensurable positions from which it is posited that “there cannot be two different types of mathematics, both necessarily true” (p.227)

Such oppositional framing however is not unique to popularization of mathematics, but, rather, resonates and participates in complex conversations about the popularization of science more generally. Hilgartner (1990) for example has argued that while the view of a culturally dominant two-stage model of popularization of science is oversimplified, it serves as an important political resource for scientific authorities in public discourse. The dominant view simultaneously constructs the epistemic validity of popular accounts as ‘suspect’ and ‘other to’ ‘genuine’ scientific knowledge and claims sole discretionary propriety to legitimate and thereby regulate the realm of popular representations via the strategic deployment of its authoritative rhetorical power to name some popularizations, ‘appropriate simplifications’ and others ‘distortions’ or ‘degradations’. Hilgartner further notes that “the discretion experts enjoy when simplifying science is a form of power, useful for influencing downstream audiences…” (p.530).

A related dimension to the question of who is doing the popularization and an issue for studies of mathematics popularization that does not seem to have become an object of concern or inquiry as yet as the perception that the most popular popularisers of mathematics are men, mostly of Euro-American descent and indeed one of the cultural motivations of PoM projects is to invite/attract more women and ‘under-represented’ groups to pursue or remain in mathematically rich disciplines (STEM – Science, Technology, Engineering & Mathematics). This is not a conspiracy, but merely another lingering manifestation of the gender and racial inequities in the discipline which have begun to be addressed. One imagines that in due course there may be a much wider diversity of popularisers, especially from previously or currently marginalized groups (ethnicities, genders, orientations etc.).

Advocates and a Climate of Crisis

As hinted at by Stewart, a significant influence on the direction of individual popularization efforts is powerfully placed advocates. Steen (1990), traces a history of

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30 The two stage model posits that scientists first develop ‘genuine scientific knowledge’ following which popularizers generate and disseminate simplified accounts to the public.
31 There is indeed more than a little irony in his claim.
popularization in the United States to an influential former President of the American Mathematical Society (AMS) and Mathematical Association of America (MAA), Saunders MacLane, who believed that the lack of knowledge of mathematics and its value to society was part of the reason that the US mathematics community was finding difficulty securing support for research and education.

Steen notes success in popularizing mathematics in the news media by US mathematicians could be attributed to two features, “a competent professional in place to make the news flow, and an orchestrated climate of crisis to make the media receptive to the news” (p.188, italics added). Steen argues that the public’s concern about the mathematics education of their children (and more generally about ‘competitiveness’ and ‘superiority’) is “the wedge” that is part of orchestrating this climate of crisis.

Consider the case of mathematics and gender research. Forgasz (2008) recalls that mathematics and gender became the ‘sexy’ research issue in mathematics education in the 1970’s following the influential work of Fennema and Sherman, especially their well-known Mathematics Attitudes Scales (1976), which provided a tool which purported to measure student attitudes to mathematics, though, as Gates (2006) describes, gender issues only began to show up in earnest at PME 8 in 1984 and received relatively little attention in ESM or JRME prior to 1985. Perhaps it was the widely reported work of Benbow and Stanley (1980, 1983) in the popular media regarding sex differences favoring males on the SAT-M test of mathematical reasoning abilities among mathematically precocious youth, which generated a template for gender panic discourses, and catalyzed the release of research funding and intensifying activity related to the educational deficit, disenfranchisement or domination of one sex or the other that continues to the present. Such coverage, as Jacobs and Eccles (1985) demonstrated, does influence parental attitudes and public opinion. Additionally, coverage of competing and refutational views to what Apple (2004) might call the “official knowledge” regarding education and gender are usually not as vigorously pursued, promoted or reported on in a timely fashion (Halpern et al., 2007).

In the current context of the increase in the number of artefacts of and venues for mathematics popularization one wonders though whether or not this strategy of orchestrating a climate of crisis has not taken on a life of its own especially in the current attention economy? Indeed, much of popular education discourse, in particular that around STEM, continues to be
framed in the language of one crisis – usually global economic competitiveness, preparedness for the future – or another. Perhaps some attempts at popularization of mathematics should also take some responsibility for the perpetuation of a sense of perilousness, with regards to ‘newsworthy’ items such as the sometimes manufactured crisis of School Mathematics or mathematics education in general. Table 1 in the previous chapter could also be seen as playing into this sense of perilousness, though I have chosen to focus not on a sense of impending danger, but on the problem of the implications of a significant proportion of a population having the common experience of ‘failing’ mathematics at the end of compulsory schooling.

To Market, to Market…

As described above, the motivations underlying mathematics popularization in changing the beliefs, attitudes and values that individuals have about mathematics, mathematicians and learning mathematics as well as keeping persons interested in mathematics beyond their school experiences could be summarized as to (p)reach and teach. The economic dimension of such activity, although tightly (but not exclusively) linked to current understandings of the concept of ‘popular’ is not usually foregrounded. However, as Devlin (1995) notes, there is definitely a market for “accessible expositions of mathematics” a fact borne out by Higginson’s (2006) partial list of the ‘torrent’ of popular, if not accessible, accounts of mathematics and mathematicians’ lives and Arnold’s (2008) somewhat rhetorical question about whether or not the public is hungry for mathematics. In a critical turn, Steen notes that the media often serves their shareholders interests while purporting to serve the public or democratic interests.

In light though of an ongoing context of orchestrated climates of crisis in education in general and mathematics education in particular (see also the description of the situation in the Caribbean in Chapter 1), is it possible that the public really is not ‘hungry’ for Mathematics, as much as for access to the discourse of power and privilege afforded to those who appear to move fluidly in this discourse? Again a further question for investigation is a closer analysis of the actual markets of/for mathematics popularization – who are the consumers of mathematics popularizations and what are their motivations for consumption/participation in that economy?

From Markets to Morals

The close relationship of mathematics with school, and school with children – one of the main/‘target’ audiences for the consumption of mathematics popularization artefacts via, perhaps, parental, societal and governmental ‘buy-in’ or anxiety around some (orchestrated)
climate of educational crisis – raises questions of in/appropriate content. Goff and Greenwald (2007), for example, discuss concerns for educators about presenting drug use and questioning whether or not violent imagery belongs in mathematics. And it is highly unlikely that Frenkel’s film given its explicit marketing as an erotic film would be presented to student in all but an extremely liberal system. It is easy however to argue that such contexts are important for drawing attention to the role that mathematics has played in war, defense and suffering and providing a more ‘realistic’ and ‘complete’ picture of the ‘power’ of mathematics and the responsibilities of mathematicians.

As Van Bendegem (1996) argues it is not mathematics per se that should be the focus of Popularization projects but the cultural entailments of taking mathematics as a “human, societal and cultural phenomenon” (p.216). He offers a critical cultural vision for what the PoM project entails, viz. that it should focus on the relationships between mathematics and other parts and aspects of culture and society at large. It should show developments in art, in religion are related to developments in mathematics…it should be a real-life history including all the human mistakes and failures… (p.227, italics added).

In framing mathematics and mathematics popularization through the lens of human culture, issues of a moral and ethical character arise as an inevitable aspect of human social life. In the ‘long shot’ in which mathematics popularization is framed, they are significant features of the current landscape in which mathematics education is situated. These too are part of the learning of Mathematics. These too should be part of the study of mathematics popularization.

Conclusion

In this chapter I have attended to the discursive construction of a genre of materials that could be called mathematics popularization artefacts as part of situating the film All is Number, within the wider cultural system of the “popularization of the elements of culture” understood most broadly. It has been my intent in this chapter establish a context and situate films like All is Number within a broader context – that of mathematics popularization artefacts – and to present and critically engage with what I perceive to be some aspects of the explicit and implicit philosophies and world-views or, alternatively, discourses and values, present and presented in projects that are described as popularizations of mathematics. The last century has witnessed a shift in conceptions of mathematics popularization from its early days as an interesting secondary for professional mathematicians – always secondary to the primary work of doing real
mathematics – through practitioners being held in deep suspicion as ‘mere’ popularisers, to it being seen as necessary, if not urgent, and perhaps a new form of cultural industry. For some, popularization is an ameliorative aid, an aesthetic and affective supplement to more common anaesthetizing experiences in the teaching and learning of mathematics. While individual learning and change is one locus of concern, almost all popularisers seek effects that involve transformation of attitudes and beliefs of collective populations and of the cultural perception of mathematics.

The “former trickle of publications [which] has become a torrent” (p.137) described by Higginson (2006) as one direction in the “empirical ‘rejuvenation’ of mathematics” (p.135) or what Doxiadis (2003) has labeled “a benign revolution…amazingly, mathematics has suddenly become the subject of storytelling!!!…Like all good revolutions, this one too was started by people outside the establishment, the pariahs, the ex-communicants, and the imported labor” (p.3) could possibly be understood as an inevitable consequence of the activities in ‘the most mathematical century’ and the one in which mathematics education became a popular (and profitable) obsession. The concern and interest in the burgeoning/torrent of mathematical artefacts from different media is perhaps not really extreme or anomalous but rather might be understood as participating in the perpetuation of the meme of a manufactured educational crisis about which we must be concerned or to which we ought to pay attention. The development is perhaps nothing less than the inevitable, but by no means innocuous, consequence of the gaze and concern that fell upon education in the 20th century as the panacea to fix all social ills and to create the ‘good’, ‘free’ and ‘prosperous’ society. That mathematicians and mathematics educators and others are using the diverse forms of popular media for popularising mathematics may be understood in relation to this historical context such that it is easy to frame popular mathematics education as a social good made even more desirable because of its accessibility by the general population.

I have attempted to situate the specific object of analysis – the film All is Number – in relation to some relevant aspects of a specific discourse in which it participates – that of mathematics popularization. Subsequent chapters will offer other framings and re-positionings in relation to other discourses. In the next chapter however, I discuss my analytic frame.
CHAPTER 3: ANALYSING FILM

In this chapter I elaborate a transphenomenal conception of film in setting the stage for the analytic chapters that follow. I describe the methodological approaches that have provided the foundation for the analyses. These include compositional interpretation, anthropological approaches, and ideological analysis. In the final section I lay out the framework for my own reflexivity as an audience member who is simultaneously an insider and outsider with respect to the viewing of the film.

A Transphenomenal Take on Film

In Chapter One, I described film as any deliberately juxtaposed, reproducible sequences of moving images (with or without an accompanying soundtrack) that is (potentially) viewable by audiences and not merely the physical medium produced by chemical processes. There are many other ways to think about film. A non-exhaustive list includes aesthetic, analytic, cognitive, critical, discursive, ideological, semiotic, philosophical (Smith, 2008), psychological, postcolonial and transnational (Sarkar, 2008), pedagogical and technological. These are not mutually exclusive approaches. Theoretical perspectives percolate, bleaching one into another. For example Lau (1991, quoted in Dudley, 2010) approaches film “inter-discursively” as simultaneously text and discourse while Dudley (2010, p.273) adopting a more phenomenological approach compares film to the mind as a form of consciousness and way of experiencing the world. O’Neill and Wayne’s (2007) view of film as praxis, i.e. a means to contest structural inequalities and create opportunities for socially marginalized and excluded individuals and groups through “fostering a critical engagement with the structural and ideological underpinnings of the media in our neoliberal corporatist world” (p.11) is founded on Giroux (2001) who describes film as communicative, pedagogical, and political. Film can also be understood as having mythic elements (Hill, 1992, cited in Dudley, 2010) and as a central element in modern imaginal industries (Bishop, 2008). Each of these ways of thinking of film is influenced by the writer’s purpose, priorities, privilegings, and anticipated audiences.

In Chapter One, I also framed this dissertation as a transdisciplinary study and defined a transphenomenon as forms (structures) or happenings (phenomena) that emerge and can only be understood, albeit still only partially, by considering simultaneously other relevant forms and happenings across multiple levels of organization often emerging in contexts through by the co-actions of social agents. In this section I wish to elaborate upon my earlier description and offer a
more expansive transphenomenal framing of film which addresses the multiple audiences identified earlier with whom this dissertation seeks to dialogue and sets the stage for the type of engagements presented in the analytic and concluding chapters.

To frame film transphenomenally is to begin by acknowledging or deliberately attending to its polysemousness. It is neither simple technology nor static artefact and is entangled with the human and more/other than human world. Enacted, it is simultaneously product and producer of culture. Embodied, it is a type of performative alchemy of science, engineering, art, poetry, anthropology, psychology, literature, drama, theatre, design and myth. Transhistorically, it is progeny and parental contributor to evolving transnational networks and circuits of information, capital, natural resource and human flows that are coeval with the production of waste-lands and wasted lives (Bauman, 2004); like other human-with-media technologies, film is reproductive. However, such reproduction is not static, but adaptive, responsive and situated. As Murray Smith (2008) describes, the history of sound film as a hybrid art form, short as it is, has demonstrated, “considerable stability, adaptability and durability” (p.152). But film is tricky, ‘artful’, – a deliberately deployed deception of our evolved perceptual apparatus that takes advantage of our propensities for simultaneously drawing distinctions, making connections, perceiving continuities and discontinuities, categorical and analogical thinking, and for attaching affective weight(s) to (visual and aural) stimuli that allow for multiple coding and re-coding of experience(s) to create novel narratives and nets of meaning(s). Such a phenomenon necessitates drawing upon work across a variety of disciplines related to the study of images/pictures/visual representations, sound, movement and performance ranging from the individual through the cultural.

There are many theoretical and methodological frameworks for examining film. These range across a constructivist materiality of film as a visual and audio-visual medium to more socio-cultural, socio-constructivist and embodied framings of film as an affective/experiential/sensory medium emergent within a given socio-cultural context and demonstrating political effects. In the next section I describe the relevant methodological approaches upon which I have grounded my analyses.

**Methodological Approaches to Film Analysis**

Different methodologies from different disciplinary traditions concern themselves with visual phenomena at different scales of inquiry. For example, ‘visual competence’ (Müller,
2008) is a concept that emerges out of social scientific approaches concerned with basic research and inter/multi/trans-disciplinary communication while ideological analysis emerges from media studies. Fundamentally though, as (W.E.) Jones (2011) argues, the study of film is an appropriate subject for philosophical inquiry, ethics in particular. Filmic narratives, he argues are, …ethically significant because the narrative (1) manifests an evaluative attitude toward its own characters, events, and context, and (2) encourages the spectator, through the latter’s enjoyment of and satisfaction with the narrative, to adopt a similar attitude” (p.4).

That is to say, films teach something about how to relate to some aspect(s) of the world. The object of analysis in this dissertation is a pedagogic film and one way in which my inquiry can be conceived is as an ethical engagement with it.

One of the ways of attending to a film like All is Number, which emerges from a complexly and multiply-burdened colonial heritage, and one that I attempt to rehearse throughout this dissertation, begins by acknowledging that the film acted as an ethical prompt for me, that is it afforded an occasion to consider the ethical dimensions of the work – what the work might be doing – as well as to engage in a rehearsal of an ethically vigilant mode of dialogical inquiry as enacted in the discursive practices at play throughout this dissertation.

In this dissertation I also work closely with a ‘critical’ approach to ‘visual materials and (visual) culture’ (CVMC) suggested by Rose (2007). Other texts focused on one specific methodology (e.g. Pink, 2007), discussed approaches much more generally (e.g. Burnett, 2004), provided a broad range of source reading materials with little critical discussion of methodological issues (e.g. Mirzoeff, 2002), were more concerned with culture (e.g. Sturken & Cartwright, 2009) or were already ideologically inflected (e.g. Vinson & Ross, 2003). Rose (2007) proposes a framework in which three criteria are used to characterize, to varying degrees, and with different emphases, the different critical approaches to studying visual culture. These criteria are that approaches and visual researchers:

- “take images seriously”;
- “think about the social conditions and effects of visual objects” and
- (researcher-practitioners) reflexively “consider [their] own way[s] of looking at images” (p.12).

According to Rose (2007), CVMC approaches entail thinking, “about the visual in terms of cultural significance, social practices and power relations in which [they are] embedded;
and...about the power relations that *produce*, are *articulated through* and *can be challenged* by ways of seeing and imaging” (p.xv, italics added).

Rose (2007) argues that at the three different sites where the meanings of images are constituted – viz. production, the image itself and the audience (the site of consumption) – three different modalities – the technological, the compositional and the social – are at play. With respect to the technological, following Mirzoeff (1998), Rose (2007) takes a visual technology to be “any form of apparatus designed either to be looked at or to enhance natural vision” while compositionality “refers to the specific material qualities of an image or visual object” and social is used as a “shorthand term...to refer [to]...the range of economic, social and political relations, institutions and practices that surround an image and through which it is seen and used” (p.13).

In considering *All is Number*, I attend almost exclusively to the compositional and the social in the analytic chapters as these are more closely aligned with the goals I identified in Chapter 1, namely to raise *critical* concerns regarding representations of mathematics and mathematicians in visual media; *curricular and pedagogical* concerns regarding the teaching and learning of mathematics from pedagogical film; *political* concerns regarding the work of ideology in attempts at mathematics popularization via the medium of pedagogic film; and to contribute to developing a language and vocabulary for talking about education in the Caribbean. My focus is not on the technological modality as described by Rose (2007); while important such a focus would be outside of the parameters of the goals of this work.

**Compositional Interpretation**

Compositional interpretation is a foundational approach to the interpretation of images which is descended (with modifications) from art history approaches to painting. For Rose this involves a form of engaged looking *at the site of the image itself*, a “visual connoisseurship” which “refuses to be either methodologically or theoretically explicit” (p.35) and which “claims to look at images for ‘what they are’, rather than for...what they do or how they were or are used” (p.36). The compositionality of an image refers to, among others, aspects like its content, colour, spatial organization (positioning, perspective, logic of figuration), light, expressive content and the relations amongst these. In addition to these, how the film is organized spatially, how the film is organized temporally, sound and narrative structure are part of the compositional interpretation for moving images. As a critical visual method (as defined by Rose, 2007) it attends less to the very broad social dimensions of production and interpretation and is not
reflexive on its practices. To the extent that aspects of composition such as spatial organization, mise-en-scène and montage may have something to say about possible effects on a viewer, it can be considered a part of a critical visual methodology, mindful of the fact though that it is reflexively restricted.

The analysis of the pedagogical film *All is Number* reported in subsequent chapters depended upon an extended and engaged period of repeated looking at the images, and listening to the sounds in the film. However, as the goals of this dissertation are explicitly social, my analyses go beyond compositional interpretation to include other methods in which greater emphasis is placed on researcher reflexivity.

**Anthropological Approaches**

A related approach to understanding what people do with visual materials is grounded in those anthropological approaches which emphasise exchange practices as the matrix in and from which human social relations emerge. These approaches take visual materials “less as texts to be decoded…and more as objects with which things are done…”, foregrounding, “the practical mediatory role of visual objects in the social process” and entailing a “careful observation of interactions between people and visual objects” (Rose, 2007, p.217, italics added) based on the perspective that images are simultaneously social and situated, “globally disseminated and locally appropriated” (Pinney, 2003,p.1, cited in Rose, 2007, p.218). According to Rose (2007) these approaches share three characteristics: materiality, performativity, and mobility.

Materiality, performativity and mobility are inter-related concepts in these anthropological approaches. Materiality refers to a methodological practice of treating and working with images as if they were material objects. This entails “paying attention to their specific qualities, their complex sensuality, their materiality: how they look and feel, their shape and volume, weight and texture…it also implies placing photographs in particular geographical locations and in their social and cultural contexts” (Rose, 2007, p.219). This is a more complex and nuanced socio-constructivist perspective than that of traditional compositional interpretation and is closer in practice to the type of analyses presented in subsequent chapters.

Performativity, within this framework, refers to the view that images (as material objects in a world) are not static and stable representations, but are taken to be “compressed

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32 Rose (2007) explains that she considers these approaches to be anthropological because they are all based on “extensive ethnographic fieldwork” (p.221), like anthropology they are concerned with “the materiality of objects” (p.222) and enact a commitment to “learning from elsewhere” (p.222).
performances” (Pinney, 2004, p.8, cited in Rose, 2007, p.220) which become “actualized in a specific moment of use…producing both the object and the sort of person looking at it” (Rose, 2007, p.220) as entangled and differentiated sites of/for meaning-making. At the level of methodological application Rose (2007) notes that, “performative understandings of the co-constitution of image and observer thus demands a fine-grained analysis of how images and people relate to each other in specific times and places, producing each other in particular ways as they do so” (p.220, italics in original). In this work, the primary observer that is being co-constituted with the pedagogical film All is Number is myself. There are inter-related ‘I’s that are produced on each viewing and in the writing of the analysis. However, different readers of this work who have had cause to look at the film under question are likewise co-constituted in their own moments of looking, and likely in ways very different from myself.

The concept of mobility links materiality and performativity and with this linkage a recognition that visual materials have lives and biographies (Rose, 2007). Mobility refers to the fact that visual objects historically, and increasingly so in the interconnected present, are observed/viewed/watched/consumed in sites far removed from their initial production. That is, as material objects, they travel, and in so doing perform themselves (with their viewers) differently in the different spatio-temporal and geo-cultural locations in which they are viewed (or consumed) or, following Thomas (1991, cited in Rose, 2007, p.223) they come to be recontextualized. Recontextualization, Rose notes, “enable[s] the discussion of power relations as they play out through the movement of objects” (p.234). I develop this point in a subsequent chapter.

**Ideological Analysis**

A major concern among critical scholars in the 1980s was that the privileging of information processing approaches of educational psychology to studies of media in educational settings excluded and limited other important dimensions of educational and curricular significance, namely, “the ideological work of constructing meaning, selecting content, setting objectives, and creating contexts for media use” (Ellsworth & Whatley, 1990, p.2). Ideological critiques of educational media, including film, begin from the premise, that, like other media, the forms taken are not neutral and do not merely or unproblematically carry informational or educational content. Rather, as ideological forms they “inflect content with particular meanings”
(Ellsworth & Whatley, 1990, p.3). Through these representations, or failures to represent, they silence or skew, particular interests of particular groups at different times.

The purpose of ideological analysis of educational media then is political in demonstrating how such media construct and serve specific, oft-times normative, powerful interests. Ellsworth and Whatley (1990) note for example that with the exception of textbooks and some pre-packaged curricula, “the ideological work of images in the classroom remains one of the most hidden of the hidden curriculums” (p.1). Further, they identify two common concerns addressed by researchers who attempt ideological analyses of educational media: “How does the use of visual representation in curriculum materials privilege some ways of knowing over others?” and “How do the terms and interest of such privileging relate to the school’s role in society?” (p.3).

Though not couched in the language of ideology critique prevalent in educational or curriculum studies, Stys (2006) clearly articulates some of the same critical concerns for health care education in advocating for the careful selection and inclusion of documentary bioethics films which are applicable to my analysis of this mathematical documentary. He engages with questions such as “who gets to tell these stories?...who do we support in making these films?...[and] how can we determine their different agendas?...[given that] many documentary films are funded by private sources” (p.65) that seek to advance “their own “mission and values (p.65). Indeed, documentary films in general are seen as especially problematic as a genre as they tend to be viewed as more factual and less ideologically laden than fictive re-enactments or even traditional educational films (Rosenstone, 2006, cited in Stoddard, 2009). Viewers may implicitly put more trust in this genre than others.

Ideological analysis is perhaps the main methodological genre of critique that has been applied to the study of visual materials in education. Ellsworth and Whatley (1990) identify ideological analysis, as a type of critical hermeneutic praxis, i.e. a methodology that, “can identify aspects of educational media production and use that must be changed” (p.4). They identify its objective as seeking to, “expose the underlying operations of a text by means of a symptomatic reading, that is, attention to a text’s silences, gaps, and absences...[through] locating and accounting for what is not in a text [more so] than what is actually in it” (p.4). More methodologically explicit they explain that it usually involves, “a commentary on each segment in turn, an analysis of its underlying operations and a signalling of the processes at work.
in individual segments and across the text as a whole” (p.87). However, some analyses may “concentrate on specific moments of the film which are seen as in some sense condensing its ideological processes” (p.87) and then subject these sequences to in-depth analysis” (p.5). Ellsworth (1990) for example discusses the concept of ‘viewing experience’, which is not merely an individual’s subjective or aesthetic experience of watching a film but the total inter-subjective “experience of being addressed by the film in ways that invite [the viewer] to take up particular kinds of physical, social, and ideological involvements in the unfolding of the film’s story or discourse” (p.13).

In subsequent chapters I parse the film All is Number into a number of segments following the main emphases and sharp transitions of the narrative. I attend both to what is presented visually and aurally, as well as what is not presented, in some of these segments in questioning the ideological and pedagogical work of the film. In the next section I address methodological issues related to my status as an audience member who is both inside and outside.

**Audiences**

Visual portrayal is highly contested, and no longer restricted to intended audiences. Any visual published has the potential to be disseminated to audiences in very different cultural contexts who interpret these de-contextualised visuals in very different ways (Müller, 2008, pp.101-102).

The seeing of an image…always takes place in a particular social context that mediates its impact. It also always takes place in a specific location with its own particular practices…These different locations all have their own economies, their own disciplines, their own rules for how their particular type of spectator should behave, including whether and how they should look, and all these affect how a particular image is seen too…These specificities of practice are crucial in understanding how an image has certain effects (Rose, 2007, p.11).

Sturken and Cartwright (2001) argue that “what is important about images is not simply the image itself, but how it is seen by particular spectators who look in particular ways” (cited in Rose, 2007, p.7). Visual materials, such as those in pedagogical film, are intended to be viewed and seen. The ways that different audiences make meaning from visual images in different situations and settings is the focus of audience studies. Moores (1993, cited in Godwin, 2003, p.22) suggests that audiences have typically been conceived as “a ‘mass’ that was passively subject to ideological manipulation or moral decay…(p.5)” in audience reception studies. Such a positioning Godwin (2003) notes is out-dated and argues that in seeking to understand audience
receptions and interpretations of pedagogical film it is becoming necessary to traverse the multimedia-sites where such meanings are produced both in and out of the classroom.

In this dissertation report the researcher comprises the viewing audience. Where and when a film is/was intended to be viewed makes a difference both to the researcher as viewer and the researcher as a member of the different audiences that come into being in these different spaces on screens of varying sizes. For example, sites of film spectatorship/consumption can include, large multiplex cinemas, smaller independently run cinemas, drive-ins, open-air projections, vehicles, living rooms, bedrooms, audio-visual rooms, classrooms and increasingly anywhere on a variety of mobile-media consumption devices. The researcher can be a member of an audience that ranges from several hundred to one and with the ability to re-view across multiple sites, with different audiences, any of the above. It is important that the where and the when of viewership does matter in the analysis that is produced and that aspects of films intended to be viewed in one place-space-time, do not necessarily translate easily or fluidly across these various sites and audiences. In a subsequent chapter I discuss the ways in which I viewed the film.

Rose (2007) notes that, “if…ways of seeing are historically, geographically, culturally and socially specific…then as Mieke Bal (1996) for one has consistently argued, it is necessary to reflect on how you as a critic of visual images are looking” (p.12). This position requires of the visual researcher to ask questions about their own relationship as a member of the intended/imagined audience of the film/image such as “How am I being invited/manipulated/imagined/constructed/taught in and by viewing this particular film as a member or non-member of the producers’ intended audience?” It also allows the researcher to mindfully address epistemological concerns/criticisms related to their insider-ness or outsider-ness in relation to the intended audience. The question of who the intended audience is has been addressed in Chapter 1 and will be revisited in subsequent chapters. However, there are two basic, not mutually-exclusive, relations that the researcher as audience can have with a given film – as an insider or as an outsider.

On Being ‘Inside’

If the researcher is (clearly) part of the intended/imagined audience/consumer or belongs to a culture about which the film is about a concern might be raised as to whether or not the researcher can achieve sufficient ‘distance’, ‘objectivity’, and cognitive and emotional
‘neutrality’ to ‘unbiasedly’ analyse, interpret, and represent the film critically or fair-mindedly. This is a valid concern, though one premised on there being accepted reliable and valid means and standards to characterize sufficient distance, objectivity, neutrality, bias and fairness, and one must be mindful of whenever a researcher perceives that a film is ‘about me’, ‘speaks directly to me’ or ‘my experience’ or the experience of a group/culture to which I belong or claim to have knowledge. Such a feeling of recognition should serve to give one pause to proceed even more mindfully. In addition there is a problematic essentialist dimension to this concern, i.e. the researcher is necessarily like the intended audience in all the ways that are identified or privileged as mattering. Additionally, such a concern assumes that the researcher is a passive receptacle for the meanings intended by the film producers and that the film achieves its intended purposes (whether pedagogical or other) easily and unproblematically. It is also necessary then to be attentive to this possibility and to address it as directly as possible.

What a researcher who recognizes themselves (or is recognized by others) as belonging to the intended/imagined audience offers is their particular *emic* readings and writings, i.e. how the film was received and perceived and re-presented by a member of the intended/imagined audience. Here too there is the need to be mindful and to remind one’s own audiences that one is not claiming to be reading/speaking/writing as the representative for the entire imagined/intended audience – another essentialist danger – but rather if one’s emic interpretations have wider resonances among the imagined/intended audience this may be the result of being able to communicate (consciously or not) some of the nuances and colloquial aspects or culturally specific codes not necessarily (easily or immediately) available to a researcher who is less fluent.

As a perceived member of the intended audience, a researcher may also have some agency to interrupt the view of a homogenous audience and essentialist and singular readings and direct-transmission. They can deliberately choose to read against the F/film grain and subvert some of the F/film-maker’s intentions. What this pre-supposes is the ability of the researcher to fluidly transition among different discourse communities and to successfully communicate using the appropriate rhetorical and genre-coded strategies in each community. Thus there is also an important power dimension to be mindful of in articulating this relationship of the researcher as a member of the intended/imagined audience. Researchers who are so positioned have the potential to reveal the gaps between producer’s intentions and how meaning is made from film because they bring their own knowledge, beliefs, emotions, experiences, ideologies and myths to
the filmic text. In this way they reveal that such filmic texts are not primarily writerly (or
directorly) but also readerly, i.e. meanings are not pre-determined by auteurs, but are
constructed. In the analytic chapters I have attempted to write in this way.

On Being Outside

If however the researcher is positioned or positions themself as NOT being a member of
the intended/imagined audience/consumer/culture then there is a need to mindfully attend to the
following concerns about how this might affect their interpretations and representations. One of
the most important considerations is that of the degree of awareness of ego and ethno-centrism in
one’s analyses, interpretations and representations. That is, that the categories and strategies one
uses in performing an analysis, in interpreting and in representing are always filtered through the
categories and strategies that one has become conditioned to take for granted or as givens. This
can be extremely problematic for example in renderings of any species of otherness including
race, ethnicity, sex, gender and dis/ability etc. There are also the attendant dangers of
misrepresenting, over-simplifying, romanticizing, idealizing, or its converse, demonizing,
natalizing, neutering, negating etc. There is also the need to come to terms with the possibility of
not being able to appreciate certain nuances, inflections, and coded meanings of metaphors,
analogies, stories and images in particular.

In the now transnational globalized flows of media including F/film and individuals there
is a very high likelihood that one will encounter many filmic texts as both insider and outsider.
Thus it may be necessary to attend to all of the questions and concerns raised above. This is not
an easy task. One has to be continually called back, to continuously call one’s self back, to reign
in one’s conditioned impulses and tendencies, even as one necessarily loosen the strictures on
what can/not be thought and follow some lines of flight. That is the need to be reflexive.

Reflexivity is expected of all critical researchers but as Trinh Minh-ha (1994, 439-440,
cited in Holliday, 2000) has cautioned,

whether reflexivity and multivocality contribute anything to ethnography or not would have to depend on
the way they are practiced…If it reduced to a form of mere breast beating or self-criticism for further
improvement, it certainly does not lead us very far…if the tools are dealt with so as to further the
production of anthropological knowledge, or to find a better solution for anthropology as a discipline, then
what is achieved is either a refinement in the pseudoscience of appropriating Otherness or a mere stir
within the frame (p.507).
That is to say, somewhat ironically, reflexivity can be deployed without deep sensitivity to its broader effects and awareness of values.

Human choices depend very clearly on what we value (Montague, 2006), i.e. it is our valuation networks which allow a complex system to “care” by embedding “meaning” in the form of goals, some of which are explicitly available, articulable, and representable to consciousness and others which are not. Not all choices have equal value and one is constrained in one way or another to have to make a choice. Which methodologies one chooses to be engaged with is thus very much related to what one values i.e. the weighted (social, cognitive, affective, psychological, economic, identity etc.) costs of those values and choices and the dynamics of their variability and perceived relevance in/to a given situation. A researcher really can never write with full consciousness of how his/her biases, prejudices and systems of valuation might be influencing the work. With time however a researcher can become more and more mindful, attentive to particular biases, and habits of mind, styles of rhetoric, linguistic preferences etc. and deliberately try to interrupt these – but even in such a case biases and preferences are at work. Acknowledging the bias that one is aware of in one’s work and writing does not make the work more suspect but attunes a researcher-scholar as to things of which to be (more) attentive. I attend to these in a subsequent chapter.

**Conclusion**

…the most exciting, startling and perceptive critics of visual images don’t in the end depend entirely on sound methodology. I think. They also depend on the pleasure, thrills, fascination, wonder, fear of revulsion of the person looking at the images and then writing about them. Successful interpretation depends on a passionate engagement with what you see (Rose, 2007, p.xvi).

Rose’s (2007) advice in the epigraph above is a reminder for critical visual researchers that the work of visual analysis is not always methodologically explicit. However, she notes that, “[p]recisely because images matter, because they are powerful and seductive, it is necessary to consider them critically. Whatever method you choose to use, make sure that your account acknowledges the differentiated effects of both an image’s way[s] of seeing and your own” (p.262, italics added). In the analytic chapters I have tried to be sensitive to this mandate to attend to and account for what is present in the film, i.e. what is there as well as what and how I read what is there (and what is not).
So, where does the critical researcher of visual materials, including pedagogical film begin? Aesthetic arousal, curiosity, and engagement form the initial conditions for my interpretation of the film. Other criteria that I have relied upon include the need for grounding and justification that are attentive to the multi-situatedness and partiality; and address the inter-relationships of representations, ideology, and knowledge/power.

In the next chapter I ‘zoom in’ for a close-up on the film, *All is Number*, its producers and some more about the context or discursive ecologies of its production.
CHAPTER 4: A SYNOPSIS OF All is Number

In Chapter 2 I attempted to situate the artefact with which I engage, the short film All is Number, in a wider discursive field, that of mathematics popularization. I identified a number of inter-related issues that are attendant with the field of mathematics popularization. In Chapter 3 I explained my take on film as a transphenomenon and discussed the ground for my analyses. In this chapter, I ‘zoom in’ on the artefact itself and present a visual and narrative synopsis of the film. I note that in performing this ‘translation’ from an audio-visual medium to a visual narrative there is significant data loss, in particular the loss of an entire dimension of aesthetic experience – the aural realm and consequently of the inflections and intonations of the Caribbean accents of the narrators, the background sounds of the natural environment, and the musical soundtrack that accompanies some of the scenes. In addition, I acknowledge that there are justifiable concerns regarding the apparent fixity of the images and texts. The translation from moving picture to static images and accompanying narrative transcription can be considered a preliminary act of compositional interpretation in presenting certain images ‘as is’.

In the first section I give a brief background to the film and its producers. In the subsequent section I describe the rationale and partitioning strategy adopted. This is then followed by a word-for-word transcription of the utterances and statements used in the film which are supplemented with screen captures from the appropriate scenes. I consider both of these strategies and the various representations – a bar-graph, the narrative synopsis and the visual and verbal transcription – as rehearsals of/for the analysis which follows in subsequent chapters.

Background to Film & Producers

The Campus Events Calendar (2010) of the University of the West Indies, St. Augustine describes the film All is Number as

the second in a series of local science documentaries …produced by The University of the West Indies…[which] reveals the myriad elements in the region that appear to have little to do with Mathematics, but are, in fact, highly influenced by the field.

The producers of the film are Dr. Shirin Haque and Prof. Leo Moseley both affiliated with the University of the West Indies. In addition to Haque and Moseley, the film features members of the University community. The film was directed by Mr. Terry Sampson and funded by the Peter Moores Barbados Trust. The film premiered on Sunday 21st March, 2010 on the Carib Vision
channel and was aired repeatedly across the Caribbean and North America for the following year (Campus Events Calendar, 2010).

*All is Number* is the second documentary that Haque, a physicist, and recipient of the UWI Guardian Life Premium Teaching Award in 2002, the Distinguished Teacher Award from the Association of Atlantic Universities in 2004, and the Vice Chancellor’s Award for Excellence in Teaching in 2005 (Pelican, 2010) has produced, the first being *Adventures in Discovery*. In an interview with UWI Today (2010), a print and electronic publication of the Marketing and Communications Office of the St. Augustine campus, she is reported as describing the film as a “math appetizer”. In describing her motivation for pursuing the production of regional science documentaries, she is reported as saying,

> I have a real passion for science and television – together they are a potent combination to ignite the spark for spreading the good work of our science and our scientists. The Caribbean is known for its beaches and Carnival and Nobel Laureates in literature, but science had a gaping hole. I wanted to celebrate the spectrum of our scientists and their work. My strongest message was that *it was all fun and an adventure* (UWI Today, 2010, italics added).

Haque, the chief narrator of *All is Number*, gives a background to how the film came to be, noting that,

The folks at UWI Cave Hill Campus, Barbados, were delighted at “Adventures in Discovery” and had supported it financially to include a segment on science in Barbados (“Caves and Canes”)
The proposal for a feature on Mathematics came from Prof. Leo Moseley of Cave Hill, who is a co-producer on this one, and he was instrumental in obtaining the major funding from the Peter Moores Trust in Barbados. Terry and I took it from there, developing the story line and treatment and doing all the research. This one was a year in the making…and you must realize it was two persons doing it all part time!

She also identifies some of the major challenges in such an endeavour as time and funding and acknowledges the importance of the (former) campus Principal, Dr. Bhoendradatt Tewarie, “for taking a chance on us; and the continuing support of the Vice Chancellor, Principal and Dean” given that they started with “a wild card of an idea and a passion, with zero dollars, zero experience…” She identifies the target audience for the film as being the “general public and in particular at the level of High School and above” and states that, “[t]his feature is particularly suited for high schools and the Ministry of Education in Barbados has indicated that they would like to have both features in all their schools” (UWI Today, 2010).
In her own words, Haque summarizes what she sees the film *All is Number* as being about:

It takes the viewer on a journey into the world of mathematics through the lesser beaten path, and brings home the point that mathematics is all around us in things we do everyday that we are not consciously aware of…We show the role of mathematics in nature, the environment, electronics, climatology, medicine, music, architecture, art, economics, highlighting new areas of mathematics like fractals and chaos theory. We show how numbers are in all kinds of patterns everywhere. I could have produced an entire feature on each aspect alone. But this is an appetizer to the wonderful world of mathematics (UWI Today, 2010).

**Partitioning Strategy**

Following the description presented in the last chapter by Ellsworth and Whatley (1990) of what ideological analysis of audio-visual materials like film might methodologically entail, in this section I describe the partitioning strategy I employed in sectioning the film as it related to the subsequent analysis of the film. I acknowledge that other partitionings of the film are possible with the consequence that other analyses and conclusions could be drawn. My interpretations are based on this particular partitioning strategy and I make no claims as to the applicability of this analysis to any other partitioning. Although it is possible for this film to be watched ‘out-of-sequence’ in a classroom or personal computer environment, the partitioning sequence I adopt follows the temporal unfolding of the film as this was the way that I first encountered the film online and on television. In addition, this viewing strategy which mirrors the actual presentation of the film is based on the belief that the specific narrative sequence in the film is meant to communicate something in particular. The pedagogical dimension of the film is related to this sequence and it is this that is my focus in this dissertation. Finally, although I do not concern myself at present with how teachers and students actually use the film in teaching in real classrooms, or elsewhere, it is not unreasonable to expect that a first viewing will likely follow the film’s arc from beginning to end.

After repeated viewings (at least 7 complete viewings) I partitioned the film into 15 segments. This partitioning is not arbitrary. Some sections like the funding notification, the title and credits are standard parts of films and documentaries. The content sections of the film were determined based on the perceived function (e.g. introduction, summary) or main mathematical idea (e.g. Fractals, Chaos, Math and Business etc.). A greater number of partitions is possible using, for example, individual scene changes (at least 70) with the upper limit determined by the
number of frames in a frame-by-frame-analysis. However as I am more interested in the narrative and discursive content of these scenes than these individual scene changes, I felt that partitioning this already short film into a greater number of parts would result in too large a set of elements at an inappropriate grain size for the type of ideological and discourse analysis that I employ here. Fewer partitions are also possible by combining some of the thematic sections I have identified into longer units. Thus for example, sponsorship and the title sequence could be combined; the Blake opening sequence and Pythagoras the discussion of which all occur on a beach; Fractals, Chaos and Climatology which share thematic threads and the segments on the Golden Ratio, Music and Harmony which share the theme of ratio, proportion and aesthetic value. The middle-range grain size I have chosen however has the consequence that no segment is longer than three minutes and none is shorter than 14 seconds. This allows for decomposition to consider individual scene changes within a given segment while facilitating cross-segment analysis in order to consider larger themes and continuity of ideas.

The figure below illustrates the structure of the film through the specific partitioning strategy that I have adopted.

![Bar Chart](image)

**Figure 3:** Graphical depiction of temporal duration of film segments in seconds. All durations are plus or minus one second.
Narrative and Visual Synopsis of *All is Number*

In this section I offer a representation of the film through my partitioning of it into a series of segments as described in the previous section. I have transcribed the verbal content of each segment and have attempted to give a sense of the what the salient on-screen images are, their duration, and the transitions from one scene to another that serves to illustrate the ongoing narration of the mathematical content through the selection of a set idiosyncratic screen captures. For example although segments 1 and 2, Sponsors and Title respectively, are approximately of the same duration, the first is represented by only two screen captures, while the latter is represented by six. This is as a consequence of the latter segment being more visually complex in terms of the use of effects and transitions.

<table>
<thead>
<tr>
<th>Segment</th>
<th>Time</th>
<th>Narration</th>
<th>Screen Captures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Sponsors</td>
<td>0:15s</td>
<td><em>Unknown Narrator:</em> “Major funding for this project has been provided by the Peter Moores Barbados Trust and additional funding from the University of the West Indies.”</td>
<td></td>
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<tr>
<td>2 Title</td>
<td>0:14s</td>
<td><em>SH:</em> “To see a world in a grain of sand and a heaven in a wild flower”</td>
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<tr>
<td>3 Opening: Blake</td>
<td>0:20s</td>
<td>“To hold infinity in the palm of your hand and eternity in an hour. William Blake could have been writing about the myriad of things in the universe that at its heart and soul are described by mathematics” [End with sound of waves crashing/surf.]</td>
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<tr>
<td>Segment</td>
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<tr>
<td>4</td>
<td>0:46s</td>
<td>SH: “It was well over two thousand years ago that the Greek mathematician Pythagoras showed that in any right-angled triangle, the square of this side plus the square of this side, gives you the square of the hypotenuse.</td>
<td><img src="image1" alt="Screen Captures" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indeed, we could not get through school without having been taught that.</td>
<td><img src="image2" alt="Screen Captures" /></td>
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<td></td>
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<td>Pythagoras is known as the father of numbers. He led a school of thought that believed that all things around us could be explained and understood by mathematics, or as he so elegantly put it, All is Number.</td>
<td><img src="image3" alt="Screen Captures" /></td>
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<tr>
<td></td>
<td></td>
<td>Join me, on a journey, as we discover that mathematics is the heart and soul of all things around us, even when we least suspect it.</td>
<td><img src="image4" alt="Screen Captures" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LM: “All science depends, very heavily on mathematics, which is the language of Science.</td>
<td><img src="image5" alt="Screen Captures" /></td>
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<td>Segment</td>
<td>Time</td>
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<tr>
<td>Mathematics</td>
<td>0:50s</td>
<td>Now you may think that as a Biologist you do not need that much mathematics, but when you think of the sophisticated statistics used by biologists as they examine the natural world, then you will see perhaps that you have a quality of mathematics which is beyond many other people.</td>
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<td>Even in Social Sciences where they tend to think of themselves as somehow different they depend very heavily on graphs and analysis of graphs which is of course mathematics. Everywhere we go there is mathematics.”</td>
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<tr>
<td>Fractals</td>
<td>2:35</td>
<td><strong>SH:</strong> “Clouds are not spheres, mountains are not cones, coastlines are not circles and bark is not smooth, nor does lightening travel in a straight line.”These are the words of Mandelbrot, the man who discovered the geometry to describe such complex patterns known as Fractals.</td>
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<td><strong>LM:</strong> “At first, I should try to explain in a very superficial fashion, exactly what a fractal is. Everyone knows that a line is one-dimensional, and that a plane is two-dimensional, a cube or a sphere, three dimensional, and so on. But what many people do not realize is that there are objects which have a dimensionality between 1 and 2, and between 2 and 3. They have what is called a fractal dimension. Which may be 1.6, 1.4, 2.3 or anything like that. A prime and simple example of that is a coastline.”</td>
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|               |      | **SH:** “A fundamental question is, “How long is a coastline?” Well? The answer depends on the measurement stick used. If we look at the coastline of Barbados, a metre stick will give you a shorter length, than if you use a string which can allow you to go around every stone and pebble. The more you increase the accuracy of
<table>
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<th>Narration</th>
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<td>your measurement, the longer your distance becomes. This is a property of fractals. Fractals are figures with an infinite amount of detail. The more detail you measure, the size increases. There is structure at all scales.</td>
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<tr>
<td>LM: “Trees, leaves, all of these things have fractal characteristics. The characteristic of what is called self-similarity.”</td>
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<tr>
<td>SH: Self-similarity is easy to see in a tree, where at every scale you look, the pattern repeats itself, from the spreading veins in the leaf to the branching of the whole tree.</td>
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<td>SH: Dr. Donna Commissiong is a mathematician at the University of the West Indies who brings a little order to the world using Chaos Theory.</td>
<td>2:07</td>
<td>DC: Chaos Theory is what I like to talk about, it’s a relatively young science, and it’s the study of things that are not predictable. Things that might seem to be random, but there is some sort of pattern in it. Things that if you change the initial conditions slightly, the outcome could be greatly different from what you would expect. This is why it’s a relatively young science. Chaos is something that is not understood, but is necessary to be understood for certain things that might even occur in the human body.</td>
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<tr>
<td>Donna Commissiong &amp; Chaos</td>
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<td>The heartbeat. People with chaotic heartbeats, often find themselves in hospital and the doctors have to try to understand what to do to make the heartbeat more regular. So chaotic</td>
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patterns in the brain is also important in order to understand what is happening inside of the brain you think that there are these alpha patterns that can be captured by a person who is resting, can you imagine what would happen with a person who is alive, and well and …?

So, there are many things that need to be understood and are not yet understood by these conventional laws of mathematics. And Chaos Theory, for that reason, is very, interesting, young and unexplored science.

*SH: “An interesting application of Chaos Theory is the butterfly effect.”*

*DC: “The butterfly-effect is quite a famous example. If a butterfly flaps its wings, the air-pressure around the wings could change, just minimally, but that minimal change, as we said before, Chaos Theory deals with the way that a pattern could change tremendously, based on a small change in initial conditions.”*

Well if a butterfly flaps its wings you can imagine that the pressure change might later generate a hurricane in some other part of the planet.

*SH: Mathematics is used even in Climatology. Adrian Trotman is a researcher at the Caribbean Institute of Meteorology and hydrology whose work relies heavily on statistics.*

*AT: One of our tasks in this section is to be able to develop a number of climatological products which can be used across multiple sectors- water resources, agriculture, biodiversity, ecosystems, you name it. And these products that are developed, because of the nature of Climatology, which is the Statistics of weather. Essentially we are fitting distributions, for*
example normal distribution, gamma distributions to try to better understand and to better show to others and those in those sectors how the weather is operating. How is it developing trends, frequencies of occurrences, all this is important information for people in these sectors so that they can plan, so they can develop strategy and so on.

DC: As an applied mathematician I can attest to the fact that mathematics is used in many different fields, many different avenues, in many disciplines. And it’s necessary, because in order to understand any process that repeats itself, or not just repeats itself, that has a pattern, or evolves in a certain way, you must understand first, or be able to build a model that would help you to understand or predict what would happen in the future. So anything that has predictability or needs to be accounted for or needs to be added up or estimated in any way would require mathematics. So it’s a very versatile field and there are many avenues for research and future development.

SH: I’d like to get that one….Thank You. [This is the only scene in which there is a potential for dialogue…the whole film is direct speech to the viewer]. Making sure you get the right change is certainly mathematics. But it goes much deeper than that. Mathematics is a powerful tool in understanding the world of business.

BT: “To manage the outcome of profitability in your favour it means you have to manage everything else, and that depends on mathematics, it depends on numbers. It depends on targets, it depends on having numbers to let you know, as markers, how well you are progressing or how badly you’re doing. If you’re dealing with sales, numbers are important. If you’re dealing with marketing, targets and numbers are important. If you’re dealing with productivity,
numbers are important to measure productivity. So in business, numbers are fundamental. They are basic and everything depends uh in Business on your appreciation of the value and significance of numbers, because as they say in business, you can only manage what you can measure.

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<th>Segment</th>
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<tr>
<td>Zero and One</td>
<td>2:15</td>
<td>SH: It has always been easier for humans to represent that which they can see over what they cannot. Like right here I have one stone. And if I get another one I have two stones. Two stones take away one stone, leaves one. And one take away one leaves none. But how is that any different from having no fruits or no leaves? That concept was so difficult that it took humans centuries to be able to grapple with it and to be able to represent it. Or as the Greeks said, “how could nothing be something”? Today we know that can be represented by the zero.</td>
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<td>SH: The simplest number scale therefore can consist of zeroes and ones. The Binary scale. This is the language of our high-tech world of information technology and communication. All the manipulation that is needed is for a one to represent an ON state and a zero to represent an OFF state.</td>
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<td>Using these two bits of logic the most complex engineering design can be built using digital electronics. [Music]</td>
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“Numbers, numbers, they are everywhere.”

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<tr>
<td><strong>11 Fibonacci &amp; The Golden Ratio</strong></td>
<td>1:57</td>
<td>SH: Starting with a zero and one, each new number in the series is simply the sum of the two before it. We have just built the set of magic numbers known as the Fibonacci Series. We never have to look far to see these numbers in nature. The magic number five is a favourite with flowers and plants.</td>
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<td>If you divide each Fibonacci number by the previous one in the series they all converge to the ratio one point six. This number is known as the Golden Ratio and is used in architecture and art due to its pleasing sense of balance. The Parthenon in Athens and structures such as the Pentagon and Washington Monument all utilise this Golden Ratio.</td>
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<td>Even some well known faces.</td>
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<td>If a rectangle with the ratio of the sides equal to 1.6 has a section which is a square removed, the remaining figure has the same golden ratio. This can be repeated numerous times and when the opposite ends of the square are connected one of nature’s favourite forms emerges - the spiral.</td>
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<td>The sunflower is a striking example of this. The seeds appear to be spiraling outwards. Nature has found an optimum packing method using numbers. Pine-cones, ginger-lilies all exhibit this pattern.</td>
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<td>SH: The harmony of music is based in mathematics. When the notes are in</td>
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<tr>
<td>12 Music &amp; Harmony</td>
<td>1:34</td>
<td>certain ratios music becomes a delightful sensation, rhythm and pitch are born. Noise is a mixture of many different frequencies at the same time with no clear pattern.</td>
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<td><em>It was Pythagoras who noted the sound of a hammer on a metal produced pleasant and discordant sounds. He discovered that when their masses were simple ratios like 2 to 1, or 4 to 1, then the notes were in harmony.</em></td>
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<td><em>The ancients produced wind and string instruments with the spacing of the holes and lengths of the strings in exact mathematical proportions. The tone that is produced by a vibrating string depends on its length. [Harp music]</em></td>
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<td><em>Tuning a guitar is nothing more than adjusting the tension in the string with mathematical precision.</em></td>
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<td>13 Musical Review</td>
<td>0:36s</td>
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<tr>
<td>14 Closing Statement</td>
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<td>SH: The beauty of mathematics is that it does not matter if you are at a river’s edge on a Caribbean island or the far-reaches of outer-space. It does not depend on a place or time a people of culture. It is universal in its relevance. It describes that which we can and cannot see, choreographs the dance of</td>
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the atoms on the tiniest scales while describing the universe on the grandest scales. Nature speaks and if we listen carefully enough it speaks mathematics.

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<tr>
<td>15 Credits</td>
<td>1:07</td>
<td>the atoms on the tiniest scales while describing the universe on the grandest scales. Nature speaks and if we listen carefully enough it speaks mathematics.</td>
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Throughout: SH = Shirin Haque ; LM = Leo Moseley

Table 2: Visual and narrative synopsis of All is Number (© 2010, The University of the West Indies, images used throughout dissertation with permission of Dr. Shirin Haque.)

In the opening chapter I noted that popular mathematical artefacts are seldom given any degree of prolonged and critical scrutiny. In this dissertation I attend very closely to a single artefact of mathematics popularization, the film All is Number. The question of whether the film is deserving of, or warrants, such prolonged and sustained engagement is important. In the domain of pedagogic film such a warrant must extend beyond simple evaluative aesthetic criteria such as ‘good’ and ‘bad’, entertaining or dull. I justify my attention to this artefact based on its explicit address to ‘school’ age audiences and its declared pedagogic intent. As noted above the film is likely to be used in classrooms in the Caribbean, and has been selected by the Barbados Ministry of Education for distribution to their schools. It is, by the delimitation offered in the opening chapter, precisely a pedagogic film.

In chapter 2 I identified several inter-related issues that accompany the discourse of mathematics popularization. These include the issues of distortion – which arise as a result of the need to ‘simplify’ for a diverse audience, and the requirements of genre and audience appropriateness; the related issue of stereotypical presentations of mathematics and mathematicians; the role of powerfully placed advocates; the orchestration of a climate of crisis;
the economic or market milieu in which popularizations are enmeshed; and the issue of ethics. I intend to argue throughout the remainder of this dissertation that all of these are at work/play in this film.

This chapter can be thought of as having ‘set some of the main characters on the stage’ for the next rehearsal. These characters include the human and ‘non-human’ mathematical subjects. The visible human subjects are, Dr. Haque, Prof. Moseley, Dr. Commissiong, Mr. Trotman, Dr. Tewarie, the vendor, the Harpist, and the guitarist, as well as those mentioned in the film’s credits. In addition there is an invisible/inaudible human subject – the imagined audience for the film. The ‘non-human’ mathematical subjects that are explicitly presented in the film include topics that range across the binary number system, Chaos Theory, Fibonacci, Fractals, the Golden Ratio, harmonic ratios, numbers, Pythagoras theorem, series, and zero. Geographical settings and features of the physical environments as well as sponsoring institutions are also included in the category of non-human mathematical subjects in this film. The final character is Discourse – the ‘greater than the sum of its parts’ phenomenon that emerges from the interactions and utterances of all of the other players. The set of inter-related issues that I have identified in a previous chapter that attend mathematics popularizations constitute a part of the Discourse of mathematics popularization.

In the next chapter I examine some aspects of the mathematical discourse in the film through a consideration of how mathematics and mathematical authority are represented.
CHAPTER 5: REPRESENTATIONS OF MATHEMATICS

In this chapter which is divided into two parts, I attend to specific moments, utterances and visual elements in the film All is Number. In part one I critically engage with the question of how mathematics is represented in this film. Specifically I attend to the ways in which mathematical authority is represented and constructed in the film and how this authority interacts with the other modalities through which mathematics is represented in the film. In part two I draw upon use Ellsworth’s (2005) notion of an anomalous place of learning in elaborating the discussions in part one, viz. representations in the film.

A Grain of Sand

Shirin Haque: “To see a world in a grain of sand and a heaven in a wild flower. To hold infinity in the palm of your hand and eternity in an hour. William Blake could have been writing about the myriad of things in the universe that at its heart and soul are described by mathematics.”

The images and narrated text above serve as the visual and aural introduction to the film after the funding notifications and title animation. This opening scene sets the stage for the remainder of the film. The one-to-one correspondences of the juxtaposed Caribbean image and the Romantic poet’s ideas (sand : beach; wildflower : Lantana sp.; infinity/eternity/hour : sunset) serve to ‘bridge’ or permit ‘passage’ between/among worlds. One bridge connects the historical colonial relationship of the (Anglophone) Caribbean and England. Another bridge connects poetic imagery/imagination and mathematics, or more broadly the two disciplinary cultures of the Humanities and the (‘Natural’) Sciences (Snow, 1963). Only the latter bridge however is part of the explicit itinerary of the film as it works to address its imagined audiences, which range from high school students and above, to the general public, by showing that ‘mathematical’ ideas do not only occur in classrooms, blackboards and textbooks, but also, “that mathematics is all around us in things we do everyday that we are not consciously aware of... in nature, the environment, electronics, climatology, medicine, music, architecture, art, economics...” (Haque, UWI Today, 2010). With this in mind, the opening sequence juxtaposing Blake’s poetry with Caribbean imagery of sun, sea, sand and natural beauty is an appropriate anchor for the film’s
overarching messages of the ubiquity of mathematics in one’s environment and a relationship between sciences and the humanities.

What other meanings and readings though, might one offer about this opening sequence? Consider for example the way that the quotation from Blake is appropriated, unmoored from its location within the larger body of work from which it is derived. Indeed, in mathematical domains, especially those that rely upon ideas of infinity, recursivity, chaos, fractals and complexity, this particular quote has become a cliché. The quotation is frequently invoked as a descriptive metaphor for complexivist sensibilities and sensitivities that seek to attend to the fractal unfolding and expanding space of possibilities, the potentials of worlds within and without. It is often used in this disembodied, disconnected form to celebrate complexity, the fertility and fecundity of the mathematical imagination and seemingly innate and unreasonable effectiveness of mathematics to describe every aspect of the universe. So satiated, I have found no instance thus far where, when used as an analogy for mathematical concepts, readers are encouraged to seek out the source and to engage with the remainder of the original poem, *Auguries of Innocence*, in which Blake criticizes the injustice and suffering that are socially constructed through violence, oppression, and thoughtlessness. Blake, in couplets such as,

“A robin redbreast in a cage / Puts all heaven in a rage,”

“A skylark wounded in the wing, / A cherubim does cease to sing”

implicates the pain, suffering, confinement and vulnerability of individual and collective biological bodies with social activities and points to the outrage felt/sensed/embodied at the level of the more than-human world. The poem, taken in its entirety, suggests that for Blake, it is these confined and wounded bodies, the spectral presences of the robin and the skylark, that are like the ubiquitous grains of sand to which the poet would ask us to attend more carefully and towards which he asks us to orient our consciousness in order that we might recognize the sort of worlds that bodies live within and understand how this comes to be through the complex interplay of the worlds without, in which we are complicit. While Blake ‘could’ have been writing about things that “at its heart and soul are described by mathematics” as a matter of historical fact he was not – at least not directly – unless the implication that mathematics is involved in the caging and confinement of nature, slavery and impoverishment are also allowed.

Now consider who the intended and imagined audience might be for this poetic utterance. The English Romantic poet William Blake and his work are unlikely to be familiar except
perhaps to a small minority of High School students in the Caribbean. Thus the deliberate choice by the film-makers to begin with this particular excerpt of this particular poem suggests that it is directed to a different audience – perhaps a more general viewer – one who is more likely to be familiar with English Romantic poetry. The argument could be made that this excerpt functions to introduce students to a poet they might not have otherwise encountered in their education – as I suggested earlier – thereby demonstrating a historical and contemporaneous connection between England and the Caribbean. This could be considered a fair and justified rationale for its inclusion in a pedagogic film of this nature.

Consider for a moment however an alternative opening quotation which might begin not with English Romantic poetry, but perhaps with a Caribbean poet, musician, or lyrical artist. This imagined alternative is not an argument for ethnocentrism or playing into stereotypes and worn tropes about the Caribbean, but one that acknowledges the broad and diverse socio-cultural milieu in which education takes place in the (Anglophone) Caribbean and in which Caribbean High School students, without seeking or attempting to imagine some prototypical, idealized or generalized school-age child, are enmeshed. It is however an argument that asks academic scholars, especially those who would also be producers or disseminators of popular culture and pedagogical artefacts, in particular pedagogical film, to be more broadly attentive to the sticky resonances in their work. It is also an argument for a greater degree of inter-disciplinary dialogue and conversation within the community of Caribbean scholars.

Now, to begin with an excerpt from a regional author that is perhaps as unfamiliar as Blake’s is to some audience members, is to court the well-rehearsed criticism of some of being elitist, i.e. of wanting to demonstrate one’s erudition and scholastic prowess by drawing upon somewhat obscure or less well-known works. On the other hand, it is also a way to demonstrate that ideas and analogies like Blake’s have also found expression in poetic language of the Caribbean. So then, just as this film seeks to introduce the idea that elements and personalities within the Caribbean might also be considered mathematical, it might, in another formulation or recursive elaboration also work to further an idea that Caribbean poets too have found their own language to express sentiments akin to Blake’s, albeit perhaps their expressions bear the mark of a different history and different ways of looking at and being in the world. Part of my critique

33 However, it is important because of the arguments being made in this dissertation that I demonstrate a self-reflexive awareness that arguments about stereotypes and cultural bias could be directed back at this work.
then is a response to the too easy accommodation of the film-makers/producers to the dominant tropes in the literature on fractals, chaos, and complexity, without sufficient attention to situate these in their own historical contexts and perhaps to also consider whether or not there exist relevant and resonant ideas in the artistic products emanating from within the region itself.

The second point I wish to make with respect to this opening scene considers the choice to present an image of a beach. There is probably no more stereotypical representation of the Caribbean than the beach. This image, when aligned with the idea of sand from the poetic excerpt, however does not allow for a singular or simple interpretation. It is likely that the image of a beach will resonate with the experiences of many Caribbean secondary school students who are the primary intended audience of the film. At the same time, the image also addresses an imagined viewer from ‘outside’ of the region and draws upon a ‘tourist’ gaze of the Caribbean or of tropical islands more generally. My point here is simply that we be aware of these multiple interpretations and the different audiences to whom these images and utterances might be addressed and how they might be functioning differently for members of different audiences who engage with the film through their different histories. Once one considers a broad conception of audience characteristics, then, even in this very small excerpt, there are hints of polyphony – a complex mixture of ‘voices’ and ‘images’ doing very different things, not all of which one can always be aware.

Representations of Mathematical Authorities in *All is Number*

In this section I address the question of how different mathematical authority figures are represented in the film *All is Number*. Specifically, I address the question of the strategies used to construct the image and idea of a mathematical authority figure in this film. In the subsequent section I will address how mathematics (or mathematical authority) is represented.

In Chapter 2 I drew attention to some of the literature in mathematics education that has elaborated critical concerns about the representation of mathematicians in popular media such as film and television (e.g. Goff & Greenwald, 2007; Greenwald & Thomley, 2007; Mendick, Moreau & Hollingsworth, 2008) and in particular some of the negative stereotypes associated with the authority figure of the mathematician. I noted that Mendick, Moreau and Hollingsworth (2008), who have a primary focus on gendered representations, reported that representations of mathematics are both *invisible and ubiquitous* in popular culture; that describing something as ‘mathematical’ is dependent upon who the viewers are, their relationship with mathematics and
ability to decode cultural tropes as well as the context in which the representation occurs; and that the majority of popular culture texts, despite an emerging corpus of texts featuring women mathematicians, strongly supported oppositional associations and privileged framings of mathematics with masculinity, whiteness, middle-class privilege and heterosexuality. I also highlighted their recommendation for producers of popular culture to develop,

more representations of women doing mathematics and particularly more adult women whose abilities are independent of the men in their lives; representations of women doing mathematics who are classically attractive, feminine and engaged in heterosexual relationships and of those who are not; a greater diversity of people doing mathematics, in particular, people from different ethnicities, nationalities, sexualities, ages, social class backgrounds and with different bodies…[particularly] ones that go against the clichés; a range of ways of engaging with mathematics happily and successfully, including presenting mathematics as a hobby…incidental…occupational…so that mathematics can be seen as part of someone’s life rather than as all consuming; representations…that present it as accessible to all and that do not obscure the mathematics; [and] representations of the process of doing mathematics that present effort as part of ability and show the process as creative and collaborative (p.iv).

In many regards, All is Number can be seen as a positive response to many of these recommendations and an example perhaps of what Mendick et al. (2008) envisioned.

The film presents and constructs an identity of being a mathematical authority for men and women, older and younger individuals, as well as diverse ethnicities and nationalities, all of whom are presented as happily and successfully engaging with mathematics in their professional lives. Engagement with mathematics is also not presented as being all-consuming (see Figure below). In addition, images alluding to the relationships between mathematics and music suggest a role for mathematics in other areas of life.

**Constructing Mathematical Authority Figures in All is Number**

Several strategies are used to construct the image and identity of a mathematical authority figure in All is Number. These include the use of captions, the contextual positioning of individuals, and the differential presentation of different tools/technologies of power among the genera of different professions and activities represented in the film.

Captioning is one of the first processes by which individuals in the film come to be established as authorities and representatives for mathematics and mathematical ideas, that is, mathematical authority figures. The captions serve not only to identify the individuals by name but more specifically, the particular labels that are used – Scientist, Professor of Physics, Mathematician, Agricultural Meteorologist and Director – identify them by professional
occupation. This strategy is perhaps better illustrated by considering the contrast between the first set of images in which individuals are identified and their specific authorisation visibly captioned, with the second set of uncaptioned images of the sidewalk vendor, the guitarist and the harpist (the musicians are identified in the credits) whose activities are described as having a mathematical component but who are not identified in a similar way through captioning.

In a similar fashion, mathematical authority is also established for specific historical mathematical personalities by having their names uttered (Pythagoras) and captioned (Fibonacci, Mandelbrot).

The situating of individuals within a particular scene also works to establish or extend a certain type of authority that works in tandem with the process of captioning or the phenomenon of an absence of captioning. By positioning certain individuals within specific backgrounds the film/images also convey a sense of where these specific mathematical authorities exert an influence – in the natural world (beach, river, outdoors), in classrooms/lecture halls/seminar rooms, in managerial positions (indoors), and in economic transactions. Looking from the literature in mathematics education and the popularization of mathematics, this diversity of locations is important in illustrating that a career in which mathematics is involved does not relegate one only to teaching or research situations but can be one in which one participates in the ecological and economic aspects of a culture.
A contrast is again evident however with the images of the guitarist and the harpist where the backgrounds are darkened and the individuals are removed, isolated from any recognizable social and cultural context. This positioning situates the type of work with which these individuals are engaged differentially with artistic and creative expression (handicraft and music) and are not given the same kinds of authorizing agency as science and business in the film. Thus, while the film is attentive to its representation of mathematical authorities in a way that positively works to interrupt some of the stereotypical representations of mathematical authorities across a number of different markers identified previously, the film does not give the same attentiveness and care does to the representation of those others whose activities the film inscribes within a mathematical locus.

The scenes above also index differing degrees of mathematical authority via the presentation of different tools/technologies of power. The tools used by the mathematical authorities are all invested with a power to transform the world in some way – the stick writing in the sand, the voice, the whiteboard and marker, a scientific instrument, and the implements in manager’s office (pen). In contrast the dimensions of power and agency of musical instruments and handicraft are left uncommented upon and at the level of individual and aesthetic pleasure.

’We’ again

Pronouns also function as a powerful technology for instituting and maintaining authority in mathematics education. Rowlands (1999) has argued that, “in the context of mathematics…pronouns serve to code some transactional and interactional functions of language” (p.19). For example, the way that the first person plural subject pronoun, ‘we’, is deployed in classroom situations has been discussed by Pimm (1987) and also by Rowlands (1999). Pimm (1987) asks, “Who is ‘we’?” (p. 64) in mathematics classroom communication, “who is the community to whom the teacher is appealing in order to provide the authority for the imposition of a practice which is about to be exemplified?” (p. 69). In the context of pedagogical film, the narrator functions as a substitute, or perhaps interlocutor for a classroom teacher. However the audience is potentially much more diverse than one typically finds in a single classroom. While pronouns have been studied in relation to mathematics classroom use (e.g. Khan, 2006), their deployment in mathematics pedagogical films has not been commented upon. Thus it is of interest to consider, for example, ‘Who is we’, and how this pronoun functions in the context of this pedagogical film.
In pedagogic and documentary film, ‘we’ is a rhetorical device used to bridge the distance created by the medium between the physically separated narrator and the audience member(s). This is seen for example in the statement by Mosley, “‘Everywhere we go there is mathematics” and in the final scene when Haque offers, “Nature speaks and if we listen carefully enough it speaks mathematics.” The function of these two utterances is to close the gap between the on-screen narrator and the audience member through an inclusive, human, ‘we’. However, the ‘we’ that is referred to includes both the imagined and intended audience of high school students and mathematical authorities – those present in the film and those that are implied. In these utterances the viewer is invited to become a part of a mathematical community.

‘We’ though can be ambiguous referent. For example, in the early scene on the beach when Haque suggests that “…we could not get through school without having been taught that [Pythagoras’ Theorem].” It is not clear who ‘we’ is referring to here. This utterance seems to be directed at audience members who have already left school and not those currently in school, who are not the primary intended audience of the film. This differs from the utterance later in the film where she states, “[w]e have just built the set of magic numbers known as the Fibonacci Series. We never have to look far to see these numbers in nature.” This utterance more closely follows the types of usage found in classrooms by teachers in episodes described in Pimm (1987) and Rowlands (1999). In such cases, ‘we’ is often used in a demonstrative activity to illustrate ‘the way’ a generalized procedure is to be performed. However, as in this case it is not really the ‘we’ that has ‘built’ the set of Fibonacci numbers, but the ‘I’ of the narrator which serves to co-opt any possible dissent.

**Even in Mathematics – Marking Otherwise or the use of Mathematical Authority**

Representations are not neutral. As argued above, one of the things that particular practices of signification do in this film is to construct and communicate a particular view, or ideology, of mathematical authority. Such authority itself is not neutral. For example, in my earlier work (Khan, 2006) I illustrated how the authoritative discourses of mathematics were involved in creating a hierarchy of learners in a classroom situation, in which those more distally located authorities (in space or time) were less able to be questioned, while those students and their teacher enmeshed in negotiating their own authorities often found themselves “doing without understanding” (double entendre intended).
In this section I examine the clip (01:40-02:25) which introduces Professor Leo Moseley and the ideology in his utterance and ask after what mathematical authority is being used for in this segment. In particular I want to suggest that mathematical authority is being used here to generate difference, to mark otherwise, an otherwise that is not merely in relation to but is ‘less than’. In the clip, Professor Moseley states,

“All Science depends, very heavily on mathematics, which is the language of Science. Now you may think that as a biologist you do not need that much mathematics, but when you think of the sophisticated statistics which are used by biologists as they examine the natural world, then you will see that you perhaps have a quality of mathematics which is beyond many other people. Even in Social Sciences where they tend to think of themselves as somehow different they depend very heavily on graphs and analysis of graphs which is of course mathematics. Everywhere we go there is mathematics” (emphases mine).

Consider the following rhetorical sequence i) “you may think that”, ii) “but when you think of”, iii) “then you will see perhaps”. The first part of this sequence is an attempt to call some viewers’ beliefs about the role of mathematics in Science, Life Science in particular, into question. It is simultaneously permissive yet derisive. The second part of the sequence begins to use the mathematical authority of the presenter to introduce another thought to the viewer. Finally, the third part suggests that only when one begins to think in the way identified in the second part of the sequence that one will be able to see, and even then, the inclusion of “perhaps” is an acknowledgement that there is no guarantee. According to the rhetoric in the sequence, in such a case the cause lies in uninformed thinking.

In this clip the constructed mathematical authority is used to direct viewers’ thinking away from a perceived belief towards a different one. However, the specific conclusion to which viewers are being directed through the deployment of mathematical authority is another potentially crippling belief, namely, that the type of mathematics used by Biologists is something “beyond many other people.” This conclusion may function to reinforce beliefs that mathematics is a special gift/quality/capacity which only some people possess. The research literature in mathematics education however has repeatedly demonstrated that such beliefs often function as self-fulfilling prophecies.

This particular segment stands in sharp contrast with some biologists’ perspectives. For example, E. O. Wilson (2012) is reported as saying that, “[i]t is far easier for scientists, including medical researchers, to acquire the needed collaboration in mathematics and statistics than it is
for mathematicians and statisticians to find scientists able to make use of their equations.”
Wilson’s perspective underscores the increasing emphasis on collegial and collaborative work
across the sciences where all of the expertise needed to solve a particular problem is distributed
across a number of individuals.

Now, in the second main utterance, the mathematical authority of Professor Moseley is
used to further position Biology (Life Sciences) and Social Sciences in relation to mathematics,
as dependents. The use of the word “even” in this utterance, in relation to the role of
mathematics in social scientific disciplines, functions to make those subjects seem
simultaneously exceptional and non-exceptional. It can be read as being somewhat dismissive of
those aspects of the social sciences which do not quantify as being ‘less than’ ‘real’ science.
Indeed the example offered that social scientists who analyse graphs are doing mathematics is
probably somewhat offensive to both mathematicians and social scientists – a gross over-
simplification of what professionals in both domains are up to. What is ironic however is the fact
that this scene reveals that, even in mathematics, where some may tend to think of themselves as
somehow different from the social sciences, their utterances depend upon language,
representation, authority, and ideology, precisely some of the things that critical social scientists
might study with or without graphs. One might even go so far as to claim that everywhere we go,
even in a mathematical film, there is ideology.

What these two utterances do in the very short timeframe of the clip is to identify, label
and mark Biology (as perhaps a representative of the Life Sciences) and Social Sciences as being
imaginatively different from mathematics yet scribed within an inescapable locus of
mathematical authority, as suggested by the final statement that, “everywhere we go there is
mathematics”. What Professor Moseley accomplishes here is an act of Othering of independent
but related disciplines.

The “Other” is a concept that comes into being from within an intersubjective encounter
with difference. “Othering” is linked to political, ethical, and performative processes of naming,
describing, inscribing, and ascribing identities, meanings, and values to individual and group
differences. These processes of othering have historically not been equally kind to individuals
and groups in the encounter (Kapuściński, 2008). In several ways, and for many students, school
mathematics is such an encounter with difference. While mathematics, as an ever-growing body
of knowledge, is part of the ongoing legacy of the whole of human civilization, as a formal
academic discipline its practices and epistemic entourage are entrenched in particular aspects of Greek rationality and relationality which continue to underlie the practice of what can be called Western mathematics and mathematical education practice.

Shulman’s (1996) feminist genealogical retelling of the Foundations of Mathematics project, for example, which begins with Parmenides’ poem, *On Truth*, reflects the dichotomous and oppositional categorization, gender and social hierarchies, the taboo associated with the transgression of impermeable boundaries present in Greek social life and the search for “eternal” and “perfect”, “objective truth.” It is Plato though who, according to Shulman, would

project above the limited world of bodies an ideal world of hierarchically ordered logical forms which came in opposite pairs…the highest most general level being existence (and non-existence)…From the vantage point of this higher reality, sitting in his binary tree of concepts, the philosopher could now make comparisons and discern sameness and difference (pp. 433-434).

Coupled with this, Plato’s the bivalent logic of Plato’s dialectical technique, underwritten by the law of the excluded middle, limited statements to being either true or false and,

effectively disenfranchise[d] all those who could not or would not follow the rules of proper logical form (in particular, slaves, women and children). Anyone who ventured away from the tree of logical concepts was summarily dismissed for lack of rigor and ridiculed for lack of understanding of the categories of rational expression (p.435).

The practice remains effective in mathematics and mathematics education for “othering” and separating its practitioners. In the scene offered above, Professor Moseley effectively utilises similar strategies that in effect dismisses the notion that Biology and Social Sciences are disciplines in which mathematics plays no part – a belief to which few would probably ascribe in the first place.

The dominant educational discourse of mathematics as a masculinely gendered domain depends on this logic. In this discourse to be successful at math is usually equated with being successful at reasoning, which is synonymous with rationality, attributed as being a “male trait”. Walkerdine (1989) explains that, “[t]he powers of rationality and mathematical thinking are so bound up with the cultural definition of masculinity”, and "that the discursive production of femininity [is] antithetical to masculine rationality to such an extent that femininity is *equated* to poor performance, even when the girl or woman is performing well” (p. 268). Again, it is possible to see a parallel here, that what is occurring in this scene is a re-enactment of elements
of this discourse in which the Biological and Social Sciences are being similarly positioned as ‘feminine’ in their inability to attend to the mathematical dimensions of their identities and as antithetical to a masculine rationality ascribed to mathematics.

Following the examples of Shulman and Walkerdine, Damarin (2000) begins her interrogation/interruption of the way that mathematics 'marks' the mathematically (en)abled as a 'deviant' othtered body by rejecting as axiomatic the assumption of the universal desirability of mathematical ability which positions both male, but particularly female bodies as, "empty vessels that get filled up" (Dowsett, 2005, cited in Greig, 2009, p.70) to become "repositories of blame" (Damarin, 2000, p. 69) for their relative or disproportionate mathematical accomplishments. In this scene then the invisible bodies of the Biologist and Social Scientist (neither is explicitly identified in the film) are constructed as having to embrace mathematics as a desirable if not universal aspect of their identity – sophisticated statistics and analysis of graphs. The disciplines are marked by an ethnocentric emphasis in which unique differences are over-written to produce a singularity of sameness.

**Representations of Mathematics in All is Number**

In the previous section I examined how mathematical authorities are represented in the film *All is Number*. These individuals function as representatives for Mathematics, that is to say, the representation of a mathematical authority is linked to the way in which Mathematics is represented and to how conceptions of Mathematics’ ontological status, what *it* ‘is’, are developed. But Mathematics also functions as an authority in authoring the identity of being seen or not seen, ‘counted’ or ‘discounted’ as being a representative of mathematics’ authority.

How Mathematics is represented is important. For some members of the public the only space in which a conception of Mathematics develops is through experience with that particular branch known as School Mathematics. Núñez and Lakoff in *Where Mathematics Comes From* (2000) for example describe what they consider to be a general conception of (Western) mathematics, namely that:

- Mathematics is abstract and disembodied – yet it is real.
- Mathematics has an objective existence…
- Human mathematics is just a part of abstract, transcendent mathematics.
- …mathematical proof allows us to discover transcendent truths of the universe.
- Mathematics is part of the physical universe and provides rational structure to it.
Mathematics even characterizes logic, and hence structures reason itself…

To learn mathematics is therefore to learn the language of nature…

Because mathematics is disembodied and reason is a form of mathematical logic, reason itself is disembodied (p. xv).

In addition to this general narrative, a rich literature has developed on the specific conceptions that the imagined audience for this film – school age children – have about mathematics (e.g. De Corte et al., 2000; Khan, 2006; McLeod, 1992; Schoenfeld, 1992).

Schoenfeld (1992) for example lists the following as among the main conceptions (beliefs) that students hold about the nature of mathematics:

- Mathematics problems have one and only one right answer; There is only one correct way to solve any mathematics problem – usually the rule the teacher has most recently demonstrated; Ordinary students cannot expect to understand mathematics, they expect simply to memorize it and apply what they have learnt mechanically and without understanding; Mathematics is a solitary activity, done by individuals in isolation; Students who have understood the mathematics they have studied will be able to solve any assigned problem in five minutes or less; The mathematics learned in school has little or nothing to do with the real world; Formal proof is irrelevant to processes of discovery or invention (p. 359).

In my previous work (Khan, 2006) I found that the predominant conceptions held by an atypical group of Trinidadian students (11 year old high-achieving girls transitioning to the secondary school of their choice) about mathematics included: that mathematics is about calculating or numbers; that mathematics is about solving problems; and that mathematics is about applying basic rules. These students already held strong associations between success in mathematics and career prospects in the sciences as well as mathematics’ usefulness in everyday life.

In this section I address the question of how mathematics is represented in the film All is Number. Representations of Mathematics on film have not received the same degree of attention and scrutiny as representations of mathematicians, though as I have noted above, these two are closely inter-related but not necessarily coterminous. In addition to mathematical representatives (authority figures), Mathematics is represented in films like All is Number through the specific mathematical topics or themes that are chosen. These are elaborated upon through the visual elements in a given scene and aurally/orally in the specific words spoken. These elements work to interrupt or reinforce particular sets of conceptions about Mathematics. In this section then I also ask after the conceptions of mathematics that are being interrupted and those that are being reinforced and consider how specific representations might be functioning to do this.
Mathematical Topics in *All is Number*

The set of identifiable mathematical topics or mathematical ideas and concepts that are presented in the film are: the Pythagorean Theorem (Geometry), Fractals and self-similarity, Chaos theory and the butterfly effect, meteorological statistics, business statistics, zero, binary number system, Fibonacci numbers together with the golden ratio, and musical ratios. In the film these are juxtaposed but not well connected to each other. In the following sections I consider what ideas of what Mathematics ‘is’ might be communicated by the collection and juxtaposition of these particular topics and, by extension, what ideas are not? Using the Caribbean Examinations Council’s (CXC) mathematics syllabuses for the Caribbean Secondary Examination Certificate (CSEC) and Caribbean Advanced Proficiency Examination (CAPE) together with the National Curriculum of Trinidad and Tobago as starting points, the only topics present in these curricular documents that are explicitly addressed in the film are the Pythagorean theorem, number systems including the binary system and statistics. There is then only a small visible overlap among the topics addressed in this film and the formal curriculum documents which influences mathematics teachers and students in the region.

There are several ways to interpret this small degree of overlap with the formal or ‘school’ curriculum. Firstly, it can be seen as an attempt to interrupt strong associations of mathematics with ‘school’ experiences and to provide a broadened horizon of what could legitimately be considered mathematical to the intended/imagined primary audience of high school students. The film succeeds in doing this by introducing extra-curricular items such as ideas related to fractals, self-similarity and chaos. At the same time however it is necessary to provide familiar points of reference from which to begin such an elaboration and this is accomplished by reference to one of the most familiar of school mathematics topics – the Pythagorean theorem – which is referenced at the beginning of the film and later ideas related to number systems.

While the film does seem to offer a direct challenge to the notion of mathematics as not being very useful in the day-to-day lives of individuals, the deliberate choice by the filmmakers to address the number and diversity of mathematical ideas as they have without connecting them clearly to one other might reinforce the belief among some students and teachers that mathematics is a collection of discrete topics that share only loose connections to each other.
In short the presentation of the set of mathematical topics in the film works to extend the notion of the types of things that mathematics enables one to study and go beyond that which might be presented in school, while simultaneously reinforcing an idea of mathematics as a collection of discrete topics to be studied with little or no connection to each other.

**The Visual Representation of Mathematics in *All is Number***

In order to attend solely to the visual representations of mathematics I looked at the film with the sound muted. I acknowledge that how mathematics is represented in the film is the result of an interplay among authorities, topics, images, and utterances. However, in choosing to attend solely to the visual presentation, I seek to understand what idea of mathematics might be communicated through this sensory modality alone. This rehearsal also acknowledges that a significant part of mathematical instruction in and out of school often takes place through the use of illustrative visualization and that the medium of film offers tremendous affordances for mathematical visualization in the service of pedagogical aims.

A limitation of this approach is that what I count as being a visual representation of mathematics is very much influenced by my own prior mathematical experiences and exposure as well as an awareness of the values of the communities to whom this work is addressed. For example, with audio muted, the animated image of the pulsating ‘tree’ fractal pattern presented in segment 6 (See image below) might not be counted as being a representation of a mathematical object were I not already familiar with images and ideas of fractals. The mathematical and educational cultures that I have experienced have taught me to attend to images like the one below in a very particular way – as an image or representation of a set of mathematical ideas to which I have attached some value and imbued with personal meaning. In addition, in this work I cannot attend to all of the images that are representative of mathematics and I have chosen to highlight only those about which a strong claim about a representation of mathematics in a popularization artefact might be made.

![Fractal Image](image)
The scene which presents Dr. Donna Commissiong is the only one which is set in a classroom environment with a whiteboard and mathematical notation and symbols in the background [See screen cap below]. Visually, the scene seems to place a traditional image of mathematics as being made up of esoteric symbols as secondary to the body and personality of the mathematician. The film then does not shy away from representing one area where mathematics is traditionally encountered – the classroom – but by placing the mathematical notation in the background and not directing the audience’s attention to it in any significant way, the focus on the individual emphasizes the idea that mathematics is created and used by human beings. Another reading of this image is that the ‘mathematics’ (notation and diagrams) in the background is used like a ‘prop’ in the scene – it is not that it is not important, but its importance lies in creating the sense of a familiar environment.

A related scene in which mathematical ideas are represented via mathematical symbols is the segment which introduces the Fibonacci sequence. Unlike the scene with Dr. Commissiong, here the mathematics and its visible representation via symbols (numerals, equality sign, addition sign) take center stage. In this scene a series of equations appears which illustrate the iterative generation of the sequence and the approximate value of the ratio of two consecutive terms of the sequence. In these images, the numbers are kept ‘small’ as only the first few iterative steps – enough to illustrate the pattern – are shown. In addition, the number of decimal places in the division is restricted to one, making 1.6 – the result of the division of 13 by 8 – approximate and not an equality. By presenting only the first few terms and a single decimal place, the idea of mathematics that is being communicated seems to be one which involves numbers that would be manageable to most viewers and would not likely cause anxiety as might be encountered were more decimal places or larger Fibonacci numbers which have more digits used. This scene thus renders mathematics as a discourse which could potentially be approached by anyone.
Arising out of the concerns about distortion in popularizations discussed in an earlier chapter, however, we might ask whether or not the simplifications offered in the presentation of the mathematics of the Fibonacci sequence contain any distortions and whether such distortions might be significant. Looking at the two images above side by side, and given the duration of their presentations, a few seconds, it would be easy to miss the simple approximation error that 13 divided by eight is not 1.6 but rather 1.625. As discussed above, presenting only the first decimal point might serve to make the visual representation of the number less ‘frightening’ and more conceptually approachable for some members of the intended audience. However, by using the same symbol as is used in the left-hand image for equality, an idea that the division of 13 by 8 is equal to 1.6 is communicated. This approximation by itself I do not consider as being a significant distortion. However, this simplification as a result of approximation does lead to a significant distortion. I need however to refer temporarily to the voice-over narration of this scene in which the idea that the ratio of consecutive Fibonacci numbers ‘converges’ to a rational number, namely 1.6 is communicated. This is a significant distortion of the mathematical fact that the convergence of consecutive terms of the Fibonacci sequence is to an irrational number phi (\( \phi \)) whose approximation to one decimal place is 1.6. In attempting to keep the mathematics ‘simple’ then an image of mathematics that is inaccurate and may need correcting at a future point is potentially introduced.

The Representations of Mathematics in the (Aural) Narrative of All is Number

In this section I attend to the aural dimension of the film, that is, what is communicated about mathematics in what is said by its mathematical authorities. As above, what is said necessarily interacts with the visual composition and the specific authority who utters it to produce meaning. Methodologically, for this section I listened to the narrative of All is Number without looking at the images of the film while simultaneously reading the transcript. As in the previous sections, it is possible to code almost every utterance, especially those involving the word mathematics, as furthering one or another representation of mathematics. I took a chronological reading, that is, I made a first pass through the narrative to identify some of the
main themes as they are introduced and then checked if these ideas were reinforced or repudiated, consolidated or contradicted as the film progressed.

Mathematics describes things in the universe.

The opening scene on the beach with Dr. Haque states one of the main emphases in the film about mathematics, viz. that mathematics describes things in the universe. This thread also ends the first scene where the invitation is extended to the viewer to journey into the heart and soul of things where one will find mathematics. The idea continues with Mandelbrot’s description of clouds, mountains, bark (of trees) and lightning, the idea of the length of a coastline, self-similarity in trees, as well as the discussion by Dr. Commissiong of heart rhythms and brain waves, Fibonacci floral patterns, sunflower, pine cone and other spirals, and musical ratios and appears in the closing scene in the utterance by Dr. Haque that, mathematics, “describes that which we can and cannot see, choreographs the dance of the atoms on the tiniest scales while describing the universe on the grandest scales” (italics added).

This idea then, that mathematics describes things in the universe or describes the universe is a single coherent narrative thread that runs from the beginning through to the end of the film. The viewer is sometimes informed of what mathematics describes – which particular feature of the universe – but what is not communicated is how mathematics is used to describe these aspects of the universe. This can be understood as a result of the need for simplification in a popularization presentation of this length that touches on many different areas of mathematics.

Mathematics explains things in the universe.

Closely linked to the idea of mathematics describing things in the universe is the idea expressed towards the end of the opening beach scene of the Pythagorean belief that “all things around us could be explained and understood by mathematics.” This idea is developed in the segment which follows – the interview with Prof. Mosley in which another key idea of the film is communicated, namely that “mathematics is the language of science.” Throughout the film however, there is very little in terms of exemplification of how mathematics explains things in the universe and the ways in which mathematics functions as a language in science.

School mathematics is not all there is to Mathematics.

The early scene on the beach contains the utterance by Dr. Haque that, “we could not get through school without having been taught that” in reference to the Pythagorean Theorem. This is the only time that school is mentioned in the film and as described above, there is only one
other scene which calls to mind school mathematics – the one set in a class/lecture/seminar room. This de-emphasising of the mathematics that one learns in and for school is important in interrupting one of the strong beliefs of students reported in the literature viz. that school mathematics is all there is to mathematics. The Pythagorean Theorem is perhaps used here as a stereotypical representation of high school mathematics – a concept that begins to braid together complex ideas from measurement (length and area), algebra (exponents) and geometry (right-angled triangles) – and one which might be seen as irrelevant to the everyday life of a high school student. This representation of mathematics is accomplished mostly by not referencing school mathematics significantly in the film.

**Mathematics is useful.**

Another idea that is conveyed throughout the film is that mathematics is useful. This is exemplified especially in the scenes with Mr. Trotman (meteorology), Dr. Commisiong, and Dr. Tewarie and in the very brief discussion of the importance of binary switching in electronic applications. This is stated directly in the utterance by Prof. Mosley in which he identifies the ways in which he perceives mathematics as being useful to Life and Social scientists in terms of “sophisticated statistics and analysis of graphs”.

**Mathematics is associated with beauty.**

While the association of mathematics with beauty and pleasure is more explicitly made with the visual images supporting text can be found for example in the discussion of the use of the golden ratio in architecture and painting and the discussion of harmony in music. The final scene also contains the utterance to the effect that the beauty of mathematics resides in the ability to function as a universally relevant language.

**Mathematics is everywhere.**

Mathematics is everywhere is the overarching theme of the narrative beginning with the title itself, *All is Number*. This idea is conveyed metaphorically in the repetition of the idea of mathematics being at the “heart and soul” of all things in the universe and is reinforced through the other themes described previously of mathematics, describing and explaining things in the universe, mathematics being useful, mathematics being a kin to beauty and that school mathematics, while offering an experience of mathematics to a mass, and captive audience, is an impoverished view of what mathematics is. Prof. Mosley too in an early scene states this recurrent theme that “everywhere we go there is mathematics.”
Discussion

Dyer (2002) notes of the current *mode* in the literature on visual representations following the elaboration and echoing of the crisis of representation across academic disciplines that,

> much image analysis seems only to demonstrate that everything is the same and it’s all awful. There is something deadly about such reductive work: it tells one little and thus does rather little politically...[and] needs to be tempered by considerations that get more nearly at the complexity and elusiveness, the real political difficulty of representations (pp.1-2).

In taking up this challenge I want to argue that there exists a polyphonic representation of mathematics in the film *All is Number* that simultaneously works to interrupt some aspects of the general narrative and students’ conceptions of mathematics but reinforces others. In particular, I engage with specific aspects of the film identified in the previous sections of this chapter in relation to larger concerns about pedagogical film in the literature.

The somewhat innocuous mathematical inaccuracies in the film, *All is Number*, in the context of broader conversations about misinformation or inaccurate representations in film, are a concern for researchers in education. Educators’ concern with accuracy, misinformation or distortion, has to do with the idea that learning (knowledge acquisition, recall, retention and transfer) is compromised by problems with the fidelity and efficiency of information transfer processes. Their concerns are not unwarranted. Butler et al. (2009) for example in a small study (n=54) with US undergraduates found that when a film and printed text presented consistent historical information student recall was higher than if they were presented the text alone. When information in the film contradicted that in the text students more frequently recalled the misinformation and the effects were large.

By utilising its artistic license in serving mathematics as palatably as possible, the film at times appears to be less concerned with accuracy and its possible effects on student learning. While such inaccurate representations present pedagogical cause for concern, they remain fairly innocuous as ends in themselves. However, taken in tandem with issues of representation in the film as a whole, they present a more urgent pedagogical situation with implications beyond the scope of the film.

Consider for example, the film’s problematic depictions of artists and vendors, discussed above. Following the social and cultural turns in the social sciences and humanities, an increasing concern across disciplines and professions is the (in)accuracy of representations of
beliefs, values and behaviours, and the stereotyping and public perceptions of some group(s) in films. These include Accountants (Felton, Dimnik & Bay, 2008), Mathematicians, Scientists, Teachers, Doctors (Dans, 2000, cited in Felton et al. 2008), Librarians (Walker & Lawson, 1993), Jews (Friedman, 1982, cited in Felton et al. 2008), Blacks (Bogle, 1991, cited in Felton et al. 2008) and others. Across all of these the general concern is that particular forms of cinematic representation not only might hold up an uncomfortable mirror to a society reflecting its beliefs and values, but might also act as a lens shaping public perceptions and behaviours. The manner in which particular professionals are named and labelled in the film in effect establishes a hierarchy of privilege at the level of the narrative, which uncomfortably reflects and reinforces the power structures of the social hierarchy. In this light, the film reinforces deeply entrenched mathematical stereotypes by appearing to privilege mathematics in the academy over mathematics as a lived experience.

Consider also Dr. Haque’s descriptions (Chapter 4) of the film as a “math appetizer”, and the intended message of her science documentaries as seeking to convey a sense of science as “all fun and an adventure.” The analogy of an ‘appetizer’ positions the film as something to be consumed, as opening an ‘appetite’ for a mathematical main course, which is kept in perpetual abeyance, never delivered by the film. If the film should be successful though in whetting the appetite for more mathematics, where and to whom should the ‘hungry’ viewer turn? As Drew (2011) suggests, while “middle and high school students are having most of the fun…[t]he excitement quickly fades [in college] as students brush up against the reality of… ‘the math-science death march.’…then many wash out.” Learning mathematics, it turns out, can be quite difficult – and many students find the presentation of the main course disappointing and the meal itself, unpalatable. A significant number also elect to leave the table (HERI-UCLA, 2010).

A sense of fun and adventure is necessary for being engaged with mathematics, but is not sufficient for overcoming and managing the psycho-emotional difficulties of learning mathematics. One of the shortcomings of popularization projects that offer a one-sided presentation of fun and adventure without attending to the necessity of discipline, commitment and hard work is to oversimplify and potentially mislead impressionable viewers about the time and sustained effort needed to develop a connoisseurship for mathematics through study.
In the next section I draw upon Elizabeth Ellsworth’s (2005) notion of an anomalous place of learning in continuing my discussion of the relations discussed above in the film *All is Number.*

**Anomalous Places of Learning and *All is Number***

For Ellsworth (2005) anomalous places of learning are, “peculiar, irregular, abnormal or difficult to classify *pedagogical* phenomena” (p.5, italics added), which “refuse to be contained by an understanding of pedagogy as the *mere construction or representation* of objects (for example, concepts, bodies of knowledge, curriculum, events in the world) for or to subjects (learners)” (p.7, italics added). One way to interpret this partial description is that an anomalous place of learning provides an experience of pedagogy, i.e. of a process of being taught and of learning, in ways that exceed and problematize a too simple discourse in which teaching and learning are understood as being ’in a 1-to-1 relation of constructed objects for pedagogical subjects in a given moment of space-time.

The film *All is Number* can be seen as a difficult to classify *pedagogical* phenomenon. But what is it that makes this film’s pedagogy difficult to classify? The film itself as artefact is easy to classify – it is a pedagogical film with multiple intentions. Among these intentions are to render some mathematical ideas in a way that arouses interest in mathematics and careers in which mathematics might be involved. As such it does not appear to be primarily concerned with “the mere construction or representation of objects for or to subjects”, though there are imagined subjects – high school students and teachers – that are being addressed through the film and as described above, an idea of mathematics is being represented and communicated in the interplay among mathematical authority, choice of topics, visual imagery and narrative (aural) content.

Ellsworth (2005) describes anomalous places of learning as, “*material* tales,” “*conceptual* test-pieces,” and “*poetic* products”... *catalysts*... (p.9, italics added), “highly charged *event potentials* that promise surprise and constantly challenge us with new and unexpected questions” (p.11, italics added). These anomalous place of learning are also, “...*assemblages* that incorporate *pedagogical pivot points*” (p.38, italics added), “*radical singularities*” (p.168, italics added) “...putting inner realities in relation to outer realities” (p.48), “*creat*[ing] topologies of *relationality* between self and other, inside and outside, inviting us to inhabit those topologies in

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34 In ‘staging’ her work itself as an anomalous place of learning, Ellsworth strews a multitude of complementary and contradictory metaphoric and analogic associations that serve as an invitation for readers to freely-associate with a variety of images and ideas – to play *with* and to learn from them.
ways that release potentialities for thoughts, feelings, and (inter)action…” (p.117, italics added). The idea of pedagogical pivot points is a key conceptual motif in understanding Ellsworth’s construction of the idea of an anomalous place of learning and one that I use to describe what I have attempted in a later chapter.

**Pedagogical Pivot Points**

How is it that the peculiar pedagogies of anomalous places of learning achieve their goal of presenting, inviting and involving us in an experience of coming to awareness of the learning-self in-the-making? What are the key assumptions? What is it that they [their designers and the places themselves] ‘know’? Ellsworth’s necessary assumptions here are the ontological primacy of radical embodiment and (inter)subjectivity. Anomalous pedagogies, she offers, ‘work’ by, “attempting to move us through “sensations, prelinguistic and presubjective,” that precede concepts, images, or recognitions as things made and promise to “bring something new and unexpected into the loop” (p.26). Consequently, Ellsworth (2005) argues such pedagogies, work to “stage learning as a “material process” that arises out of the imbrication of the *material* elements of mind/brain and body…and attempt to provide sensations that create the conditions for potential learning experiences” (p.27), [using] indirect forms of communication to point out oblique itineraries to the learning self (p.168).

The designers of these spaces do so by,

…locat[ing] pedagogy at and as a pivot place…[that] puts inside and outside into relation…striv[ing] to create the experience of the learning self by putting inner thoughts, feelings, memories, fears, desires, and ideas in relation to outside others, events, history, culture, and socially constructed ideas…drawing attention to how we are made up on the inside of our neverending interactions with and constantly changing images of people, events, and experiences from the outside — which is itself shaped in turn by what we bring to it from our inner realities (p.37).

Ellsworth’s description of the aesthetically deceptive conceptual metaphor of a ‘pedagogical pivot point’ has proven to be most useful to other scholars thus far (e.g. The Curriculum Collective, 2007) because, as she suggests, these pivot-points, or radical singularities, can be deliberately incorporated in a pedagogical design.

As she elaborates further, these places, “attempt to insinuate the outside into thought. They do so by “drawing knowledge outside of itself, outside of what is expected, producing *a*
hollow which it can then inhabit — an outside within or as the inside” (Grosz & Eisenman, 2001, p. 68) (p.117, italics added). This hollowing out facilitates,

…interaction between inner reality and outer reality [which] allows neither to impose itself on the other, but results instead in both being interrelated, [so that] thought is able to confront us from the only place where it can confront us: from outside the concepts we already have, outside the subjectivities we already are, outside the material reality we already know (p.55, italics added).

To multiply metaphors (mindfully), pedagogical pivot places created by/through anomalous pedagogies might also be described at different scales of inquiry and associated theoretical frameworks, as ‘third-spaces’ (e.g. cultural/post-colonial theory), ‘enabling constraints’ (ecological/complexity theory), transitional spaces (psycho-analytic theory) and, as a kumbla (embodied psycho-analytic/Caribbean literary theory). This proliferation of associations suggests what is made possible in the in-between, the juncture, the suture, the seam, a third-space, when and where at least two elements articulate to create – borrowing from yet another embodied metaphor – ‘movement’ or ‘play’.

Ellsworth is careful however that it is only from certain positions and perspectives, namely, “the “center” of dominant educational discourses and practices…that takes knowledge to be a thing already made and learning to be an experience already known” (p.5) that the specifically pedagogical dimension, intention, and force of (the specific) anomalous places of learning (she discusses) “appear anomalous” (p.26).

At first glance All is Number appears not to be in any way similar to those places of learning that Ellsworth describes. The film All is Number, presents a number of stages where mathematics is employed that are perhaps meant to be anomalous – the beach, a University Principal’s office, a river’s edge, trees, hurricanes, shopping – but they do not work as such, rather they are attempts to bring us back into education’s familiar orbit.

For the film-makers however, All is Number is their conceptual test piece, a poetic product, an experiment in and for learning about the making of science documentary (and pedagogical) film in the Caribbean. The film is intended as a catalyst for education in the Anglophone Caribbean. From its opening allusions via Blake’s poetry and confidently stated thesis about the universality of mathematics it does promise surprise for the viewer. Some of its pedagogical pivot points, like the attempt to link Mathematics (or Science) and the Humanities (Art, Architecture, Music) might not be particularly surprising for viewers with a wide and diverse set of experiences with mathematics. For others, this association might be surprising and
function as an important singularity in thinking about mathematics and its connections to other aspects of life. The bringing of these two domains of human achievement and expression together works to create a topology of relationality between the two, and between the two and the viewer. It puts an inside (mathematics) in relation to what is sometimes scribed outside in school mathematics (artistic enterprise and positive affect) or from the perspective of an individual the locations of these might be reversed, i.e. the inside can be seen as the artistic/aesthetic/affective while mathematics is more frequently experienced as being outside of one’s experience.

Another set of ‘realities’ that are put into productive relation is that between school mathematics – as exemplified in the statement about Pythagoras’ Theorem and the image of the class/lecture room – and the images of mathematics utility in a variety of Caribbean settings. This juxtaposition however is unlikely to function as a pedagogical pivot point. Rather, the most radical singularity I find in the film, the one that puts “…inner realities in relation to outer realities” (p.48), for me in “creat[ing] topologies of relationality between self and other, inside and outside, inviting us to inhabit those topologies in ways that release potentialities for thoughts, feelings, and (inter)action…” (p.117) is that tension between the ‘inner’ Caribbeaness of the film formed in the elements of its audio-visual construction and the audience it addresses and the ‘outer’ realities of a mathematics education that has emerged from a long history of European colonialism (Spanish, French, Dutch, and British) in the region.

The film affords an opportunity, if not offering an explicit invitation, to engage with this tension, the inner reality of what it might mean to be a Caribbean student/person emerging from a complex history of negotiations and negations with the outer realities of globalized knowledge systems – such as mathematics – that often seem to come from elsewhere but not t/here. Engaging with and not eliding the tension of this topology of relationality is perhaps where Ellsworth’s stated release of “potentialities for thoughts, feelings, and (inter)action…” (p.117) is likely to occur.

Ellsworth also suggests that the goals of (the specific designers of) anomalous pedagogies (discussed in her text) are democratically and humanistically oriented. They seek to, “present us with new ways of thinking about the experience of the learning self” (p.17, italics added); offer us invitations to “participate in attempts to invent new ways to see and new things to say [that] does not preexist [the learning self’s] involvement” (p.7); attempt, “to engage learning in the
making...” (p.28); and to, “…shape space, time, experience, and objects with pedagogical intent…seek[ing]…new ways of knowing that also transform knowledge, self-experience, awareness, understanding, appreciation, memory, social relations, and the future” (p.37).

This is one of the specific areas where I think that the film All is Number can be considered to be successful, that is it presents an opportunity for thinking anew not only about mathematics and its relation to other disciplines, but perhaps more importantly for a learner in and from the Caribbean about the need for involvement and self-investiture in coming to an experience of the learning self during intense periods of self-learning. Because one of the significant intended/imagined audiences for pedagogical films are learners of a variety of ages, that is, such films are intended to be educational in some way, they are always invested in transforming relationships with selves and futures as yet in the making.

One of the critical insights that Ellsworth’s discussion raises for pedagogy in general and for the work in this dissertation project specifically is the aesthetic, political and ethical implications of the question of subjugated/subaltern performativity, namely, “…who can get away with “wearing,” as students and teachers, the sensations/movements of the anomalous, sensational places of learning…?” (p.146). At stake is the inclusivity of these anomalous pedagogical performances which as Ellsworth warns,

…are not for everyone. [Since][i]f learning selves are going to be open endedly noncompliant, if they are to be able to destroy knowledge in order to revitalize it, a scene of pedagogical address must necessarily remain open and vulnerable to learning selves who might misuse it, reject it, hate it, ironize it, find and exploit its limits, and even ridicule it (p.165).

Most importantly perhaps are the sets of related questions that anomalous places of learning and their pedagogies raise for individual action, namely,

Are we up to it? Are we up to the trial of experience, to walking the spaces of difference between? Are we up to putting who we think we are at risk by putting ourselves in relation to outside others, the very others who we have used through our fantasies of them to create a sense of ourselves? (p.86).

Ellsworth’s answer is a cosmopolitan inflected yes, that, in facing the questions of ethical interdependency that are aroused, “[p]erhaps we can be up to it with others, without collapsing the irritating and productive differences between us that democracy requires” (p.86), what I elsewhere have called avoiding essentialist “singularities of sameness” (Khan, 2010).
Important to the work undertaken in this chapter are the speculations that Ellsworth offers in attending to the instructional film *Hemo the Magnificent*, a very different sort of pedagogical film, and its anomalous pedagogies. As a critical media scholar, she wonders,

> [h]ow can an educational film, probably one of the most nonanomalous, “closed” pedagogical texts…unfold in a way that seems to precede its own determination?” and suggests that perhaps its genius/merit is in, “figur[ing] out how to explain without imposing compliance… manag[ing] somehow to make explanation metaphorical and nonliteral…somehow manag[ing] to take explanation back even as it offers it (p.172).

In framing this chapter as an anomalous place of learning my goal is to “somehow manage to take [my earlier explanation] back” even as I invite readers’ into an experience of my and their learning selves in-the-making. I attempt to perform this alchemy by bringing insides and outsides into relation. Subsequent chapters then serve as my pedagogical pivot points bringing the film *All is Number* into relation with (some of) its outsides in mathematics education, curriculum studies and post-colonial studies, in an attempt to, “break up closed circuits of exchange of ideas, identities and practices inside education” (p.97) and to engage with a self in the process of making.

In the next chapter I change scales, drawing further away from the object of analysis itself – the film – and turn my attention to another way that mathematics popularization artefacts like *All is Number* might be considered. I move to the cultural and mythic spheres where I propose that rehearsing the implications of thinking *ethnomathematics* as *mythopoetic* curriculum is one way that might occasion the polyphonic conversations that are at the heart of this dissertation.
CHAPTER 6: ETHNOMATHEMATICS AS MYTHOPOETIC CURRICULUM

The ideas in this chapter are probably the most well-rehearsed in the dissertation. That is to say, in preparing this chapter I have recognized a trace, a long-gestating line of thought, and under-appreciated resource in my own writing and in the writings of those with whom I have been engaged. The ideas in this chapter can be traced from my earlier work on ethnomathematics (Khan, 2008a, 2008b) through more ethically inflected considerations (Khan, 2010) and into the most recent iteration (Khan, 2011), which this chapter follows closely and elaborates upon through examining the specific example that is All is Number.

This chapter represents an attempt to read and connect two literatures that present themselves in education – that of ethnomathematics in Mathematics Education and that of mythopoetics in Curriculum Studies – towards an end of more complicated and productive conversations. I propose that wrestling with the implications of thinking ethnomathematics as mythopoetic curriculum (e.g. Leonard & Willis, 2008a) – a conceptualization that is nowhere yet explicit in either literature – might occasion such polyphonic conversations.

In the first section I introduce the field of ethnomathematics, discussing the current state and highlighting an important critique. In the second section I introduce the mythopoetic strand in curriculum studies. I also claim and demonstrate that the pedagogical film All is Number can be considered an ethnomathematical artefact. In particular I argue that the field of ethnomathematics is perhaps in need of allying and allying with perspective from other affiliated disciplines. I then offer a re-framing of ethnomathematics as participation in mythopoetic curriculum.

**Ethnomathematics**

At present, ethnomathematical studies and critiques come from all parts of the globe. It is worth noting, though, that as a response to (ongoing) histories of physical, psychological, and pedagogical colonialisms and imperialisms (Bishop, 1990) the majority of research continues to be situated in, if not generated by, formerly colonized states. Selin (2000), in the introduction to the book *Mathematics Across Cultures*, states that “every culture has mathematics,” which she defines as “the study of measurements, forms, patterns, variability and change” (p. xvii). Barton (1996), however, reminds us to be cognizant of the fact that “the category mathematics is not common to all cultures” (p. 216). The origin of activities and questions that we might consider

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36 This section is a combined, condensed and revised version of Khan (2008b) and Khan (2011)
mathematical under this definition of mathematics is related to the practical necessities of
everyday life in different societies at different times, as well as religious and ritualistic
connections, what D’Ambrosio (2000) refers to as the “needs of survival and transcendence” (p.
80). The academic literature demonstrates that there is as yet no ‘simple’, universally accepted or
completely satisfactory definition of ethnomathematics. This difficulty of definition is a
reflection not merely of the differences of opinion among the many advocates of EM but
represents a healthy diversity of interests, foci, methodologies, and agendas of the various
researchers and practitioners.

Bill Barton (1996), for example, from a perspective of knowledge creation, defines
ethnomathematics as, “a research programme of the way in which cultural groups understand,
articulate and use the concepts and practices which we describe as mathematical, whether or not
the cultural group has a concept of mathematics” (p. 214, italics added). Ron Eglash (1997) adds
that this type of research, “generally strives to include conscious intent as an important
component of the analysis” (p. 81, italics added) while Rowlands and Carson (2002) suggest
that, [t]he emphasis in EM seems to be on the ‘doing’ of mathematics, in the sense of cultural
groups and peoples creating their own mathematics out of their everyday lives…” (p. 84). For
Adam, Alangui, and Barton (2003), however, ethnomathematics is better described as, “a lens
through which mathematics itself can be viewed” (p. 329, italics added) which “forces us to
reflect on our practice as mathematics educators, to reflect on our discipline…” (p.329).

The EM research project can be seen as a socio-political one involving a postmodern
critique of both the social construction of science, mathematics in particular, and the
consequences of the particular sociocultural construction that dominates most of the discourse in
the West. At a very fundamental level, EM aims to challenge hegemonic conceptions of what
counts or should count as mathematical. Barton (1996), for example, states that “part of the
purpose of ethnomathematics is to challenge the perceived universal nature of mathematics, and
to expose different mathematical conceptions” (p. 216).

At present the field/area/discipline of ethnomathematics (EM) can be said to be
productive. Evidence of this productivity is visible in the continued interest by and publications
in ‘major’ journals (e.g. Doolittle & Glanfield, 2007; Khan, 2008a; Palmer, 2010), books (e.g.
Barton, 2009; Nicol, 2011), book chapters (e.g. Rivera & Becker, 2007; Rosa & Orey, 2007),
conference proceedings, plenaries (e.g. D’Ambrosio, 2010; Doolittle, 2007), and symposia.
Another, perhaps more significant, indicator of the health of the field is continued debate and critique among members in (e.g. Pais, 2011) and allied with the field itself (e.g. Denzin, Lincoln & Smith, 2008; Nasir, Hand & Taylor, 2008) that seek to advance knowledge and praxis and which are not identical iterations of well-worn conversations. Teachers in multicultural societies are increasingly turning to ethnomathematically inspired research in an attempt to address or redress curricular inequities affecting various groups. This practice however is not without criticism.

Pais (2011) for example has recently argued that “ethnomathematical research runs the risk of conveying an idea of culture where the Other is squeezed from its otherness” (p. 209). Drawing upon the work of Slavoj Žižek, particularly his critique of multiculturalism within capitalism, Pais utilizes Žižek’s concept of a desubstantialized Other with respect to ethnomathematical projects in referring to pedagogical practices in which cultural artefacts with mathematical significance are stripped and sanitized of all other cultural (social, political, economic, religious) associations to become “just another way of teaching mathematics” (Pais, 2011, p. 224). Addressing directly those of us who work in or come from privileged societies, Pais (2011) argues that:

> [t]he power of capitalism to produce variety is at work in the educational applications of ethnomathematics […] This incorporation of ethnomathematical ideas into capitalist dynamics is made possible through the deployment of an ideological injunction where we are willing to accept the Other deprived of its otherness (Žižek, 1992). That is, we are willing to accept the Other as long as it fits into our symbolic order; as long as it is kept at a safe distance, the distance that prevents us from reaching its non-symbolic dimension. I love the Other (the poor, the indigenous) precisely because he is poor, oppressed, and utterly helpless, needing protective care (p. 225).

In calling our attention to a tendency of desubstantialization, Pais reminds us of one of the field’s major ongoing epistemological issues: the conflation of the term “ethno” with the otherness that is represented by the terms “ethnic” and “indigenous”. This conflation means that ethnomathematics-informed curriculum projects sometimes involve no more than translating and inserting situated mathematical practices (Palmer, 2010) into classrooms, often from marginalized cultures into the dominant culture of school (see also Vithal & Skovsmose, 1997).

Pais (2011) also argues that “a problematization of society and the role of school in society is…a priority in a research program like ethnomathematics. But that is far from happening” (p.219, italics added). In particular, he raises critical concerns about the co-opting of
the liberatory and emancipatory potentials of ethnomathematics by school practices (cultures) when the situated knowledge and institutional cultures of the dominant models of mass schooling and the power of capitalism are not simultaneously considered. While not going quite so far as Illich (1971) in calling for deschooling, his argument resonates with some of the sentiments in the Learning Sciences (eg, Sawyer, 2006; Schank, 2006) and Critical Mathematics Education in terms of questioning the formatting power of the mathematics taught in schools (Skovsmose, 1994) and of challenging those whose ethnomathematical work seeks to bridge different situations.

Following Pais’s critique above, there is also a need to problematize the ethnomathematical practices of privileged school systems. This is the next turn that I believe ethnomathematics needs to explicitly take: to examine the specific, yet diffuse and abstracted mathematical practices in the networks of powerful and privileged elites across diverse societies as specifically ethnomathematical research projects. Using Pinxten and François’s (2011) analogy of ethnomathematics as the “car repair department of mathematics education” (p. 7), this turn towards the uses of mathematics in privileged societies, is a deliberate political intervention meant to directly engage the absence of any consideration of what happens in the car design and car sales promotion program of mathematics education in which many of us participate (p. 7). Until and unless the frameworks in the field are used to frame, name and investigate ethnomathematical practices and artefacts that are closer to home, whose peculiarity perhaps is that that do not seem ‘strange’ at all, the term will continue to index that which is Other to “traditional” mathematics.

Watson (2008) for example calls school mathematics a “special” kind of mathematics. I would like to suggest that a productive reframing may be to temporarily shift our attention off the signifier “ethno,” with its emphases on cultural associations and orientalist concerns towards drawing from and upon the linguistic and semiotic resources in considering ethnomathematics as a specifically human genre (Khan, 2010a). I see one of the pressing tasks for the field as collecting the relevant fragments scattered under related rubrics such as ‘Critical Mathematics’ (e.g. Skovsmose, 1994), ‘Mathematics for Social Justice’ (e.g. Gutstein, 2006) or ‘Mathematics for Sustainability’ (e.g. Renert, 2011) and situating them in relation to ethnomathematics or, more cautiously as ethnomathematics without necessarily having to make Ethnomathematics a superordinate generic category.
In the next iteration of the field ethnomathematicians will have to address less visible mathematical practices, albeit ones that are more familiar and in which they/we are likely deeply implicated, from which they/we derive benefits, and which demand complicity if not compliance. Those powerful mathematical practices in and out of education increasingly, invisibly and invariably structure the patterns of negotiations, transactions, dispersals and disposals of the modern world. They will have to do so by choosing not to eschew the political dimensions and implications of their work, adapting insights and strategies from the work already developed in the ‘field’, and perhaps doing more intensive ‘fieldwork’ closer to home. It is not likely to be easy, painless, pleasant or without troubling and unsettling consequences for individuals and collectives. Perhaps what are needed now, more than ever, are distillations and juxtapositions, if not deliberate and judicious hybridizations with other fields of inquiry. In the next section I present what I perceive as one such propaedeutic alignment emerging from the field of curriculum studies.

Framing Ethnomathematics as Mythopoetic Curriculum

...mathematical language is a finished language, which derives its very perfection from [an] acceptance of death. Myth, on the contrary, is a language which does not want to die: it wrests from the meanings which give it sustenance an insidious, degraded survival, it provokes in them [those language objects which attempt to resist myth] an artificial reprieve in which it [myth] settles comfortably, it turns them into speaking corpses.

Here is another language which resists myth as much as it can: our poetic language (Barthes, 2009, p.158).

Myth

Similar to the concept of ethnomathematics, the idea of ‘myth’ has come to mean different things and there is no single agreed upon definition of what myth is in an ontological sense. Heller (2006), for example, argues that the modern world itself is characterized by an absence of ‘living myth’ which she suggests has been, “whittled down to its romantic appeal and entertainment value” (p. 1). However, one facet that is agreed upon is that myth, despite the generic use, is not necessarily an ‘untruth’ or ‘fanciful story’. ‘Myth’ is not an Other to ‘truth’ or ‘fact’. Myths mean something to the teller and to the audience and creates assemblages of associations that animate individual, social or cultural life in their continued (re-)telling (Ellwood, 2008).
Myths as Narratives and Signs

Marderness (2009) articulates a complementarity between narratological and
semiological formulations of myth arguing that a given myth takes on, “distinctive significations
depending on how it is read” (p.31). In mythical readings, for example, a myth is a truth; cultural
readings take myth as a cultural convention; in extramythical readings a myth is an enigma; and
finally in mythological readings myth is an artifice (Marderness, 2009, p.127). It is mythological
readings with which I am concerned.

Mythological reading foregrounds the meaning of myths and their interpretations, and
begins by acknowledging that “myth is motivated” (Marderness, 2009, p.98). Such readings
attempt to “decipher myth” by “approaching it from outside the myth itself” (p. 99). Deciphered
myths may be revised and reinterpreted and may again come to function as myth. These two
processes are central elements of mythopoiesis where they are referred to as “demythologizing”
and “remythologizing”.

Mythopoetics

In North American curriculum scholarship the term mythopoetic, whose two roots
(mythos + poiesis) literally mean “myth-making”, is traced to the work of James B. Macdonald
and his 1981 essay “Theory, practice and the hermeneutic circle”. In that work, Macdonald
parsed methodological approaches to curriculum theorizing into three genres: scientific-
ratationalist, critical, and mythopoetic. For Macdonald, the mythopoetic is a type of imaginative
thinking, identified and associated with the work of humanistic and holistic educators who rely
project for Macdonald is translated into a vision of curriculum theorizing as “a prayerful act” in
which all three methodological approaches (science, critical theory and poetics) are reconciled.
Curriculum methodologies are seen as participating in and contributing to greater understanding
and “a more satisfying interpretation of what is” (p. 180) in education. Specifically, “‘technical
and utilitarian control’ are offered through scientific technique; ‘emancipatory praxis’ is made
possible through critical reflection, and […] ‘aesthetic, moral and metaphysical meaning’ is
available through poetics” (p. 182). Mythopoetics, then, “offers a way of synthesizing the best of
the progressive and critical approaches to education in post-Industrialized contexts” (Leonard &
Willis, 2008a, p. 8) and its goal is to re-establish the place of imagination in the curriculum
(Leonard & Willis, 2008b, p. 265).
Some curriculum theorists, however, draw too fine a boundary that, in effect, sidelines mythopoetic scientific writing on education. Such theorists ignore the fact that science and mathematics have their own poetics and construct powerful mythologies. Perhaps, as Barthes’ quote above suggests, they, like many others, have come to believe in a myth of mathematics as a “finished” language with a body (of knowledge and ancestors) made up of “speaking corpses”. They also overlook the role of mathematical and scientific narratives in demystifying and demythologizing powerful cultural truths and in positing alternative ones. Perhaps it is difficult to conceive of the language of mathematics (or mathematics education) as also a poetic language. It may be difficult to believe that such poetry is capable not only of resisting the mythic models that reign upon the world (some of which were identified in the first section), but also of restoring and reconciling the wounded grounds upon which we have trodden, and not so lightly. As such, it is not surprising that mathematics is nowhere explicitly represented in the literature on mythopoetics in education and mythopoetics is nowhere explicitly referenced in the literature in mathematics education.

It is my claim that the emergence, evolution, and development of ethnomathematics has been a mythopoetic endeavour involved in demythologizing and demystifying dominant discourses of mathematics and mathematics education and that there are some advantages in explicitly acknowledging this relationship. The work of Ascher, Bishop, D’Ambrosio, Gerdes, Powell & Frankenstein, Zaslavsky and others has functioned to demythologize some of the myths of mathematics education, while Lakatos’ *Proof and Refutations* is perhaps the most well regarded example in both mathematics and mathematics education. More recently Hersh and John-Steiner (2010) demythologize some of the myths of mathematical life. These authors, among many others, can be considered as performing mythopoetic work that could be foundational for imagining, designing, and enacting mythopoetic curriculum in mathematics education.

Some of the advantages I see in framing ethnomathematics as mythopoetic curriculum are that: it does not necessitate a desubstantialization of the Other; it opens mythopoetic systems (whether described as “mathematical” or not) of all societies to inquiry; it requires an understanding of situatedness and embodiment understood in their widest ecological senses; and it reduces (but does not completely resolve) some of the tensions between ethnomathematics and
critical mathematics education. It also invites dialogue with scholars outside of mathematics education who may have similar concerns.

The framing of mythopoetics that comes closest to ethnomathematics is that of Bishop (2008), who explores the potential of imaginal pedagogies in pursuing a difficult reconciliation agenda amidst the complexities of painful postcolonial contexts and settler societies. Bishop views the role of imaginal pedagogies as integral to “re-mytholog[izing] western systems of knowledge” (p. 33). In Bishop’s framing, this re-mythologizing is a form of decolonizing praxis of language and of the imagination. While the field of ethnomathematics (as well as critical mathematics education) has done much to demythologize some aspects of mathematics, future work will need to actively re-mythologize mathematics education and mathematics across all levels of society. Much work on indigenous knowledges (e.g. Archibald, 2008; Castagno & Brayboy, 2008; Denzin, Lincoln & Smith, 2008) and decolonial thinking (e.g. Mignolo, 2007) is likely to be of benefit in imagining an ethnomathematics reframed as a mythopoetic curriculum project.

The mythopoetic imagination in Bishop (2008) is tempered with a “reconciliation imagination” that is sometimes understated in the ethnomathematics literature. Such a reconciliation imagination is concerned with:

- the difficult challenges faced in a double process of acknowledgement and forgiveness, of grief and trauma alongside hope and healing; the complexities of acknowledging different ways of knowing, valuing, and experiencing in an inter- or trans-cultural dialogue; the struggle to re-imagine memory, responsibility, shame, grief, land, identity, and place; how to heal the imagination in the face of tragedy; how to imagine hope and transformation; plus how imagination itself functions in the struggles for such things […] the capacity to [even] imagine the scale of injustice and oppression, in all its myriad detail. (p. 33)

Grief, trauma, forgiveness, hope and healing—these words seldom appear together in the ethnomathematics literature or, if they do, they are presented in a sanitized and anaesthetized language in which excesses of emotion and traumatic experience are safely annealed. It is to such difficult dialogues and re-mythologizing that I believe the field of ethnomathematics and mathematics education more generally must now turn.

The Language is the Thing…

As Barthes (2009) suggests, “the best weapon against myth is perhaps to mythify it in its turn, and to produce an artificial myth: and this reconstructed myth will in fact be a mythology” (p. 161). Methodologically, this implies that ethnomathematics as mythopoetic curriculum is a
(re)turn to the poetic power of languages, stories and narratives to represent difference neither as exotic, nor as a desubstantialized Other, nor within a sterile singularity of sameness. It is instead to participate in myth-making, with an awareness that this is what the work might be about.

The language of the mythopoetic reveals its close affinity with the aesthetic and imaginative dimensions of human life. Holland and Garman (2008) describe mythopoetic texts as having, “an intriguing resonant quality, conjur[ing] up visions of eloquent language and elegant ideas, provid[ing] the linguistic form and melody of hermeneutic expression” (p. 13). This synaesthetic quality of mythopoetic works is articulated by artist-educator Leroy Clarke in describing his own work “playing with the word until I find the juices, the oils in them [...] beating words until they give off flavour and scent” (in Boyce-Davies, 2007, p. 4). There is a distinctive orality and aurality – perhaps even flavours and scents – to mythopoetic texts.

Mythopoetic curriculum texts attempt to ‘revivify’ curricula. They disturb the silences that usually prevails between ethical and political life-worlds and curriculum. Ubiratan D’Ambrosio’s plea in his plenary lecture at PME 34 (D’Ambrosio, 2010) for example that ‘outside’ knowledges be given “more than token presence in the curriculum” (p.16) as well as his choice of examples ranging across time and geographical space from *The Epic of Gilgamesh*, Fritz Lang’s movie *Metropolis*, Euclid’s *Elements* through James Cameron’s *Avatar* is a challenge to the field to engage more fully with ethnomathematics’ mandate, not only to demythologize but also as, perhaps even more importantly in the present moment to remythologize, through “open[ing] space[s] for the complex realit[ies] and…unrestricted imagination[s] resulting from fantastic visionary fiction” (p.16). It is not difficult to defend the claim that Ubi’s work in ethnomathematics is now more than ever that of a mythopoet. However, we would do well to heed Pais’ (2011) timely reminder of attending to the dangers inherent in presenting EM in a folkloric way.

Coming from the Caribbean with its ongoing histories of the repeated traumas of physical, psychological, and pedagogical colonialisms, I see my work as a mathematics educator as a mythopoetic task. This task is to enable the resurgence and reinvention of the music of living mathematical and curricular landscapes. The goal is not to break the mathematical spine of the modern world (D’Ambrosio, 2010, p. 3) but to show how what is taken to be static, fixed, normal and immutable might be transformed by subtle shifts in conditions and emphases. Mathematics and mathematics education are deeply implicated in colonialism, slavery, capitalism, modernity
and ecocide (see Khan, 2010b). Ethnomathematics, as part of the anthropological and cultural turn in educational research, has reminded us of that. At the same time however, mathematics education is yet to meaningfully engage with the pressing issues of grief, trauma and reconciliation in a coherent and consistent manner. It is yet to fully embrace its potential for and role in decolonization, liberation, justice and sustainability. Ethnomathematics is necessary for us to “probe deeply into the kind of world we inhabit” (Harris, 1999, p. 76). The field must find allies and alloy itself with disciplines and perspectives in which the imagination is central if it is to address or redress some of the inequities and injustices of the present. Framing ethnomathematics as mythopoetic curriculum may be the beginning of one such alignment.

**Popularization of Mathematics as an Ethnomathematical Project?**

In Chapter 2 I presented the traditional and new models of popularizations of science. The latter is socio-constructivist/socio-culturally based and emphasizes the social nature of the processes of knowledge construction, production and dissemination. In the new model, popularization is seen not as a second-order activity, but as “an active part in the process of producing and generating knowledge…in order to gain general support from society and lay-decision makers…” (Miller, 2009, p.260). In tracing the etymological development of the term ‘popular’ I have argued that with respect to the popular, the transgressive political power and the economic power of the pursuit of leisure and pleasure through consumption have come to be joined closely in the 20th century and are discernible in contemporary popularization efforts for mathematics and mathematicians. Following Hall (2009a) I take the popular to be a space in which, “the politics of signification … [continue to be] played out in attempts to win people to particular ways of seeing the world” (cited in Storey, 2009, p.4). Furthermore, as Storey (2009) argues, there is an implied *otherness* that is always absent/present” when the term popular culture is deployed that needs to be mindfully attended to and that, “whichever conceptual category is deployed as popular culture’s absent other, it will always powerfully affect the connotations brought into play” (p.1).

In general, mathematics popularization artefacts and the most (un)popular form of mathematics popularization – school mathematics – are consciously intended efforts “to win people to particular ways of seeing the world” (Hall, 2009a) through a mathematical or mathematician’s lens. Following Adam, Alangui, and Barton’s (2003) description of ethnomathematics, we might say that popularizations of mathematics also offer us “a lens
through which mathematics itself can be viewed” (p. 329, italics added) which “forces us to reflect on our practice as mathematics educators, to reflect on our discipline…” (p.329).

In What Ways can EM Projects be Considered a Form of Popularization?
There are at least two ways in which ethnomathematics can be considered a form of popularization. The first draws from the first associations of popular as branding and signifying that which is ‘other’ than the phyla of the privileged, i.e. in referring to the practices of “ordinary people”, the ‘volk’ in contradistinction to the practices of the nobility. This is the version of ethnomathematics that frequently finds favour with funding agencies, teachers, researchers and the public. But there is another way in which ethnomathematics can be considered a form of popularization as exemplified by popularization artefacts such as *All is Number* (among numerous others) which, as I have argued above, are also ethnomathematical. In this framing the ‘other’ culture that is presented is precisely a dominant conception of mathematics’ ontology.

Popularization then as a phenomenon belongs to the set of discursive and enactive practices that are co-opted in the service of mathematics that detour through ongoing anxieties about education and competitiveness. That is to say, attempts to popularize mathematics are a specific developmental moment in the evolving and expanding culture of Mathematics and the mathematizing (really scientizing) of mass culture. The short film sits squarely within the genre of mathematics popularization films and mathematics popularization more widely – this is the culture to which it belongs. The ethno that is presented is a version of Mathematics itself.

*All is Number as an Ethnomathematical Artefact*

It would be fairly straightforward to argue that the film *All is Number* is an ethnomathematical artefact primarily because it has emerged from a formerly colonized territory. This would be to claim that its status as an ethnomathematical artefact derives primarily from its geographical and socio-historical location outside of the imaginary loci of so called mathematical cultures as well as the national identities of its mathematical interlocutors. This essentialist construction would also likely depend upon a view that the film is part of a culture that is not typically considered to be ‘mathematical’. Indeed, ‘mathematical’ is not the usual association for many in North America (and Europe) with an imaginary of the Caribbean. As the film-makers note even within the region itself, this belief is not typical among students and the general population.
From the account above, *All is Number* is not what might be construed as a typical ethnomathematical artefact or ethnomathematical narrative. It is certainly however an artefact of mathematics popularization that has emerged from a region (the Anglophone Caribbean) in which there remain few traces of ‘indigenous’ populations and where individuals from cultures from around the world have been transported, transplanted, and transformed. These represent another category of absent others in the film to go along with biologists and social scientists and the way that artists and artisans are represented as discussed previously in Chapter 5.

What makes the film *All is Number* an ethnomathematical artefact in the second sense used above is the particular culture of mathematics that it describes and seeks to communicate. Similar to ethnomathematical projects that have taken place in other multicultural post-colonial contexts, this film can be thought of as a pedagogical response to a particular historical experience of colonization and the remnants of that colonial process in the specific contents of school curricula, examination practices and pedagogical practices that are often viewed as being constrained by the former (curricula) and funnelled towards the latter (exams). Unlike many of those projects which are currently classified as ethnomathematics and which are premised upon a social-constructivist view of mathematical knowledge resulting in the understandable emergence of different mathematical concepts and different mathematical practices in different settings, the underlying philosophical framework for *All is Number* seems more closely aligned with a Platonic universalism (Ernest, 1991). This Platonist ideology bookends the film from the opening title of the film – the Pythagorean declarative that “*All is Number*” – to the final utterances about the universality of mathematics. One of the ideological messages of the film is of a universal and culturally independent mathematics. This ideology would typically result in locating the film ‘outside’ of one of the traditional framings of ethnomathematics as attempting to deconstruct the hegemony of Western models of mathematics.

It could be argued that the film presents evidence for an internalized mathematical colonialism which is reproducing one of the dominant ideological discourses about mathematics that ethnomathematics as a research discipline has worked to counter in the 20th century, namely that mathematics is universal and independent of culture. I would argue too then that this reading of the text as an instantiation of ‘internalized colonialism’ is perhaps too an instance of internalized colonialism albeit perhaps from another end – that of the colonizer. I note that making the case of seeing this particular film as an ethnomathematical artefact opens the door for
a consideration and problematizing of other pedagogical films about mathematics that come from
North American and European communities. By taking this film as an ethnomathematical
artefact it demonstrates that ethnomathematics is not an Other to Western mathematics or an
Other’s mathematical practices.

In the next chapter I further develop the idea related to the mythopoetic potential of
ethnomathematical texts by framing *All is Number* as a maroon narrative.
CHAPTER 7: *All is Number* AS MAROON NARRATIVE

In Chapter One, I stated that a concurrent goal of this work was to contribute to developing a language and vocabulary for talking about education in the Caribbean. In this chapter I situate/locate the work of this dissertation as simultaneously participating in, enacting, and iteratively elaborating a particular historical-contemporaneous genre in the aesthetic literary practices of the Caribbean – that of “the maroon narrative” (James, 2002). Both the work of this dissertation as well as that of the central focal point of its analysis – the film *All is Number* – are successors to and in this tradition of maroon narrative for reasons I elaborate below.

I adopt as a working assumption and take as my starting point the expanded perspective of the significance of the maroon as a useful trope as articulated by Caribbean theorist and educator Cynthia James (2002). Examining the historical archive and articulating a dialogical relationship of the maroon concept in the context of to the trans-historical and trans-geographical development of Caribbean literatures in English, James loosens the concept ‘maroon’ from tight afro-centric moorings, demonstrating a multi-ethnic, cross-cultural current along which it has sailed and suggesting other routes it may yet take.

I do not, however, engage with the specific conversations within the field of Caribbean Literary Studies around the usage of the term. The two positions demonstrated in the literature – of self-emancipated mainly afro-Caribbean slaves and a more expansive conceptualisation as articulated by James (2002) – represent two inter-related axioms for generating the geometry of the field, each independently producing a fully consistent system in which to work. However I find the latter perspective more useful and productive for my work in this dissertation and, in particular, in rehearsing the implications of the film *All is Number*.

It should be noted that while related concepts like exile, migration, and diaspora are well-studied and can be found in the main introductory texts of Postcolonial and Cultural Studies (e.g. Ashcroft, Griffiths & Tiffin, 2000, 2002, 2006; Young, 2001) as well as within their own disciplinary formulations (Migration Studies, Diaspora Studies), there are fewer scholarly considerations of ‘maroon’ and ‘maroonage’. These studies tend to be confined to literary and culture studies, the historical study of maroon communities or, in one case, as a metaphor in education (Gift, 2008). While Gift (2008) uses the concept to explore the teaching of the Transatlantic Trade in Enslaved Africans, to my knowledge, the concept has not been used either literally or as a conceptual metaphor in educational or curriculum theorizing.
I take ‘maroon’ as a complexly embodied psychoanalytic hermeneutic aesthetic in Caribbean literatures in English that, as James (2002) notes, has been underexplored and perhaps conceptually undervalued among some (postcolonial) literary theorists. In the particular framework developed by James (2002) I feel harmonic resonances and suggest that such a concept might be useful and even important for education in the Caribbean, as well as in ‘multicultural’ Caribbean-like societies (CLS) engaged in the complex negotiations and endless re-articulations of assemblages of inter-cultural contact zones. In this chapter I bring the concept to bear on the film *All is Number* as an experiment in developing a language and vocabulary for Caribbean Curriculum Theorizing.

First, I describe/explain the features/characteristics of maroon narratives, and briefly make the case for the value of this concept as relevant to and potentially useful in formulating a specifically Caribbean curriculum theorizing. I also argue that mathematics education can be thought of as a maroon narrative. Finally I will attempt to demonstrate the value of this conceptual framework for reading this dissertation and interpreting the film *All is Number*. I will, throughout this section, offer speculative insights into the potential value of this concept for education and curriculum theorizing more generally.

**Characterising Maroon Narratives**

**Conceptual Development**

In this section I succinctly outline the development of the maroon concept in Caribbean literature and the evolution of its characteristics. The term ‘maroon’ in Caribbean history and literary theory is generally used to refer historically to primarily African slaves in the 17th and 18th centuries who, having escaped plantation slavery, formed independent communities in mountainous and forested areas. James (2002) notes that these maroon communities continued to “harry the British…eventually securing autonomous existence in [some] territories” (p.8). Tracing the different articulations of the concept James (2002) offers evidence for an origin in the Spanish word “cimarron” which “in the New World originally referred to domestic cattle that had taken to the hills in Hispaniola and soon after to [Amer]Indian slaves who had escaped from the Spanish as well” (p.11). By the 17th and 18th century the term “maroonage” had entered into Anglophone Caribbean vocabulary via its French usage and was transformed into a referent with connotations of “shipwrecked” or being “isolated”, a common feeling among European
This feeling foreshadowed the psychological ambivalence and anomie associated with the term in 19th-century literature about the Caribbean when, ‘to be marooned’ meant to be psychologically placed in the condition of a Caribbean runaway with all its attendant connotations of deprivation, brutality, withdrawal, and separation from ancestral culture… harboring connotations of pleasuring for a period in the wilds like the natives…[and suggesting] connotations of ‘tourist’ behavior. (James, 2002, p.13)

As the concept evolved over time, “depictions of physical confrontation in a plantation context” (italics added) associated with plantation runaways waned and emphases on “psychological confrontations mainly in villages and urban yards” (italics added) increased so that, “Maroon becomes less associated with open rebellion…and more associated with self-analysis, rootlessness, and identity formation within the context of ethnic diversity and ethnic estrangement” (James, 2002, p.55).

In the hands of Caribbean poet and cultural critic Kamau Brathwaite, maroonage becomes a trope in which ruin and dispossession become “the survival rhythm from which [societal] transformation may proceed” (232). Thus he introduces features such as resilience, survival, resourcefulness and innovation alongside concepts such as ancestral guidance and tragic warriorhood into his maroon embrace (James, 2002, p.8).

The concept of psychological maroonage as “withdrawal, with flight…manifesting itself in internal dis-ease” (James, 2002, p.8) is developed further by Gordon Rohlehr in exploring the terms “‘self-in-maroonage’ and ‘the submerged self’…terms connotat[ing] inner resistance and self-affirmation” (p.8).

Cultural maroonage is perhaps the conceptual articulation that will be most familiar to readers. René Dépèstre defines it as, “an artistic mission of resistance – in postcolonial terms, artistic effort that stakes its distinction on writing against the grain of the European and European depiction of the Caribbean (20)” (quoted in James, 2002, p.9). In maroon narratives postcolonial emphases on ‘writing back’ and ‘contrapuntal readings’ represent “an emergent voice that seeks to refashion English. [It] no longer wishes to be destabilized by the English pentameter…[and is] burdened with an “urge to interrupt the text” (James, 2002, p.6). This mission of resistance manifested in writing back and contrapuntal readings can be seen as an example of polyphony at play in these works in the way that the multiple ideas of maroon and maroonage inter-relate, the way they shape each other through dialogue.
Maroon Significations

Accompanying the evolution of the concept is its growing set of significations over time. The complex evolutionary entanglements and miscegenated history of the term ‘maroon’ in Caribbean literature to date is recapitulated in a polyphony of textual signifiers which are dually inflected/infected in ways that correspond to differences in the intersubjective positionings of its two archetypical protagonists – the European and the non-European maroon – and by their somatopsychic vulnerabilities, or what James (2002) euphemistically describes as the consequences of, “the differing conditions of their tenure in the Caribbean” (p.14). James’ (2002) comprehensive listing of these signifiers is worth quoting at length. She writes,

[a]mong textual signifiers of maroon narrative, negative landmarks include: feelings of abandonment, exile, isolation, and withdrawal, lawlessness, plunder and piracy; the plantation; slavery; domination; racial conflict and prejudice; a sense of historyless-ness and dispossession; mental aberrations; power struggles and revolts; betrayal and revenge; an ambivalent relationship with the past, with the past home and with the adopted home as loved places, lost places and places of hurt; itinerancy, a sense of transience and a sense of impermanence; a preoccupation with and a high regard for foreign standards, an illusion of greener pastures elsewhere; distortions of normative standards such as beauty; dystopia and defilement; and a tendency to license and abuse.

Positive markers include: a cultivation of psychological and physical defense mechanisms; a heightened sense of warriorhood; accommodation to loss and insecurity; development of survival skills and an effort to retain ancestral ways in addition to an investment in their propagation; a lowering of standards and expectations; miscegenation and creolization; religious and cultural syncretism; a heightened respect for the spiritual world; resourcefulness, resilience, and improvisation; a preoccupation with questions of identity; a desire to make history or to write oneself into history and a desire to establish order out of disorder and to invent the world afresh (p.15).

In light of the above, the maroon narrative in Anglo-Caribbean literature can be said to manifest/embody a mythopoetic struggle to reconcile, or perhaps dwell-well-with, oppositional binaries at the level of divided, competing, often contemptuous selves and cultures in half-made societies.

According to James (2002),

Transculturation and creolization are also central to Caribbean maroon theory, Unlike “assimilation” …transculturation signifies both hybridity in cultural features such as language and customs, and reciprocal interpretation of cultures…[while] creolization connotes interpenetration of cultures, but toward adaptation…The mulatto [becomes] a key figure in transculturation, metissage, and creolization. Consequently, miscegenation becomes an important marker in maroon texts as a medium for deconstructing the polarity between European and non-European. Miscegenation also provides a metaphor for collaboration and syncretism (p.10).
More recently, historian Keith Sandiford (2011), further develops the idea of this mythopoetic struggle in describing a Caribbean-Atlantic Imaginary\(^{38}\) that is, “at once ahistorical and metatextual…residing within a central mythic core” (p.20), “uncolonizable” (p.22), “an ocean of movements and cycles and flows” (p.149) in which the dynamic counterorders of maroonage or “flight to the hinterlands” (p.30) and practices like obeah function as critical if not kairos moments of deliberate epistemic “delinking” (Mignolo, 2007) from the static oppressivity of colonial orders. This imaginary Sandiford contends,

consists in the conceptual power to dissolve conventional mental boundaries…that promote the myths of masters and vilify the myths of slaves…unit[ing] scattered parts and transcend[ing] ‘instituted’ negation…it is the repository for meanings, memories and values in which the epistemic vitality of Caribbean-Atlantic culture may be found. (p.150)

Sandiford’s discussion of the Caribbean-Atlantic Imaginary may represent another articulation of Harris’ (1999) ideas regarding the necessity of being wary of strongly polarized thoughts and the vigilant need to rehearse the implications that I discussed in Chapter 1 that are perhaps one significant feature of the maroon consciousness.

In the literature of the mid to late 20\(^{th}\) century, Caribbean maroon narratives do not only continue to depict rebellion, but wrestle with the tensions of accommodation. James (2002) notes,

…increasingly the word maroon comes to signify syncretic, indigenous adaptation, arising out of accommodations made by the variety of ethnicities and mixed population…texts depict populations grappling with the fact that they can never reclaim the lost home that recedes in their memory. Characters…are challenged to find ways of dealing with a sense of distance, inferiority, and loss in evolving new identities and new societies (pp.55-56).

Thus the phenomenon of estrangement, of physical and psychical struggle and resistance of the “difficult knowledge” of not-B/being-at-home, comes to characterize the psychological spaces of the disparate members of the different groups involved in the colonial-modern mission and its current post-colonial variants.

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\(^{38}\) Drawing upon philosopher-social theorist Cornelius Castoriadis, Sandiford takes the imaginary to be “the magma or creative force from which a society's cultural origins may be traced…mostly invisible, self-creating and fluid...fashion[ing] the shape and order of social forms...creat[ing] or institut[ing] the foundations on which the values, norms and symbols of a society rest.[and which are] in a processual motion of becoming” (p.1). In this way he delineates his project as being concerned more with the “social and group relations...[of] individuals and communities in…phases of transition” (p.16) than with the individual psyche which occupies other theorists of the Imaginary such as Jacques Lacan.
While marronage is an important element in Sandiford’s (2011) articulation of a Caribbean-Atlantic imaginary that crosses and links Amerindians and African slaves’ resistance and which “brings into focus the deployment of the landscape” (p.90) in producing the Imaginary, James (2002) argues that, “an Afro-centered ideology has limited the concept…to a focus mainly on flight, resistance and survival” (p.1). As James (2002) argues, the experience of marronage is perhaps “the most recurrent feature of the Caribbean narrative from the beginning of fictional writing about the Caribbean” (p.2) where “innocence, exile, and a history of hurt, all revolving around a quest for identity” (James, 2002, p.6) are its early signifiers and the strict afro-centric ideological identification perhaps “marginalizes” other marooned populations in the Caribbean and its diasporas.

**The Value of the Maroon Concept for (Caribbean) Curriculum Theorizing**

Since the beginning of modern times each successive generation has had its shipwrecks marooned in the social void: the collateral casualties of progress. (Bauman, 2004, p.15)

If the implications of “maroon” were explored to the fullest extent, it would be observed that the maroon experience, broadly defined, is the most recurrent feature of the Caribbean narrative… (James, 2002, pp.1-2)

Over roughly 5 centuries of usage the concept of the maroon mutates from an embodied and enacted ecological signifier of otherness, resistance and rebellion during the birth of the coloniality-modernity-capitalism-slavery epistemic world-view, to being expressed in the variegated psychological states and socio-cultural consciousness of individuals and societies who do not find themselves at home anywhere. While the concept persists, it tends to circulate within a too narrowly conceived scholarly imaginary of the historical maroon – though care must be taken that the literal and embodied history of the concept does not become occluded. Others have noted this unusual confinement. For example, James (2002) notes that, the French Caribbean poet Edouard Glissant, “sees the Caribbean as having failed to make the maroon its ‘tutelary hero’” (p.8). In this dissertation I consider what can be learnt by taking the maroon ethos as an anomalous place of learning and encountering the difficult knowledge of those things that cannot be healed, mended, cured, saved or salved but must be lived with for as long as they persist.

Miscegenation, hybridity, transculturation, métissage, creolization have become descriptors, if not hallmarks, of the colonial legacy in the Caribbean and elsewhere at other inter-cultural contact zones. These phenomena speak – albeit unequally – to the violent and forced
inter-penetrating cultures as well as to the resourcefulness, vigor, and adaptability of the species thus produced, whether this be people, language or culture. Such crossings – the interpenetrative inter-relations of peoples, places, things and thoughts – are often, as James (2002) notes, markers “in maroon texts…for deconstructing the polarity between the European and non-European” and “…also provides a metaphor for collaboration and syncretism” (p.10). However an Afrocentric situating of the maroon concept limits its ability to perceive the phenomenon’s applicability to a much wider Caribbean community, viz. other intra-Caribbean races/ethnicities, the diasporas, and perhaps, by taking the “Caribbean” as an equal concept, as say for example Europe, and not merely as a geographically defined region (Knies, 2006), to exo-Caribbean people.

What then do I view as the potential value of this concept for education and curriculum theorizing in the Caribbean specifically and Caribbean-like-Societies39 more generally that goes beyond the particular analysis of the film presented in this dissertation? I am mindful of an underlying situated epistemology, an implication of which perhaps is that much of what is called ‘Theory’ does not often travel, translate, or bridge easily to other societies or contexts except possibly to the extent that the phenomena under consideration share sufficiently similar historical and developmental trajectories and have been part of the expression of relevant global genotypes of dominant epistemes. In this section then, I rehearse what I see as some of the implications of the maroon concept.

It is my goal here to trouble and unsettle the relative ease and facility with which scholars in education continue to translate and write European, North American, and Continental theories upon the landscapes of “living ruins” (Khan, S. H., 2010). It is my goal to use this lesser-studied and as yet under-valued concept from Caribbean literary theory, not as a wedge, shovel, sword, or pen but in a more mindful way – as a sacred comma, a pause, and a sacramental moment for reflection. What I am hoping for is the fact that Theories ought not to be used as indiscriminately

39 There are many ways to talk about the Caribbean which has been imagined and imaged in different ways (Mohammed, 2009). Following Caribbean philosopher Lloyd Best (2001) however, I take three defining features of the Caribbean as: firstly, that the population is transplanted and introduced from elsewhere, secondly that the people come from many different places at many different times, and thirdly that they are colonized. This trinity as Best notes makes the Caribbean unique. He states, “[r]ight from the start there is a dimension of complexity that you have got to deal with. The Caribbean really is the workshop of the world in that sense. Over the course of 500 years…in very intimate social situations…we’ve had to come to grips with a whole new reality…” (p.25). Indeed he notes the critical importance of this experiment in attempting to make a society or a civilization from disparate groups under these conditions since —globalization is imposing that experience on everybody now” (p.25). It is this latter sense to which I refer when I use the term Caribbean-like-societies.
and without attending to their appropriateness, fit, and relevance for/to the situation(s), the object(s) or subject(s) being analyzed/described as they have been and are sometimes used in education (and other) discourses.

For the study of Caribbean Education and Curriculum Theorizing, the maroon concept provides a “paradigm that has not been fully explored for all it can yield… [to the] search for a Caribbean aesthetic” (James, 2002, p.1). Such an aesthetic is simultaneously ‘not yet’, yet critical if not crucial to re-imagining an educational project and agenda fit to the Caribbean region and its diasporas. It provides a very broad yet nuanced, that is a complex conceptual schema for talking about the individual and cultural experiences of education in the post-colonial Caribbean and its ‘outposts’ in the North American, British and European hinterlands. One of its as yet unrealized values is to enable the broadening/blurring of the boundaries of the canon of Caribbean literary and other aesthetic texts and in the case of this dissertation, narratives in education and curriculum theorizing.

For the study of education and curriculum studies in Caribbean-like Societies, the concept of ‘maroonage’ provides an important way to read the literatures in education and curriculum studies, in particular some of the more recent work on post-colonial and postcolonial studies of education, produced by scholars in ‘exile’. For example, how might synoptic histories of curriculum studies be re-read as synaptic texts, maroon narratives in which exiles and shipwrecks are to be found building anew, forming connections among peoples, places, things, and thoughts?

In addition, the concepts of maroon and maroonage add to the lexicon in psychoanalytic studies of curriculum studies of individuals and texts in Caribbean-like Societies and to the literatures on cosmopolitanism in education – much of which is being written by intellectuals in exile in one way or another. Sharon Todd (2009) for example in her recent work on cosmopolitanism reflexively notes that the monograph was,

conceived at a juncture of my own grappling with upheavals of identity, place and language…my recent move to a new country and all that such relocation entails, has brought home to me the urgency of thinking through the borders of belonging and what kinds of demands we make on ourselves and others to make a new place in the world. (Todd, 2009, vii)

This ‘grappling’ with issues of ‘identity’ and ‘place’ and ‘language’, which are the result of relocation, in working through the demands of cosmopolitanism and education are manifestations perhaps of Todd’s own unique maroon narrative, influenced by her movements –
both physical and psychological – from North America to Europe. Perhaps the concept of the maroon might have something to say to her or to other writers/educators in ‘exile’ and those who have an interest in education in multicultural contexts.

Working on the concept of maroon theory here in Canada, British Columbia and Vancouver in particular, I find that the concept is being influenced and inflected differently. Here the history of separation from ancestral cultures is different and the pain, grief and hurt of the violence of residential schools on individuals, families, communities and indeed on cultures still runs deep. This suggests a revealing alternative dimension as yet unconsidered by Caribbean maroon theory – the fate of those who were not physically separated from their land (although legally, spiritually, and otherwise) and whose ties to ancestral cultures remain present and visible but at times remote and commoditized. There is then something more even for Caribbean maroon theory to learn in considering the experience of the indigenous/aboriginal populations of Canada in the post-residential school era – in the returning to a home that is no longer home. An emergent question for further theoretical reflection with others is how might the experience of maroonage apply, if at all, if/when one has never left home? What distinguishes a maroon narrative from other literatures and descriptions of exile and migration for me is the coming to awareness of an oppressive situation, the active revolt against the oppressive situation/formulation, the conscious decision not to return to that state, the psychological wrestling with these choices and the desire and activity to create something new, and hopefully less oppressive, with others. There is perhaps some relation, a kinship with the concept of Ubuntu (Swanson, 2007) in this conceptualisation.

Having described/explained the features/characteristics of the concept of maroon narratives and the potential value I see as being afforded by a deeper consideration of its relevance for curriculum studies, I turn now to the specific object of analysis – the film All is Number – as I attempt to demonstrate how the concept is useful in interpreting the film as well as critically engaging with the film as a maroon narrative within the context of mathematics popularization.

Mathematics Education as a Marooning Activity

Réyni, (1967/2006) in his fictional Socratic Dialogue on Mathematics, presents Hippocrates’ analogy that, “the mathematician is more like a discoverer [than a painter]. He is a bold sailor who sails on the unknown sea of thought and explores its coasts, islands and
whirlpools” (p. 10), and thereafter concludes that, “[t]he main aim of the mathematician is to explore the secrets and riddles of the sea of human thought. *These exist independently of the person of the mathematician, though not from humanity as a whole*” (p. 11, italics in original). Without delving into an extended post-colonial critique of the colonial implications of the ‘explorer’ and ‘discoverer’ motifs in this analogy, Réyni in the *Dialogue*, connects – albeit likely unintentionally – the study of Mathematics with the type of dangers associated with shipwreck and therefore maroonage. This particular trope of the mathematician as discoverer, however, does not attend to the “collateral casualties” (Bauman, 2004) of such exploration or the psychological effects of the training for such exploration.

I did not start out thinking about the relationship of the concept of the maroon as developed and circulated within the flows of Caribbean literary theory for mathematics education specifically. However, I find in the descriptions and significations presented above a peculiar and painful resonance with many of the narratives of students of mathematics education (this includes teachers), reported in the academic literature and popular media. These include, “feelings of abandonment, exile, isolation, and withdrawal” “domination”, “a sense of historylessness and dispossession”, “power struggles and revolts”, “a preoccupation with and a high regard for foreign standards”, “distortions of normative standards such as beauty”, “dystopia”, “a cultivation of psychological and physical defense mechanisms”, “accommodation to loss and insecurity”, “development of survival skills”, “a lowering of standards and expectations”, “resourcefulness, resilience, and improvisation”, “a preoccupation with questions of identity”, and “a desire to establish order out of disorder and to invent the world afresh” (James, 2002, p.15). In many ways, the literature in mathematics education can be construed as extended and extensive engagements with the phenomena of physical and psychological maroonage in the lived-experience of learners of mathematics. If mathematicians are like sailors, then many students perhaps seem to be marooned – shipwrecked on the Isle of Math.

**All is Number as Maroon Narrative**

Whereas the concept of a Maroon Narrative finds its origin in Caribbean literary theory, I believe the concept has the potential to successfully cross-over into film/media-studies and education. Caribbean filmic narratives have evolved out of these sorts of oral and written narratives. In this section I want to claim specifically that the film *All is Number* is an example of a maroon narrative. In order to justify this claim I will need to demonstrate that it shares the
necessary qualities identified previously. The question with which I engage in this section is “How might *All is Number* be construed as a maroon narrative? I argue that *All is Number* can be viewed as a response to the undesirable situation in mathematics education in the Caribbean, creating something new with (and for) others.

As discussed in Chapter 1, the film *All is Number*, stands as perhaps the first attempt at mathematics popularization via the medium of documentary film in the Anglophone Caribbean, and certainly in Trinidad and Tobago. It is something new, a form of “indigenous adaptation” (James, 2002) whose destination is cultural enrichment as well as survival in the modern world. In producing the film the film-makers engage with a diverse set of individuals including those who appear in the film as well as those who served as consultants and who are credited. This however is not the most important way in which the film can be considered a maroon narrative. *All is Number is a response to an undesirable situation.*

*All is Number* can be considered to be a response to the undesirable situation described in chapter 1 (see Table 1) in which, over a period of seven years, more than 400,000 or approximately three-fifths of examination candidates’ experience of mathematics includes that of failure on the regional Mathematics examination. Such massive failure and concerns with social, political and economic well-being often serves as a prompt for mathematics popularization projects as described in chapter 2. Although the producers of *All is Number* are not reported as explicitly citing the regional failure in mathematics as an incentive for their popularization project, it is worth noting that the film emerged from within a regional higher educational institution where the context of estrangement and separation from mathematics is an ongoing concern.

The film can be read, following Dépêstre (cited in James, 2002) as an “artistic mission of resistance” on several fronts/levels. Firstly, it provides alternative ways of looking at mathematics that are rendered in sharp relief to traditional modes of presentation and elaboration often found in school mathematics. As described in chapter 4 some of the main ideas communicated about mathematics through the aural narrative are that school mathematics is not all there is to mathematics, and that mathematics is useful and is associated with beauty. These ideas are meant to offer an alternative position and some resistance to beliefs about school mathematics which often make the discipline seem tedious, cold and distant to the everyday aspirations and lived-experiences of learners.
Part of its resistance too is accomplished through the visual elements presented which are intended to be familiar to members of the imagined audience of secondary/high-school students such as the beach, trees, a river-bank, and flowers. At another level, the film also can be construed as a deliberate and artistic ‘writing back’ to practices of education and mathematics education in particular in the Caribbean and elsewhere that are not inviting and cut-off learners from sources of knowledge and understanding that might enable them to access and deploy the ‘culture of power’ that is mathematics.

*All is Number* wrestles with tensions of accommodation.

The film *All is Number* while being made in the Caribbean is positioned in relation to other films and artifacts within the genre of science and mathematics popularization that are made elsewhere. The choice of topics discussed in chapter 4 for example follows some of the more successful areas that have been the focus of repeated popularization efforts – Pythagoras’ Theorem, Fractals, Chaos, Fibonacci, Golden Ratio – in this genre. In this choice of topics there is an attempt to wrestle with and come to a suitable accommodation that is attendant to the limits imposed both by the formal curriculum structures as well as the need to start from within these structures and move outwards. This is also represented at the level of the constraints imposed on the film-makers by the genre, funding, and time in the acknowledgement by Dr. Haque presented in Chapter 4 that each of the individual topics presented could have formed the basis for an entire feature.

Another area in which the film demonstrates a negotiation with insides and outsides concerns the visual representation of the landscape of the Caribbean. In attempting to illustrate that “mathematics is all around us” the film-makers show familiar images from within the Caribbean such as sea, sand and vegetation juxtaposed with images from outside, such as the space-shuttle, the Parthenon and the Mona Lisa. In presenting images and ideas that are simultaneously proximal and distal, this visual polyphony poses an unstated challenge to viewers – namely, “to find ways to deal with a sense of distance, inferiority, and loss in evolving new identities and new societies” (James, 2002, p.56) through the narrative and ideological bridges that run throughout the film, viz. that “mathematics is everywhere” and “all is number”. The early image of a triangle traced with a stick in sand on a beach is an invitation to begin in one familiar place, and through mathematics, traverse unfamiliar realms. As a metaphor, the image of the triangle on the beach, also evokes the idea of a mathematical palimpsest which will
eventually be erased by the actions of wind and tide. It thus offers a moment for reflection and wonder as to what other mathematical traces might remain yet hidden but present in one’s environment and what forms of new inscriptions one might write for oneself by choosing mathematics.

**Self-analysis and identity formation in *All is Number***.

Perhaps the most important attribute in describing the pedagogy of the film as a maroon narrative is the space it opens up engaging with questions of individual and collective identity and individual and cultural analysis. In chapter 4 I noted that part of Dr. Haque’s stated motivation for producing her previous film and this one was to offer an expanded narrative of what the Caribbean is known for, beyond the stereotypes of the beach, Carnival, and Laureates in literature. Seen from this perspective *All is Number* can be construed as an attempt to offer students in the Caribbean region an opportunity for self-analysis and identity construction in relation to images of mathematics that are perhaps not often presented as being available to many.

The film however, as an anomalous place of learning and as a teacher can only offer the opportunity; it cannot guarantee that the opportunity will be taken up, or predict when and how this self-analysis and identity formation might occur, or even in which directions it may unfold. What is important though is taking this first-step towards an affirmation that ‘we’ too in the Caribbean, despite the fact that we have not often thought of ourselves in this way, might take on the particularly privileged label of scientist and mathematician for ourselves and come to notice and value mathematical competencies as well as challenge as part of the work that one does.

This framing of mathematics education as a marooning activity/experience troubles the motivations described in Chapter 2 around the rationales given for popularizing mathematics and in particular the discourse of simplification discussed in Chapters 2 and 5. In describing *All is Number* as a maroon narrative what are the implications for mathematics education? The film, as a maroon narrative addresses those who continue to experience conflict in the entanglement of estrangement, hurt and dislocation in mathematics and wrestles with the need to accommodate difference and otherness from the perspective of the previously colonized.

In the next chapter I situate myself in a mythopoetic rendition of my own maroon narrative and introduce the idea of a kumbla consciousness leading to my own term intervulnerability as a meta-theoretical framing for the type of analysis I have undertaken in the
previous chapters. The chapter is meant to function as my main pedagogical pivot point in this dissertation.
CHAPTER 8: A REFLEXIVE MOMENT

In many ways my experience of this particular enactment of doctoral education and of writing the dissertation can be described as a marooning one. I do not think this is a unique experience. However, in my case, very early on in the process – less than two months in – I physically abandoned my doctoral seminar and though my body returned to the classroom in the coming weeks I do not think my spirit ever has. That moment has become an identity marker, which I have indexed now to a mythopoetic re-construction of a-Being-not-at-home-with-oneself.

“My blue ballpoint pen rests uncomfortably upon the blue lined notebook paper. Its broken clip leaves a scar like a soldier’s shattered helmet. It cuts a cross, crucifying lines, point extruded, ready, quivering with every shallow breath and nervous shake of restless feet, betraying the throbbing in my left cheek that comes from holding tongue and thought in check.

She lies, waiting for me to pick her up, pull sword from stone, and press into memory of forgotten trees. No ink will spill past that meatus today! I can no more be unfaithful to my muse as to myself. The pen that moves and the tongue that speaks, without examined piety, authors ruin.

A maroon narrative continues to write itself on this plantation…

I am brown, and yellow and red, dirty proud blood – submarine memory of Eastern caravans and caravels – Caramel maroon, residue of sugar’s ménage with fire, oil, and iron.

I, inheritor of dust and salt and coral fragment, scratch a comma in this world…

In this poetic re-collection of fragments of self-identity I have attempted to honour the origins of my maroon heritage situated within the colonial history of exploitation in pursuit of
sugar and then oil as well as my own more recent ancestor maroons, coming from the Middle East – Afghanistan (a heritage and identity I never identified with until after the post 9/11 invasion and destruction) – China, and India and the peculiar genetic legacies they have bequeathed to me. As a ‘brown-boy’ from the Caribbean island of Trinidad I have become aware of the advantages, privileges, as well as dangers of exoticism in the academy. Indeed, at my very first conference (in 2005) that was one of the very first questions posed to me by Bill Pinar – “Do you feel exoticized?” I did not understand the conceptual space that Bill was coming from at the time as I had not yet engaged with thinking or reading about the debates about identity politics and post-identity politics – the politics of belonging and not-belonging and of academic visibility and invisibility. I really was coming from a different place altogether.

As Millner (2005) recounts, the reconceptualization of identity in the 1990s by scholars such as Bhabha, Butler, Chow, Fuss, Gilroy, Sedgwick et al., “as performative, mobile, strategically essential, intersectional, incomplete, in-process, provisional, hybrid, partial, fragmentary, fluid, transitional, transnational, cosmopolitan, counterpublic, and, above all, cultural” has given way to an abiding, “sense of exhaustion” and “depletion”, a questioning of the continued conceptual viability and an explicit desire by some for the field of criticism to “move on” (p.541) from its obsession with identity which leaves open the question, “[a]fter a politics of cultural identity, what?” (p. 553). Indeed, identity is only a beginning. I take a dialogical view of ‘self’ as being more than “biological and somatic, but [also] cultural and ideological” (Rolston III, 2010, p.231) with the attendant acknowledgement that one’s affiliations are frequently “trans-tribal” (p.231) and that any form of self-narration is always translational or trans-scribal.

This dissertation, in one sense, recapitulates the sort of psychological and physical disconnection from peoples and places, the struggle(s) to make anew, something new out of something old, in an at times unforgiving academic environment. It wrestles with the difficulty of, as Ellsworth (2005) says, trying to put inside and outside in relation, or adopting a more mathematically themed metaphor, to introduce a fold, a limen, within an individual self. When I claim that this dissertation is a maroon narrative I do not do so based on any essentialist representational quality of ‘maroon’, although, as narrated above, I do identify myself as a particular maroon variant. Rather, I make this claim based on the belief that the dissertation expresses some of the characteristics, qualities and psychological influences (of those of which I
am aware) that are part of what has been described above as a maroon consciousness – the
writing in exile, the feelings of estrangement, the longing and the absolute necessity of trying to
make something new out of what resources one finds at one’s disposal – both material and
spiritual.

The Emergence of a Kumbla Consciousness

I asked Shalini for help. I needed the right word to encapsulate ideas of dynamic change,
infectious entanglements, metamorphosis, amnesia, and the claustrophobia of a world held in
tension. From some forgotten well, a submerged oasis, of ancestral knowledge, she drew the
pregnant line, breathing softly an almost lost note of the music of living landscapes, and offered
me a —*Kumbla.*” A word held in tension, saline suspension, resonating and reaching out across
seas and generations, seeking, longing…Lynda pointed out that kumbla was a *Maroon* word, a
remnant of the languages of slaves, who survived. A kumbla is about survival. Jamaican novelist
Erna Brodber introduces the concept of the kumbla in the novel *Jane and Louisa Will Soon
Come Home* (1980) in this way:

A kumbla is like a beach ball. It bounces with the sea but never goes down…Moreso than the beach buoy.
The sea never covers it; it never stoops to fight. It takes no orders from the sea but neither does it seek to
limit it. The beach ball sets no measure on the sea, seeks not to guide swimmer or non-swimmers; it merely
bounces as it will upon the sea, the sand or anywhere. Haughtily. A kumbla has these properties. It bounces
anywhere. Unlike the buoy, it is not tethered. It blows as the wind blows…It makes no demands of you, it
cares not one whit for you…

But the kumbla is not just a beach ball. The kumbla is an egg shell, not a chicken’s egg or a bird’s egg
shell…it does not crack if it is hit. It is as pliable as sail cloth. Your kumbla will not open unless you rip its
seams open. It is a round seamless calabash that protects you without caring.

Your kumbla is a parachute. You only you pull the cord to rip its seams. From the inside. For you. Your
kumbla is a helicopter, a transparent umbrella, a glassy marble…., a comic strip space ship. You can see
both in and out. You hear them. They can hear you. They can touch you. You can touch them. But they
cannot handle you….Safe, protective time capsule (p.123).

Now I understood why it fit. The word itself was a kumbla, an important metaphor for
mutating contested spaces, nurturing but potentially imprisoning – like School, like the
Caribbean. Structures implicated in each other’s becoming, inviting in, offering safe space,
respite, but easily becoming another Euclidean prison. Many of the ends prescribed by current
educational discourses, like social efficiency, national citizenship, and economic
competitiveness, are not kumblas. Like a buoy they never seem to go down for very long. Tethered by strong historical, economic, and geographical lineages they permit movement only within this prescribed and defined radius, moving only as far and as much as the world around moves it. Unlike a kumbla these discourses sometimes do try to reign in the Sea, calm its unruliness and turn this unruliness to their own purposes. The lack of success of this approach is evident in the problems of schooling in the Caribbean that have spanned the last century and threaten to overwhelm in this one.

What might happen though if we played with the idea of mathematics education as a kumbla? What would be the features of this form of consciousness that could be called a kumbla consciousness? How would it relate to the other forms of consciousness that we try to bring into being in education – critical, historical, ecological, spiritual, mythological? What might this mean for thinking about mathematics education (in and out of the Caribbean) and Curriculum Studies? Can we, dare we, pull the cords, from the inside, for ourselves?

Schools, curriculum and educational discourses, oscillating between fear of vulnerability and desire for invulnerability, have not in the main taken on the form of a kumbla but perhaps, now more than ever, they might find some benefit in doing so. There is an important caveat however. A kumbla is not just a space for survival and transformation, it can also be physically and psychically constraining. As Brodber (1980) cautions,

…the trouble with the kumbla is the getting out of the kumbla. It is a protective device. If you dwell too long in it, it makes you delicate...skin white but not by genes. Vision extra-sensitive to the sun…Weak, thin, tired like a breach baby (p.130).

The kumbla is indifferent, though not unresponsive, to this transformation. A time capsule becomes a prison in time. School and most curricula exist as yet in such time capsules. The kumbla, a Maroon word, a remnant of the language of slaves, who survived by pulling the cord for themselves, taking their own freedom, learning to make a home for themselves and dwell with others, in the only place in which it is possible to do so, outside their kumblas, is a testimony, a reminder that any safe space for development and transformation, offers only temporary respite, comfort and security from being too vulnerable. What separates a kumbla consciousness from other forms of consciousness is this awareness of perpetual unfinishedness and the need to find new ways to pull the cords that bind. The kumbla as a mythical concept (Barthes, 2009) is a dissipative psychic structure, shape-shifting ember, umbra, ephemeral embryo of memory, a soucouyant seeking skein. But a kumbla is not a dwelling place.
In appreciating why a kumbla is not a dwelling place I draw upon Levinas’ ideas on welcoming and hospitality⁴⁰. Hospitality \((hospitalité)\) for Levinas is inseparable from the dwelling (home) as he says, —I welcome the Other who presents himself in my home by opening my home to him (1969, p.171). Thus, as Gauthier (2007) argues, the home/dwelling - achieves its full dignity when the Other is welcomed into it, thereby transforming it…” (p.160). The home/dwelling is unique in that it is the site from which the self, by being safely housed, by being itself welcomed as a guest into the home, can – recollect itself in earnest” (p.161) so that it might be able to extend hospitality to the Other as host. In welcoming and inviting the Other to dwell with me in my home not as an extension of myself, both dwelling and dweller are transformed. The kumbla is a space in which one resides, or finds a home albeit only temporarily. It is not a space in which the Other can be welcomed. It is a (necessary) physical and psychic retreat from the Other. It is a womb of space-time in which the Self can survive just long enough, in order to respond to the call of the Other. While the kumbla is a shield for the vulnerable self from the world outside, it too is vulnerable, from the inside. It is in being called forth from oneself, by another, and pulling, for oneself, the psychic cords that enables one to come out of one's kumbla, that the relationship of what I call intervulnerability, the need to un-settle one's Self and take up one's responsibilities for an Other are made manifest.

Brodber follows her polymorphous, polysemous description of the kumbla – her anomalous pedagogy – with a story of Anancy and Dryhead, the King of the Sea. The story connects Africa and the Caribbean/New World and implicates the birth of capitalism, modernity, colonialism and slavery within a narrative arc of transnational survival that perhaps continues to resonate with if not resemble the experience of immigrants and refugees today.

Anancy took his son Tucuma to fish in Dryhead’s waters. He was taking a chance and Anancy knew it but he didn’t intend to starve. Anancy took his son Tucuma to fish but having no skill on water, he rowed right into Dryhead’s palace and Dryhead is the king of the water. Anancy went too far this time. He put himself in deep waters. But Anansi is a born liar, a spinner of fine white cocoons, a protector of his children. Not to worry, they’ll survive. Anancy is a maker of finely crafted kumblas… (pp.123-124).

⁴⁰Bauman (2004) alludes to something similar in the analysis of Siegried Kracauer whose reflection on, Kafka’s allegory of the subterranean shelter which an unnamed safety-obsessed animal spent its life designing, digging and endlessly perfecting only to deepen the terror that kept it working, [he] suggests that in human societies “the building that one generation after another constructs is sinister, because this structure is to guarantee a security that men cannot attain...Since this fear also wants to eliminate (the) insecurities inherent to creaturely existence, the burrow is a work of self-deception (p.50).
After being caught, Anancy tricks Dryhead into believing that, unable to manage, he has brought all his children for Dryhead. He negotiates with Dryhead however to let him leave with one of his children - Tucuma. Brodber writes,

You know how sometimes when you love somebody and you don’t want the whole world to know how powerlessly in love you are, you sometimes manhandle him in public. How at the times when your love makes you most vulnerable to attack from outsiders, you scream, kick and curse the loved one in company? Anancy spoke this kind of language and knew that Dryhead understood it. His vulnerability was supposedly under double attack: he had to expose his deep love for his children in public and had to watch himself give away the things that were dearest to him. So it was expected that he would revile them doubly cruelly at a time such as this. As soon as each supposed child appeared Anancy would shout at him contemptuously...

- Your face favour…go eena kumbla-

To Dryhead and his court, this was a bad word that only a man so torn with grief could utter to his child. To Tucuma it meant: find yourself a camouflage and get back into the store house (pp.127-128).

“Go eena kumbla,” acts as a code for Tucuma to change his disguise each time. In this way Anancy tricks Dryhead and saves himself and his son. Cobham (1991) suggests that kumbla is a metaphor for the strategies and sometimes disfiguring devices used by enslaved Africans to protect their children as they struggled to survive in this New World. She also uncovers another aspect of the story. Tucuma, she learns, means “the one born away from home,” and suggests that although we may not have known it, through these stories we, Caribbean people, descendants of slaves, have passed on narratives of survival, “nam[ing] ourselves as survivors in the process” (p.42). The kumbla is about survival. The metaphor of the kumbla gestures towards a novel form of consciousness, a maroon consciousness. It is (perhaps) only in emerging from the perceived security, safety, and invulnerability of the kumblas that we now inhabit, that now colonize and cannibalize our selves, that we (might) begin to embrace the possibility of creating dwelling places and begin to enact and pursue as an end what I, in working through the traumas of doctoral education, have called intervulnerability with others.

**Introducing Intervulnerability**

A few partial definitions are required before introducing the concept of intervulnerability. The first of these is *shape*. The idea of changing the (pre)dominant ‘shape’ of the language of education draws from complexity thinking (e.g. Davis & Sumara, 2006) and postcolonial/decolonizing approaches to education (e.g. Asher, 2009; Willinsky, 1998).
former draws attention to the current horizon of ‘geometric’ metaphors in educational language in particular the over-reliance on Euclidean and Cartesian metaphors. In the framing used here I draw upon Wilson Harris (2006) who writes,

Yes I know I am [limited]. That is why I seek new shapes – not just for their novelty but as a way of approaching what is insoluble yet may be real (p.52)

…a shape which represents an eternity of riddles, a shape brooding upon ruin and unknown fulfillment and origin (100).

The latter foregrounds the need to play with dominant language in attempting what Mignolo (2007) calls an epistemic delinking.

The second term that needs to be defined is ‘Fear’. Here I draw primarily upon Jules Henry (1963) and Audre Lorde (1980/1997). Henry, a psycho-analytically informed anthropologist, discusses fear transphenomenally. For him, Fear is necessary for individual biological survival. However, at the cultural level – when fear penetrates all aspects of culture and becomes a dominant driving force – the culture freezes in fixed attitudes of attack and defense and all cultural life suffers. The Self nearly dies in the cold (p.43). Lorde echoes similar sentiments, writing that,

…we have been socialized to respect fear more than our own needs for language and definition, and while we wait in silence for that final luxury of fearlessness, the weight of that silence will choke us…for it is not the difference which immobilizes us, but silence. And there are many silences to be broken (p.22)

The next term, ‘Sun’ is used here in the sense of Harris (2006) who writes,

[t]he Sun or Brain rules us and makes us cruel to ourselves and others. We fear the testing Darkness which can bring a wholesome change if we can fuse it with the Sun and see that fusion in a new, creative universe (p.90)

highlighting the uncertainty and resistance surrounding revolutionary thoughts before new syntheses. The double entendre evoked by the homonym ‘Sun’ is intended especially when combined via the preposition ‘of’ with the next term, ‘Man’.

Finally, I draw upon Sylvia Wynter’s construction of the genre of Man which refers to the complex configurations and accretive articulations of institutional associations within which she identifies a dominant bio-cidal episteme, cultural logic or order of consciousness, a spiritual shape, that engendered and accompanied the rise of Western Humanism, rationalized colonial expansion, and undergirded the rise of the modern world. The overrepresentation of this episteme as the only ‘true’ logic or way of being human, enacts a pandemic genre which negatively marks ‘otherness’ and ‘difference’ as ‘defect’, ‘deficit’ or ‘deviance’ by default, she
calls *Man*. ‘School’, personified below, is one of the institutions *through* which Wynter’s *Man* is reproduced.

*Vulnerability and fear are the two qualities of the human condition out of which official fear is moulded...*

(Bauman, 2004, p.46)

I am dissatisfied with the service rendered by the shape of the extant vocabulary of education and have been trying, for some time now, to nourish, articulate, and steward a concept that embodies, evokes and educes the breathless, silent, forgotten (repressed?), but ever-the-restless rhizomes, archive of spectral ancestral bodies of memory, and forgetfulness, that inhabits the interstices between vulnerability and invulnerability. A concept that is brudda/sista/fadda/mudda/other, rudder; that traces ragged arcs of incidents’, accidents’ and occidents’ traumas, in dehiscent lines, along the parched pursed seams of space between abject fears of dependence and imaginary desires for independence: interdependence’s symbiotic soul.

Hear ‘*Voice*’, the Void of feeling, suffering, dis/orient-ation, becoming, homecoming, welcoming, dwelling devoid of Fear, of implacental line, of loss, of Love, of Self and Other, call out to ‘*School*’, the Sun of Man, too-big-too-fail, too big, too frail, to tolerate eclipse of reason. We *Douens* refuse to learn new ways to walk. We attempt to mimic the gaits of bodies not our own, to walk as if on lands not separated by seas and suffering and silences. Seduced, we continuously stumble into each other, gyrating, gyre hating, gaia hating, reducing the truth, beauty and wisdom of the moment of the mas to mono-manic-monument – *mere* masturbation. But, might we start *in* some different place?

Multiply positioned complexly *dis*-embodied realities, compose maroon narratives that impress upon consciousness a demand for *form*, from freedom in language, a shape, lyric lament, capable of holding the contradictions of hope and despair that accompany unruly Desire and un-

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41 In the Caribbean, Trinidad & Tobago in particular, the ‘Douen’ is a feared supernatural character of folklore. They might be read as a metaphor for disability and our ability to disable our selves, the tragedy and fear of the return of the souls of Caliban’s neglected and rejected, dead, un-baptized children, Fanon’s *dames de la terre*, *dis*-embodied in the form of the ‘deformed’, ‘twisted’ and ‘obzocky’ bodies. *Douens* that haunt and hunt us, *Douens*, those deformed liminal creatures with feet pointing backwards the embodied receptacles of our collective fears and failures. Monsters and not men. Perhaps they/we are the result of a different, parallel, developmental pathway to that which took place in the European hinterland, the other, ‘dark’ side of the modernity-colonialism project in which man was given value based on hue/hew?

42 ‘*Mas*’ is not only a contraction of masquerade. However, it is used here in the sense elaborated upon by Trinidadian carnival artist, Peter Minshall. Gulick (in Narine, 2009) explains that, “mas necessarily implies performance...it is a performance art...it is about taking the essence of a people and processing it in such a way that you can represent it in a form that has not existed before, but which the people will immediately recognize and lets them see themselves and understand their own essence.”
Desire-ability that interdependency‘s irreverent invocation invites. This half-spoken, half-heard, half-made, amniotic shape, takes on, for now, a form: intervulnerability.

[Intervulnerability] is a ‘responsible generosity’. an asymmetric asymptotic commitment to welcoming an Other that is not contingent upon the fear or pain of an Other’s capacity to wound, for it begins in recognition that in the presence of the Other, we, and the Other, are simultaneously vulnerable to each other; we wound each other, whether we intend to or not. It does not emerge from a longing for independence/invulnerability or a fear of dependence/vulnerability/disability that builds walls, sets-apart or demarcates boundaries, but it is a continuous working through, a coming forth, to materialize a valuing of the relationship between one’s own and other’s vulnerabilities. Intervulnerability interpenetrates, interrupts and re-interprets the smooth flow of an interdependency discourse that too easily slips into fears of being completely dependent on others and the fiction of independence. Its recursive recalcitrance dislodges the naïve belief that it is possible to be psychosomatically or politically invulnerable in any social world. It entails a certain spirit of insecurity, one which heralds the possibility of welcoming stranger geometries of social organization and political action in which all can belong and participate – intervulnerable societies.

For me, the intervulnerable society manifests a pantisocratic dynamic which begins with the acknowledgement that individuals do not have equal power in every sphere, except perhaps the capacity to be wounded and the need for assistance. In this type of assistance what matters greatly is how one is accompanied. For Jean Vanier (1998/2008) the Latin roots of accompaniment, cum pane, with bread, “speak to a form of community life which implies sharing together, eating together, nourishing together, walking together…helping us to come to life…giv[ing] life to one another and call[ing] each to greater freedom” (pp.129-130). In education this describes a curriculum vitae – a course of/for life that we might aim for, one that extends the bounds of learning to explore what more it might mean to be and become human or how, as Sylvia Wynter (2000, cited in Roberts, 2006, p. 184) suggests, in following an “autopoiesis of the human” we might reimagine, “…a conception of freedom able to draw all of [Man’s oppositional sub-versions] together in a synthesis”. This drawing together, following mythopoetic artist Leroy Clarke (2008), is “an act of gathering, gathering the human truth that persists, in spite of perilous efforts of our present world to drive it into amnesiac vacancy…” (p.xxv).
In the Caribbean society of Douens which now admits a historical global dimension of wasted lives (Bauman, 2004) and waste-as-way-of-life, an awareness of intervulnerability and interdependence is one way for all to move forward. One (person) keeps an eye firmly on the future, the other leads in the choreography, the mas, moving the two together in a direction which one cannot see, except perhaps in glimpses and glances, but who must trust the fidelity of the one who describes the course, that they both take, negotiating the terrain, their roles and each other through dialogue – both teaching and learning from and with each other and from the journey undertaken.
CHAPTER 9: WHAT IS MATHEMATICS?

“Full of puzzles, mathematics is a puzzle in itself” (Sfard, 2008, p.3, italics added)

At one level this chapter (and the dissertation itself) can be thought of as a full-length response to the final utterance of the film All is Number in which the female narrator opines,

The beauty of mathematics is that it does not matter if you are at a river’s edge on a Caribbean island or in the far reaches of outer-space. It does not depend on a place or time, a people or culture. It is universal in its relevance. It describes that which we can and cannot see, choreographs the dance of the atoms on the tiniest scales, while describing the universe on the grandest. Nature speaks and if we listen carefully enough, it speaks…mathematics. (Haque, 2010, 16:45)

As in classroom teaching the final summative utterance of a pedagogical film like All is Number often serves the purpose of reiterating and attempting to reinforce the main idea or concept of the lesson (through repetition or recursive elaboration). It seeks to bring a sense of closure to the particular lesson while holding open spaces for new questions, new possibilities and for renewed inquiry – the next rehearsal. This terminally placed slogan/caption provides a final opportunity for the teacher to state clearly what the point of the lesson has been and to draw together the multiple strands. In the case of a documentary pedagogical film, the final utterance functions as a metonymic signifier for the message that the film-makers have attempted to communicate to the (imagined) audience. It is the last words that the audience will hear in the film and will likely be among the things recalled, especially if such prompting takes place within that narrow window of time following the film/lesson’s end and the inevitable arrival of some other stimulus to which consciousness must attend.

In this closing utterance, as in the succinct title All is Number, a complex epistemological ideology is summarized and valorized: to enumerate and to quantify is to know and such knowing transcends people and places. Consider however the effect of juxtaposing Sfard’s (2008) critique with the closing utterance of the film presented above:

…it in their zeal to produce simplicity, order, and unification…quantitatively minded interlocutors are likely to gloss over potentially significant individual differences. It is only too tempting to believe that numbers can say it all and that when they speak, there is no need to worry about words. (Sfard, 2008, p.xvi)

In any intentional pedagogy, numbers cannot ‘say it all’, all is not number; words, image, and inflection matter. In this final utterance the political dimension, if not motive, of a pedagogical film like All is Number is rendered explicitly. This moment then, despite offering an invitation to closure, also offers an important opportunity to contest. The stake in this engagement is not only
the authority to define mathematics and consequently mathematics education itself. The stake is higher – to delineate the way in which learners are to relate to mathematics.

My own opinion and immediate reaction to the final utterance was that “this statement is untrue”. Where the beauty of mathematics is concerned I believe it does matter if you are at a river’s edge in the Caribbean, the far-reaches of outer-space, tattooed on a train to Auschwitz, or shackled and packed-for-profit in the belly of a slave-ship to a ‘New’ world. It does depend on place, time, peoples and cultures. It is not universal in its relevance and nature does not ‘speak’ mathematics. These differences of opinion are already well rehearsed in the philosophy and histories of mathematics and mathematics education (see for example Ernest, 1991).

What is being communicated in this final scene is a particular ideological view of mathematics, a mythology that has been well rehearsed and whose legacy lingers in being globally staged with diverse actors. The particular set of privileged beliefs about what mathematics is that prevails during a given period is strongly associated with what those in positions of authority and responsibility in a society choose to teach, and not teach, as mathematics. The ontological status of mathematics is thus linked to epistemological beliefs about what knowledge is of most worth (curriculum), how such knowledge can be represented and communicated (taught) to the next generation (pedagogy), and decisions about who can or cannot do mathematics (politics). The alternative perspective, a mythopoetic re-imagination and orienteering towards something that might be called a mindful mathematics, is no less ideological but is less well rehearsed in the present moment. Perhaps the resistance and recalcitrance of this educational problem resides in the very term, that contested subject, object of disgust and admiration, of love and hate, that is ‘mathematics’ itself and the quality and nature of its relations to its proliferating, hyphenated, and alienated descendants.

In a recent mythopoetic critique (Khan, 2011), I imaginatively rehearsed the possibility that any “acceptable” nominalization for what might eventually come to be construed as ‘mathematical practices or thinking’ in the future might perhaps not even deploy the word ‘mathematics’ as a privileged categorical or conceptual signifier. An earlier rehearsal of the argument is offered in Sfard (1998) who identifies one of the possible consequences or risks of such a shift as being the perception of a lack of “clearly delineated content” which renders, “the whole process of learning and teaching…in danger of becoming amorphous and losing direction” (p. 10). The seriousness of this risk cannot be glossed over and must be attended to.
Coming back to the film, to be fair, significant effort and thought did go into its production and it is regionally and institutionally important for the ground that it breaks, but, and this is my point as an educator and mathematics educator in particular, I find the film to be educationally unsound, or rather insensitive to developments in pedagogical communication, mathematics education and education in particular, and a potential contributor to perpetuating some damaging stereotypes, beliefs and myths about what mathematics is and who can do it that works against our efforts at transformative education. In particular an unstated implication for learners in the title, “All is Number” is that if you’re not ‘good’, meaning ‘fast’ or facile, with numbers then you’re probably not mathematically able. This is a disabling belief.

In mathematics education, the concept of ‘number’ occupies simultaneously a privileged and peculiar position. Wagner and Davis (2010) observe that while numbers, “permeate the existences of citizens of the modern Western world” (p.39) and that “past, present and future are framed by and infused with numbers” (p.40) there is a “numbness that accompanies quantification” (p.40) which might work against students developing the types of critical number sense (numeracy (Paulos), mathemacy (D’Ambrosio), Steen, Skovsmose etc.) that is often one of the primary and explicit justifications offered for why students must learn mathematics in many curriculum documents (e.g. NCTM, SEMP, BCMath Curriculum, CAPE, CSEC).

Good mathematics teaching, including that of pedagogical film, must present a richer more complex and dynamic network of metaphors than a singular and well-worn one. Number is but one metaphor and an inadequate and extremely dangerous ideological one at that for a mindful and responsible mathematics education.

Towards a Mindful Mathematics

Consider the pair of images below. The image on the left is a scan of a newspaper advertisement that ran in the major Sunday newspapers in Trinidad in January of 2011. I have deleted the names of the presenters, though I was one of them, and the contact person’s information. The image on the right is the same as the one on the left minus the graphic of the calculator. What difference, if any, does this removal make? What messages, if any, do they seem to be communicating about what mathematics (and by extension mathematics teaching) is about? What (discourses/mythologies) are they already rehearsing? What are the implications? What, if anything, makes them a potentially ‘anomalous’ places of learning?
Figure 4: Newspaper advertisement and public invitation to panel presentation (Trinidad Express, 2011)

A look at this advertisement in relation to others from the same university, notes that it follows the same formatting style. There is a bold header identifying the Faculty and School. Below this the content is distributed in an asymmetric 2x2 grid, with a pair of images – the University crest and calculator (in the original) – occupying the left-hand side and the information describing the nature of the event (panel presentation) – presenters, date, location, time, target audience, cost and where to go for further information – occupying the space on the right-hand side. Simply removing the image of the calculator as I have done makes the ad top-heavy and ‘unbalanced’. At the level of the structure of the ad then, the (mathematical) aesthetic values that are visible include balance, symmetry, and the regularity imposed by a grid or matrix. This layout ‘works’ to make reading the text and gathering relevant information speedy.

The first time I saw the ad, as I was flipping through the newspaper the weekend before the panel presentation, I felt annoyed. I felt that the image of the calculator worked against the idea of mathematics we were hoping to present in the panel. In retrospect, my reaction was likely a conditioned response based on the work I had read in critical mathematics education and the psycho-socio-cultural study of beliefs in mathematics as well as the privilege I gave to my own research findings during my M.Ed about this belief among high-achieving girls (Khan, 2006) that mathematics is computation. As I am writing this, however, placing the two images side-by-side, it is the first time that I am able to acknowledge that given the constraints of the genre (physical newspaper advertisement) and the mandate that ads presented to the public be
‘consistent’ and have certain features (the University crest being one), placing a relevant image on the bottom left hand corner makes sense.

In asking myself the question why would I put an image of a calculator there, the conditioned critical response would be to impute that the graphic designer strongly associates mathematics with calculation. I find that I cannot justify that claim. I can acknowledge however that the image of a calculator is perhaps one of the more salient and familiar visual associations that the public (in Trinidad) has with mathematics and is not necessarily off-putting, despite my own inclinations to read this image in a particular way. I am forced to confront the humbling possibility that despite my ‘academic’ readings and concerns, this image might be ‘fit’, ‘good-enough’ for the purpose of a newspaper ad – a piece of disposable pedagogy – whose primary purpose is to attract and hold attention in order to convey information and offer an invitation. The image of the calculator while certainly ‘objectionable’ does not interrupt understandings of mathematics as computation/calculation but may function to address those in the target audience by referencing a familiar image and/or not providing an ‘alienating’ one.

My intent in reading this particular image here is not to name, blame and/or shame anyone – that would be opposite to a mindful critique, but is connected to my view that mathematics is a human activity, part of the legacy of human culture, historically evolved, socially mediated (Hersh, 1997) biologically based (Devlin, 2000; Núñez & Lakoff, 2000), sharing aspects with art, science, language, religion and continually being created. We academics sometimes forget that!

The image below – a personal, dynamic assemblage of ideas – is a visual summary of what I think mathematics is. It is now fairly well accepted, if not widely promoted, that metaphors are fundamental to many aspects of human cognition, both more generally (Fauconnier & Turner, 2002) as well as in specific knowledge domains like mathematics (Núñez & Lakoff, 2000). The underlying justification for my constructing this particular representation/illustration of “what mathematics is” is based on attending to Sfard’s (1998) arguments regarding the relative advantages and dangers of metaphorical pluralism over metaphorical singularity/exclusivity, except that I have here applied them more narrowly to conceptions of “learning mathematics” instead of “learning” in general. Indeed, examples of acquisition and participation metaphors identified by Sfard for what learning is can be found in the view of mathematics as a body of knowledge and situated practice in the figure below.
Figure 5: What is Mathematics – A personal dynamic assemblage
The advantages of metaphorical pluralism, especially when such metaphors might appear to be contradictory or incommensurable, are: prophylactic – offering some “protection against theoretical excesses” (p.10); emancipatory – revealing the somewhat arbitrary nature of the basis for classifications and categories; mnemonic – serving as a perpetual means of, “screening each other for possible weaknesses”; and ultimately democratic – as this screening allows for “...a much better chance for producing a critical theory of learning. Such a theory would inquire after the interests of all of the parties involved in the learning process...” (Sfard, 1998, p.11). While I do not claim that the figure above could ever pretend to attend to the interests of all involved in mathematics education, I have tried to be attentive to as many communities as possible, viz. mathematicians, mathematics educators, students, teachers, parents, cognitive scientists, neuroscientists, sociologists, psychologists, critical theorists, philosophers (of mathematics and mathematics education), artists, mythologists, and eco-humanists. Following Sfard, I argue that the particular metaphor of the mycelial assemblage that is the network or concept-map above is necessarily figurative and simultaneously effective and productive in keeping open the question of what more and what else mathematics might yet be(come).

I come to the acknowledgement that mathematics is “not independent of humanity” but “created by human activity” and “part of human culture” (Hersh, 2006, p. viii) via repeated encounters – rehearsals – with the work of Reuben Hersh (1997) and Paul Ernest (1992) and the ethnomathematics literature. That mathematics is a product of human biology is evident throughout the work of scientists like Butterworth (1999), Dehaene (2011), and Núñez and Lakoff (cognitive linguistics, 2000) among others. The six black text-boxes with white text anchor my conceptualization of what mathematics is: Mathematics is Embodied, Enacted, a Form of Life and Way of Living (being-in-the-world) that involves Making Connections (‘this’ is related to ‘that’) and Making Distinctions (‘this’ is different from ‘that’ in these ways). In doing this Mathematics, like other living-learning organisms, rely upon life’s propensity and dependency on recursion and repurposing/re-appropriation (memory re-consolidation and brain plasticity being two examples). This formulation provides a potential avenue to rethinking ‘transfer’ of learning whose conceptual metaphor, grounded in motion and activity in the world, is misleading – nothing is transferred when knowledge learnt in one context is ‘applied’ in another setting. Rather new connections between domains are made in a recursion that
repurposes and refashions the already available knowledge/networks to ‘fit’ the contextual stimuli of the new situation.

Hersh (2006) speculates that given the multiplication of approaches to studying mathematical behaviour and cognition – e.g. cognitive science, neuroscience, semiotics, socio-linguistics – that the question of ‘What mathematics is’, is “detach[ing] from philosophy to become [an] autonomous discipline” more amenable to scientific inquiry (p. vii). He goes on to suggest that

if a mathematical notion finds repeated use…then such repeated use may testify to the universality, the ubiquitousness, of a certain physical property – [such] as discreteness…On the other hand, the use of such a mathematics may only be witness to our preference for a certain picture or model of the world, or to a mental tradition which we find comfortable and familiar.” (p.325, italics added)

In the case of number, for example, it is the physical property of discreteness – or the ability to make distinctions among objects, to detect boundaries – which enables humans to conceptualise and develop a technology like number. And while other species may have similar neurological apparatuses for detecting boundaries and circuits for number and symbol processing, thus far it appears we are the only species which can, or chooses to communicate this powerful idea and understanding symbolically and through cultural means.

**Divided to the vein**

"I who am poisoned [enriched] with the blood of both,  
Where shall I turn, divided to the vein?"

(Walcott, A far cry from Africa, 1246.26-7)

From the old linguistics, the linguistics of the word (Derrida, 1976, p. 20-21), we probably should never consider the signified mathematics education prior to the transcendental signified mathematics and education. Mathematics education could never be a transcendental signified, a unity, prior to mathematics and prior to education. There are two words mathematics and education and bringing them together as one transcendental signified would obliterate the unity of the original transcendental signified. In this way many people understand, for instance, mathematics in the term mathematics education, as an adjective of education. Mathematics education would be a special kind of education. In most cases then, the term mathematics education attempts to preserve the full meaning of an original transcendental signified mathematics (Batarace & Lerman, 2008, pp.44-45).

Batarace and Lerman’s (2008) deconstructive interrogation of the debate between mathematicians and mathematics educators, cast elsewhere as ‘math wars’, elaborates this branch of thinking and makes the even stronger claim that, “mathematics is threatened in the trace of mathematics education” (p. 51). What they argue is that “mathematics-education-read-at-one-go” (p.51) disrupts and “obliterates” the sign mathematics and effaces the transcendental
signified *mathematics*, which is preserved in those understandings which take the *mathematics* in mathematics education as functioning as no more than adjectival adjunct.

This process of disciplinary adjectivication of education, they suggest, constructs the potentially unified signifier ‘mathematics education’ as no more than “a special kind of education” (p.45). This process carries over, they argue, in conceptual conjunctions prevalent in mathematics education research such as, “ethnomathematics, socio-cultural studies of mathematics education, critical mathematics education and also specific notions such as mathematics for teaching, or everyday mathematics” (p.46) whose consequence is to, “promote a meaning for *mathematics* that is not exactly the meaning of mathematics, to promote a *mathematics* for those who fail in mathematics, to promote a *mathematics* which does not come from the *ethnos* of mathematics, and so on” (Batarace & Lerman, p.46). Indeed, witness my proposal here for something that could be called ‘mindful mathematics’ as testimony to yet another iteration of adjectivication seeking something askew but as yet unable to crack the kumbla or escape the gravity of mathematics’ obit.

Mathematics education, they suggest exceeds and therefore must mistrust the epistemic closure offered by being under the rubric mathematics as ever being adequate for the problematics with which mathematics education concerns itself. Simultaneously, however, mathematics education is never able to, “remove the ever-haunting trace of the classical centrality of an original mathematics epistémè” (p.46) and must incessantly “ask for help from the nature of mathematics knowledge” (p.47). This brings mathematics education into a pre-epistemic debate, a “debate against itself…a debate of mathematics education with the name ‘mathematics’ which is marked within its own name” (p.47), “a debate about mathematics” (p.51) which not only threatens the originary imaginary that is mathematics with obliteration, but also “the name of *mathematics education*” (p.51). Like the maroon, Mathematics Education too in its discipline is divided to the vein.

An indicator that the field of mathematics education is becoming more and more “divided to the vein” is the increase in adjectified and hyphenated identities (e.g. socio-cultural approaches to mathematics education) that has resulted from the (not always appropriate) deployment of theoretical and paradigmatic programmes. The conflicted identity that Batarace and Lerman (2008) and Sfard (1998) among others sense and describe is strongly suggestive of a
discipline (meaning its practitioners) perhaps wrestling with the consequences of psychological maroonage.

It is at this juncture that I begin to sense that some form of this debate has already been rehearsed elsewhere, in other terms, on Others’ bodies. The terms underwriting this debate – a psycho-somatic revolt against a self-marked by one’s own name and in one sown body which seeks successful stabilization of identity through a poetics and politics of relation with the difficult knowledges of compromised ancestries, complicities in colonial atrocities, and the unsettledness of Being-unhomed – suggests a kinship in which mathematics education can be considered to be writing its own maroon narrative. Mathematics education, “poisoned with the blood of both” Mathematics and Education, licit literate hybrid of mathematics and education’s tropical encounters, finds itself turning, trying to face self-contradictory realities and loyalties as Being-divided-to-the-vein while wrestling with the oedipal implications of an awakening of its fossilized colonized consciousness and the ever-imminent threat that such consciousness poses for the erasure and effacement of the names it names within its self – the calumny and vulnerability of not-Being or Being-alone.

The ‘work’ of some of these hyphenated and adjectified descendants of mathematics education (e.g. ethnomathematics) can thus be considered as analogous to the ‘writing back’ of postcolonial and post-colonial subjects, artists, and theorists. This though is a writing back against the assumption that mathematics education was ever a terra nullius whose inhabitants could forever remain enslaved, if not permanently indentured, eternally indebted to Mathematics – lifelong and trustworthy servant to the “Queen of the Sciences”. What these descendants have not yet done, to my knowledge, is to successfully stage performances of this genre of writing back in the very languages of mathematics, i.e. (mathematics) educational performances which take the languages of mathematics and its local and global effects as the motivating context for problem formulation (in mathematical language). That though is not the work of this thesis.

Closing Thoughts

In completing this dissertation I have found it necessary to farm/mine/pan/plumb/read/resurrect/scout/scour/scavenge the living landscape for appropriate concepts. I have utilized such concepts – like the kumbla, maroon narrative, mythopoetics, and ethnomathematics – as pedagogical strange attractors, inviting readers to attend to the sensational experience of their
own and another’s learning self in the processes of being made and unmade while
simultaneously acknowledging and responding compassionately to that which accompanies the
loss, longing, shame, suffering, and grieving for self’s previous iteration. I have also had to
invent a concept – intervulnerability – for the ways I envision a different inflection in the
relationships among mathematicians, mathematics educators, popularisers, Mathematics, learners
and interested if not always completely invested mass publics.

A resonant conceptual metaphor for the curriculum in this text is Glissant’s resurrection
and utilization of the idea of ‘Errantry’. Glissant’s translator into English, Betsy Wing (1997),
explains that the term errantry has

> overtones of sacred mission…follow[ing] neither an arrowlike trajectory nor one that is circular and
repetitive, nor is it mere wandering – idle roaming…[where] one might become lost…in errantry one knows
every moment where one is – at every moment [one is] in relation to the other” (p. xvi).

It is this dialogical sense of always Being-in-relation that has informed my reading and
engagement with the film All is Number and the literatures with which I have brought it into
conversation in the rehearsal that is this dissertation.

In thinking transphenomenally and mythopoetically about the concept of ‘rehearsal’ I
take the phenomena to be intimately related to the phenomenon of ‘repurposing’, that is, a
recurrent if not defining feature of complex bio-semiotic systems. Such ‘repurposing’ for
example is to be found at the physical level, cellular level (genetic re-purposing), the neuronal
level (cognitive repurposing, forgetting), the conceptual level (conceptual blending), the level of
whole organisms (endo-symbiont hypothesis), at the level of culture (cultural hybridity, art,
technologies) and at the level of whole communities, ecologies, and mytho-spiritualities. In their
iterative recursions Complex systems ‘repurpose’ and ‘refashion’ (across and within levels),
working with, scavenging whatever materials and resources they already have, with what they
find close at hand, to mend and make whatever is deemed necessary for meaning and for
survival. These rehearsals in life, in vivo, are all experiments in learning and survival. Some of
these experiments are perhaps also about survival with dignity (D’Ambrosio, 2000) and perhaps
for dignity. Some repurposings are directed, or motivated while others appear undirected. All
share in that aspect of the maroon sensibility of having to make a home else-where if not the
necessity of flight for survival. This ‘repurposing’ of material, cognitive, aesthetic, psychical,

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43 Wing (2007) notes that a deconstructive reading of the French ending of errance, permits a, “deflect[ion of] the
negative associations between errer (to wander) and erreur (error)” (p.xvi).
mythological, spiritual resources involves processes of boundary-making and boundary breaking, of ‘making’ similar and making different or of forming relations. The maroon sensibility too, then, seems to share a relation with that form of thinking and set of privileged practices that we might call ‘Mathematics’.

Given the importance I have attributed above to final utterances what then should be the final words of this chapter? Let me bring to a close my turn in this conversation with a quote from mathematics educator John Mason, one that resonates very much with Harris’ ideas of Infinite Rehearsal and the unfinalizability of dialogue in Bakhtin. In reflecting upon his career he writes,

…each generation [of mathematics educators] has to re-express insights in their own vernacular, even though these insights have been expressed before…This contrasts with mathematics in which it is possible to be directed along a ‘highway’ towards problems at the boundary without traversing all of the country in between. (Mason, 2009, p.6)

It is my hope that, as improbable as the salvaging of a word which has traveled precarious centuries preciously guarded and urgently uttered, the particular vernacular and register with which I have begun to develop through ‘speaking’ and ‘doing’ mathematics education in this work – a maroon mythopoetics – might find its way into the next rehearsal of mathematics education.
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