Chapter 4
The Incorporation of Fractals into Educational Management and Its Implications for School Management Models

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Abstract This paper intends to demonstrate a certain level of methodological innovation in school management systems. Its main purpose thus is to introduce and apply the fractal theory to urge and catalyze the new thinking of administrative organization method and hope to build up an effective, efficient and appropriate school management model under the guidance of fractals. The paper therefore erodes any fears that usually curtail efforts towards transformation of systems since these fears normally hinge on self-doubt as to whether the proposed ideas are commensurate with the established and accepted realms as well as custodians of knowledge. Paper thus contends that without taking giant strides and risks, educational management and school leadership cannot and will never be improved since the same old systems and weak points will remain in force and get entrenched further. Accordingly therefore, the paper has examined a number of aspects related to changing paradigms in educational management which bring about acute chaos and complexity both in terms of the concept as well as management or leadership structure. The concept of fractals is thus identified as a way forward to achieving transformation of the education management system. However at this level it became imperative to examine the relationship between Fractals, chaos theory, crisis theory, self-organizing systems, disorderly structures and complex adaptive systems. Equally, the place of Fractals in management theory and school leadership

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models was explored and how these obtain in proposed model based on fractal systems alongside the benefits of the proposed model to school management.

Keywords Fractals · Educational management · School management models · Leadership

4.1 Introduction

Without innovation, harmonious society cannot be built up, because many new problems must be solved with new methods. Indeed according to Yan-zhong (2005) it is contended that in the process of social development, various problems will appear, including the ones that have never been encountered before, so there is no choice but for continuous innovation. Along the same line of argument it is claimed that a disharmonious society usually results from unreasonable structure of supporting society, inconsonant social running mode and methods. Therefore, innovative systems and methods must be utilized to make it reasonable and harmonious. The innovation of system and method plays a decisive role in building up a harmonious society (Raye 2012). In order to realize this though, many specific systems, mechanisms, modes and methods are needed to guarantee the harmony of society, such as those related to compulsory education, public health, social security, relief of the poor, social credit, etc.

4.2 Changing Paradigms in Educational Management

Education has undergone a paradigm shift in recent years. Systems that obtain in the education field are no longer the way they were and they should not be indeed given that we are living in changing times. When subjected to educational management and school leadership in particular, the story even gets more intriguing. In fact, Yan-zhong (2005) argued that administration system is a system of complexity and chaos; the insensible disturbed motion in operation process sometimes can give rise to a dramatic fluctuation. If administrative system lacks a proper corresponding mechanism, it must be subject to the harm of systematic deficiency. It is this deficiency that ought to be addressed through new techniques and initiatives in order to achieve transformation of systems for the better.

Saad and Lassila (2004) on their part contend that today's complex, unpredictable and unstable marketplace requires flexible manufacturing systems capable of cost-effective high variety-low volume production in frequently changing product demand and mix. To them, in fractal organizations, system flexibility and responsiveness are achieved by allocating all manufacturing resources into multifunctional cells that are capable of processing a wide variety of products. In their paper

therefore, various fractal cell configuration methods for different system design objectives and constraints are proposed. The authors then conclude that these parameters determine the level of interaction between the cells, the distribution of different product types among the cells and the similarity of cell capabilities.

Meanwhile, Garmston and Bruce (1995) opine that Information from quantum mechanics, chaos theory, fractal geometry, and the new biology can help educators rethink school-improvement approaches. Chaos and order exist simultaneously. Adaptability, the central operating principle of successful organizations, stems from five human energy fields: efficacy, flexibility, craftsmanship, consciousness, and interdependence. To them thus, adaptive schools are complex, nonlinear systems.

Indeed issues like crisis, social, media-related and technological changes in the environment of education are now a visible phenomenon of this generation. But the most interesting aspect is that more than any other, one concept has a bearing on all these challenging issues in the education system; this is fractals. In this paper therefore, as a way of dealing with such unpredictable concepts and challenges in today's education system, more so in management circles, fractals are being tipped as a way forward to transformation of the school management models for proper adaptability that can ultimately inform effective leadership.

It would prove very abstract indeed if the place of fractals in educational management and school leadership is discussed without exploring the concept of fractals first, as a way of raising the curtain especially given that it boasts of an intricate meaning that challenges both nonscientists and scientists alike in the contemporary generation of knowledge.

4.3 Description of Fractals

The word "fractal" often has different connotations for laypeople than mathematicians, where the layperson is more likely to be familiar with fractal art than a mathematical conception. Indeed according to *Wikipedia*, the free encyclopedia, the mathematical concept is difficult to formally define even for mathematicians, but key features can be understood with little mathematical background. And many scholars and researchers alike have endeavored to describe the concept of fractals while steering clear of mathematical and hyper scientific modes and connotations.

Trygestad (1997) citing other prominent works especially Glieck (1987) writes to the effect that a fractal is infinitely complex (http://fractalfoundation.org/resources/). That is, if you observe any part of the fractal you will always find more detail. Each stage tends to have the same form as the original. So the fractal lacks a fully-fledged scale. A small portion of the fractal is just as detailed as the original. The amazing thing about fractals is that the formulae used to generate them are often extremely simple. A simple formula can lead to complex images. These images are sensitive to the initial conditions.

Fryer and Ruis (2004) set the tone for understanding fractals without their mathematical connotations but rather in a simple and comprehendible manner by

classifying them as a concept, system and theory. As a concept therefore, Fryer and Ruis (2004) assert that Fractality is the study of the behavior of macroscopic collections of such units that are endowed with the potential to evolve in time. Simply put, a fractal is a geometric object that is similar to itself on all scales. Mendelson and Blumenthal (2003) argue that if you zoom in on a fractal object it will look similar or exactly like the original shape. However, it is important to note here that, by merely looking at or exploring features already influenced by fractal emerging patterns, we may not be able to realize the original similarity carried by the fractals.

As a system, a fractal system is a complex, non-linear, interactive system which has the ability to adapt to a changing environment. In addition to unpredictable behavior of systems in chaos, they have fractal patterns that symbolize strange attractors (Erçetin 2001). Such systems are characterized by the potential for self-organization, existing in a non-equilibrium environment. This view applies in the same way as far as the Wikipedia, the free encyclopedia is concerned.

Meanwhile as a theory, Fryer and Ruis (2004) argue that Fractal theory is a theory based on relationships, emergence, patterns and iterations. A theory that maintains that the universe is full of systems, weather systems, immune systems, social systems, etc. and that these systems are complex and constantly adapting to their environment. Crucially, Wikipedia, the free encyclopedia shares the same view regarding the description of fractal theory. Examples of phenomena known or anticipated to have fractal features include; Clouds, river networks, fault lines, mountain ranges, craters, lightning bolts, coastlines, Mountain Goat horns, animal coloration patterns, Romanesco broccoli, heart rates, heartbeat, earthquakes, snowflakes, crystals, blood vessels and pulmonary vessels, ocean waves, DNA, various vegetables (cauliflower and broccoli), soil pores, Psychological subjective perception and many others.

Nevertheless, examples of fractal systems cannot be explored within one attempt of a study and in the case of this paper; the identified fractal systems include living organisms, the nervous system, the immune system, the economy, corporations, societies, and education systems. It is important to point out that fractal systems also happen in day to day life situations though normally go unnoticed.

4.4 Properties of Fractal Systems

Fractals are home to a number of characteristics, herein coined as properties that distinguish them from other features. Yan-zhong (2005) while reflecting on the major characteristics of fractal administrative organization pointed out the following:

- Self-similarity. The self-similarity of fractal administrative organization includes self-similarity of administrative organization structure and that of function, i.e. the function of a small fractal unit can be in harmony with that of the large one.

- Iteration. Large amount of fractal geometry examples are the figures produced by mathematical methods, especially by iteration and recursion arithmetic. The symmetry of different scale of fractal self-similarity means the iteration and recursion of pattern: pattern nesting in patterns, subdivision created on more and more detailed scaling, forming infinite delicate structure.
- Self-organization, which is the remarkable character of system internal structure with fractal feature, in different scale, whose structure has the feature of self-similarity and self-copy, appear to be a new structure on macro-scale under open system through systemic cooperation, i.e. external environment only provides some conditions but does not carry out any specific intervention and it is formed by the system itself.
- Dynamic process. Fractal means a series of dynamic processes which reflect the growth and evolution of structure. It portrays not only the still form but also the important evolutional mechanism of dynamics.
- Simple regularization in complexity. Along with economic development, social progress and societal rising hierarchy, people's needs and requirement become more and more complex, this follows that administrative management becomes more and more complex.

Following up from the above analysis, it is imperative to note that Fractal systems have many properties and the other important ones are summarized in the following forms for easy understanding and comprehension; Emergence (neither planned nor controlled), Co-evolution (exist alongside other systems in the environment), Sub-optimal (less perfect but effective), Requisite variety (cannot be in one single setting), Connectivity (interact and connect with one another), Simple rules (though complex, they follow simple rules e.g. water flow), Edge of chaos (close to chaos structure) and Nested systems (each system is a sub-system of another)

4.5 Fractals and Chaos Theory

Fryer and Ruis (2004) base on the intricate nature of fractal properties to claim that Fractal theory is not the same as chaos theory, which is derived from pure mathematics. But they go ahead to opine that chaos does have a place in fractal theory in that systems exist on a spectrum ranging from equilibrium to chaos. A system in equilibrium does not have the internal dynamics to enable it to respond to its environment and will slowly (or quickly) die. A system in chaos ceases to function as a system. The most productive state to be in is at the edge of chaos where there is maximum variety and creativity, leading to new possibilities. Gleick (1987) cited by Trygestad (1997) also conform to the above assertion.

Accordingly, Mendelson and Blumenthal (2003) opine that as fractals continue to emerge, they edge closer to chaos and cause some elements of instability in the organism or in this case organization. Once detected, they may inform the

organization on what patterns are required for transformation or improvement of the system. Since they have the potential to evolve in time, Fryer and Ruis (2004) contend that fractals can easily and steadily drag the system to the edge of chaos.

4.6 Fractals and Crisis Theory

Topper and Lagadec (2013) observe that Fractal crisis theory teaches us that crises happen on all scales and that the built-in invariants imply that leaders and decision makers will be impacted by effects just as those who are closer to the situation area. That is to say, taking the decision power away from those closest to the ground, best able to evaluate their needs, and giving it to people far from ground level and supposedly less impacted by the crisis is a fallacy.

In keeping with Topper and Lagadec (2013) thus, what is at play here is the conflict between the way decisions circulate and the way information flows. And this has been a challenge in the education system for so long now. That is why a full top-down or a full bottom-up approach cannot work. It all happens exactly as for a fractal pattern: every time you switch to a different scale, you have the sensation of seeing the same thing, but in reality the resolution has changed and what looks the same is in fact different.

The blur effect created by sense-making invariance forbids someone on one step of the decision ladder to communicate freely with someone on another step. As fractals teach us, the information flowing, at any scale, that is to say going up or down the ladder, gets distorted.

4.7 Fractals and Self-Organizing Systems

To Fryer and Ruis (2004) there is no hierarchy of command and control in a fractal system. There is no planning or managing, but there is a constant re-organizing to find the best fit with the environment. A classic example is that if one were to take any western town and add up all the food in the shops and divide by the number of people in the town there will be near enough two weeks supply of food, but there is no food plan, food manager or any other formal controlling process.

The system is continually self-organizing through the process of emergence and feedback. Indeed Fractal systems are characterized by the potential for self-organization, existing in a non-equilibrium environment. Most importantly though is the fact that we may not be able to detect the state of non-equilibrium but the fractals can do on their own. Since most organizations, schools inclusive, fall prey to dictates of circumstances, fractals may be the way forward in order to restructure the management systems so that the schools can adopt and adapt to self-organizing ability.

4.8 Fractals and Disordered Structures

Again Fryer and Ruis (2004) claim that Fractal systems appear to be disorderly, even random. But they are not. Beneath the seemingly random behaviour is a sense of order and pattern. Truly random systems are not chaotic. The orderly systems predicted by classical physics are the exceptions.

Sometimes systems may appear disorganized but actually they are organized indeed. The example of an office seemingly disorganized may suffice here in that the owner understands the way things are positioned that way; if you try to put them in order, he may not be able to know where something is. This implies that there is order in disorderliness.

Fractal systems depict a disorganized form when many sub-systems seem to emerge and confuse the structure or organizational set-up (especially as the emerging patterns are always small in size). But when looked at critically you find that a lot of organized structures and sequences are actually housed in the fractal systems and these can be used to better the processes within the organization (especially coordination and interaction). This behavior exhibited by Fractals is also supported by the views of Gleick (1987) largely cited by Trygestad (1997).

Fractals and disordered systems have recently become the focus of intense interest in research and thus many books and other related works are being directed towards this subject (Bunde and Havlin 2012).

4.9 Fractals and Complex Adaptive Systems

Oswaldo et al. (2010) assert that one of the most important properties of systems is complexity. In a simple way, we can define the complexity of a system in terms of the number of elements that it contains the nature and number of interrelations and the number of levels of embeddedness. The theory of complexity emphasizes that the relationships in the complex systems such as organizations are not linear, and have a structure revealing unexpected results and arising choices in which the events cannot be predicted (Erçetin et al. 2013). When a high level of complexity exists in a system, it is considered a complex system. It should be noted however that complex systems can be soft systems and hard systems.

Issuing from the above premise, some people draw a distinction between complex adaptive systems and complex evolving systems. Where the former continuously adapt to the changes around them but do not learn from the process. And where the latter learn and evolve from each change enabling them to influence their environment, better predict likely changes in the future, and prepare for them accordingly.

Fractal systems are as well adaptive as evolving which defines them more as complex adaptive systems.

Meanwhile, Shoham (2005) conducted a study whose analysis relied on five criteria based on the functioning of the complex system and included

synchronization of the goals of each employee as a fractal with the system as a whole, the ability to cope with the environment, decentralization of resources, work processes and knowledge transfer, and self-development of each fractal. It is important to note at this level therefore, that if these criteria are the way to go in order to promote proper planning and functioning of a complex system like a school, then the old management models cannot survive the contemporary tests of time and thus call for a review and transformation.

The conclusion of their study is that organizations that possess the characteristics of a complex adaptive system will achieve proven knowledge management capabilities, while improving the processes of knowledge performance and integration between employees. To them therefore, these organizations will be better able to respond correctly and quickly to dynamic changes in the environment.

Indeed even Mendelson and Blumenthal (2003) write that most systems are nested within other systems and many systems are systems of smaller systems. They continue that, complexity can occur in natural and man-made systems, as well as in social structures and human beings. Complex dynamical systems may be very large or very small, and in some complex systems, large and small components live cooperatively. A complex system is neither completely deterministic nor completely random and it exhibits both characteristics.

In a bid to make the case more clear, one of the appropriate examples in this case offered by Mendelson and Blumenthal (2003) reflects a classroom. The classroom is itself a system with its teachers, learners, teaching materials, and relationships. It also belongs to the school system and the larger education system of that country. It belongs to the social system and probably many more. Therefore it is part of many different systems most of which are themselves part of other systems. Each level seeks to adopt and adapt to the expectations and dictates of the other preferably larger system. Indeed a Fractal system has the ability to adapt to a changing environment of educational management and administration.

4.10 Fractals and Management Theory

Management in business and organizations means to coordinate the efforts of people to accomplish goals and objectives using available resources efficiently and effectively (Wikipedia, the free encyclopedia). But as well-known too, Management comprises planning, organizing, staffing, leading or directing, and controlling an organization or initiative to accomplish a goal. Resourcing encompasses the deployment and manipulation of human resources, financial resources, technological resources, and natural resources.

But today's management poses a rather more critical challenge since it obtains within organizations which can be viewed as systems, management reflects human action as a catalyst that facilitates the production of useful outcomes from a system. In this case therefore, management requires self-management as a prerequisite to attempting to manage others.

4.11 Fractals and Administrative Organization

For the concept of fractal management administrative organization, at the moment, there is no academic material to rely on. As an opinion though, Raye (2012) claims that fractal administrative organization refers to a kind of fashion of administrative organization; that administrative system has:

- Fractal self-similarity on administrative organization framework setup,
- Administrative organization constitution design,
- Administrative organization operation and
- Administrative organization function

Meanwhile Yan-zhong (2005) opines that Fractal theory should have a broad application prospect in the future in administrative field, because self-similarity and fractional dimension can be discovered in administrative organization system, thereby, the application of fractal theory can be expanded in administrative management. The author also continues that nowadays, the non-linear, changeable, virtual resource function such as knowledge, database etc. will become more and more important, on the other hand, team cooperation replacing management control will become the fundamental guarantee of effective operation for administrative organization.

Based on his view therefore, the old system and models of management which feature superiority and inferiority within power ranks will cease to exist or hold any value in contemporary educational management systems since cooperation and sharing or exchange of ideas between all stakeholders has taken over as driving forces in Management.

Yan-zhong (2005) indeed puts forward the concept of fractal administrative organization herein so as to distinguish it from traditional pyramid bureaucracy or linear section system and the so-called flat organization of knowledge economy age, according to fractal theory. He opines that administrative fractal organization is the way to go in today's challenging leadership world.

Similarly, in her seminal book entitled 'Leadership and the New Science', Margaret Wheatley as cited by Raye (2012) introduced the concept of the fractal organization in the following words:

> The very best organizations have a fractal quality to them. There is a consistency and predictability to the quality of behavior. Fractal organizations, though they may never have heard the word fractal, have learned to trust in natural organizing phenomena. (Wheatley 1994, 132 cited by Raye 2012).

A fractal administrative system thus consists of a number of comparatively independent administrative organization units which are called "fractal units", large fractal units can contain a number of small fractal units, and small fractal units can contain a number of even smaller fractal units, ratiocinate and extend in such a way. Using the principle of self-similarity therefore, the same aims, goals and purpose as well as approach or methodology can be maintained within the emerging smaller fractal units.

So as a matter of fact, when humans are open with perspectives and engaged with participation in collective creative efforts, we naturally thrive and create best outcomes together. The emergent collective behavior has pattern integrity, which generates trust both internally with members and externally with the public. All of the information necessary for making good decisions is available and flowing throughout the organization's structure, which ensures better use of resources and greater success.

It is being claimed here that education systems all over the world and school management systems everywhere should and must borrow a leaf or indeed take the lead in transforming organizational structure and performance. This can only be realized through adopting a more complex and effective approach to their management designs or structures and indeed nothing will prove more worthy in this case than fractal systems.

4.12 Fractals and Leadership Systems

The free encyclopedia, Wikipedia defines Leadership as "a process of social influence in which one person can enlist the aid and support of others in the accomplishment of a common task". Although Leadership is reflected within a number of myths; where it is considered as innate, possessing power over others, being positively influential, controlling group outcomes, having a group (s) following and most importantly housing group members who resist leaders, one key aspect of leadership is innovation. Leadership thus lives and dies with innovation.

Nonakaa et al. (2013) ask a fundamental question; how can a company become sustainably innovative? In keeping with this kind of question and borrowing a leaf from Sandkuhl and Kirikova (2011), whose study focused on fractal organizations and business, it is imperative to consider the following questions to investigate the relationship between fractals and leadership:

- Does it make sense to apply fractal organization when analyzing educational leadership models?
- What are the potential benefits and limitations of doing this?

As a way out of this rather complex jig-saw born of intricate questions, Mrówka and Mikołaj (2011) offer a critical view when they assert that organizational structures of global organizations are evolving into more network- in-nature, virtual, fractal-in-nature. They go ahead to argue that new types of organization will be undergoing a change in the definition of hierarchy, which will divert into heterarchical and hyperarchical structures. The duo's paper outlays an analysis of leadership dispersion in global organizations using new types of organizational structures. In such organizations, Mrówka and Mikołaj (2011) claim that demand for leadership is inclining.

Notwithstanding, leadership should be considered as a combination of multiple approaches and attitudes. Leadership should be associated with many people

scattered all over the world and carrying out their day-to-day tasks and duties. Authors of this paper focus their attention on a thesis that there will be a growing demand for lower levels of leadership. But to get to this level though, there must be a model of management or leadership to direct and guide execution of leadership roles.

Accordingly therefore, understanding fractals has significant implications for how you and your organization describe and create leadership and the structure underpinning it. That is why Fryer and Ruis (2004) insist that if you and your organization are still looking a triangle, thinking it's a good analogy of a mountain, then you're behind the times, and will be left behind like a dinosaur. It is time to move on and keep up with the leading edge of understanding. Successful organizations in the modern information era will acknowledge this shift in paradigm brought about by fractals and instigate a mass evolution in its collective psyche in order to flourish. Fractal leadership models are indeed very conceptual, very creative and very pragmatic.

In keeping with the above view, Raye (2012) actually notes that Fractal Organizations have flat hierarchies and distribute responsibility and accountability throughout the organization. A few examples of Organizations with Fractal Models as discussed by Raye (2012) and equally highlighted by Fryer and Ruis (2004) are in the Fortune 500 (such as Nucor and SAIC) as well as the Fortune 100 Best Places to Work (such as Zappos.com and W. L. Gore). These companies are open systems where employees' feedback information to central leadership, enabling continual adaptation to changing conditions.

4.13 Benefits of Fractals to Leadership

Studies of leadership have produced theories involving traits, situational interaction, function, behavior, power, vision and values, charisma, and intelligence, among others. This implies that the ingredients of leadership are many and thus the qualities of leadership equally enormous.

Similarly, the qualities of a fractal organization are indeed unlimited no matter the perspective from which they are evaluated. To Raye (2012) for example, they include shared purpose and values that create pattern integrity; universal participation in ideas and solutions for continuous improvement; decision making at functional levels; leadership devoted to employee development as a source of intellectual capital; and competition energy directed outward instead of inward.

Meanwhile on his part, Yan-zhong (2005) contends that in fractal organizations, resource allocation is based on desired outcomes and information is shared efficiently through daily interactions and regular conversations, which generate ideas and enable economic development and delivery of products and services. He further argues that relationship development enables the effective flow of information between individuals and among teams. At all scales of a fractal organization,

members share information iteratively and make decisions collectively in response to changing conditions.

Whereas Li examined business oriented structures in economic systems, not far away from the same analysis, it is a fact that educational management and schools in particular are close to a factory or industry with input, processes and output issues to deal with. Topper and Lagadec (2013) also opine that the power of the fractal approach is that it allows you to get rid of a linear and stable vision of the world, an approach inconsistent with the field of crisis. And rightly so put by Topper and Lagadec, these crisis fields are eating up the education system especially in the realm of leadership. Fractal theory indeed opens up the possibility of envisioning and navigating multiple, unsettled domains, multiple layers and dynamics within a system.

Even beyond Mandelbrot's (1983) own work, it is possible to claim that the crucial advance offered by fractal theory is the possibility to envision, capture and handle very unstable, blurred and hyper-complex states of the world. This is what the contemporary field of school management and leadership needs and not sooner or later but now indeed. However a clear and outlined view of the relevance of fractal organizations and systems presented by Topper and Lagadec (2013) reveals that:

- They will live by values, not regulations
- They promote understanding not subordination
- They bring about inspiration, not exploitation
- They empower members to function independently
- They reduce dependency on managerial overhead
- They bring a common sense of purpose and ownership of responsibility amongst all staff
- They reduce turnover because personal growth is encouraged
- They reduce Health care costs since there is no stress
- They allow a wise use of resources due to sense of ownership

A closer examination of the relevancies of fractals above points to one major aspect indeed: the old school management models are archaic and outdated and thus cannot help sustain development and progress in the school system in particular or educational management in general. It calls for efforts to rethink, review, redesign, rebuild and reconstruct the school management system which only gets better with an innovative school management model based on Fractals.

4.14 Proposing a Model of School Management Based on Fractal Systems

4.14.1 Justification

The need for this new school management model stems from the analysis of existing inconsistencies at school level regarding key management and leadership decisions. According to various studies (Raye 2012; Yan-zhong 2005), the

inconsistencies are generated by an incorrect delimitation or even the absence of well distributed responsibilities absolutely necessary for effective decision making process, and not only, this model, developed as a support tool for educational decision making is founded on a fractal philosophy.

Raye (2012) asserts that to change the perspective of limited room at the top and vanquish the personal agenda, a new structure is needed to replace the top-down model; different types of organizations will display a variety of organizational structures. Many organizations already have flattened their hierarchies in an effort to deal with systemic issues, and sometimes this effort is good enough. In a hospitality company, for example, fewer layers of management are necessary as most of the work is functional and customer-oriented. To further diminish the tendency toward internal competition, forward-thinking organizations may adopt an "in-out" pattern instead of top-down.

Yan-zhong (2005) also joins in by opining that, it is a must to treat the diversity and materiality of administrative organization system as complex issues. Therefore, administrative organization should design a system of precise, concrete, perfect, inter-supporting and interpenetrating arrangement and structure; design a systemic content of different type, different content, corresponding and coordinating to specify the administrative organization action of sufficient diversity and complexity in different hierarchy. The view put across by Li (2005) is that these systems, such as defining "responsibility" rule for fractal unit (including working staff or administrative organs) in dividing work; defining the rule what the fractal unit can do and cannot do; in regards to penalty and incentive mechanism; in regard to rule for authority, responsibility, plan and funds etc.

Issuing from the above premise therefore, the whole administrative institution has a good self-similarity and self-organization from superior to subordinate hierarchy and from subordinate to superior hierarchy, and takes on fractal structure. The administrative organization can do well in the innovation of organizational system and optimization of different hierarchy.

Furthermore, each concrete arrangement in the system also assumes hierarchy and structure of preciseness and interpenetration. For example, funds system, large fractal unit (the whole administrative organization) sets up a series of principal conditions under the guidance of principle; small fractal units (various departments, units or undertaking departments in an administrative organization) will make feasible measures according to fund principle and own concrete condition of units.

In fact according to Raye (2012) and supported by Yan-zhong (2005) an administrative organization has not only formal system arrangement, but also informal system supervision, including concept of value, ethic, morality, ideology etc. Informal system supervision, which is expansion, subdivision and restriction to formal system arrangement, reduces the cost for balance and implementation so as to realize the formal system arrangement supervision. Same as formal system arrangement, informal system also assumes structural fractal, whose structural arrangement exists between various hierarchies inside administrative organization, and takes on self-similarity between their hierarchies.

It is important to recall however that this informal system does not offer specific terms as that of formal system, so fractal design appears to be especially important. Administrative organization system, as fractal body, performs fractal with complex operation (process). Herghiligiu et al. (2013) are quick to remind us that in the administrative organization system, there not only exists structural fractal reflecting systemic design arrangement, but also exists perfect and effective system implementation mechanism, without implementation mechanism, any mechanism will be nothing but an empty shell.

The implementation of system arrangement runs through multiple hierarchies and a non-linear dynamic process, whose content displays concrete operation and implementation of system structure in different hierarchies and parts of administrative organization. System implementation mechanism is the fundamental guarantee for running of administrative organization, the process of system implementation is the operational process of this system.

It is imperative to point out that most of the proposals for incorporation of fractals are reflected in business settings and general administrative organizations and not in schools or educational management for that matter. As part of extending fractal influence and opening up within education management and school leadership therefore, a new and innovative model is being proposed for transformation of the system based on fractals.

4.14.2 The Particular Models in Question

A Management model is simply the set of choices made by executives about how the work of management gets done about how they define objectives, motivate effort, coordinate activities, and allocate resources. The flow of activities and the individuals charged with this flow is a critical aspect in management indeed.

This also determines the structure in which such operations and processes are executed in the organization. Regarding schools though, management structures define the levels of responsibility and accountability as well as the flow of power and authority in the school system.

Credaro (2006) postulates that management structures in educational institutions are organized on many levels, from the individual classroom under the management of a single teacher, to groups of classrooms supervised by a Head Teacher or Executive Teacher, to a whole-school structure, under the guidance of the principal. Independent or private schools generally report to a School Board.

There are two school management models presented in this paper, these are:

- The top-down school management model
- The count-down school management model

The two models are represented in the Fig. 4.1 below:

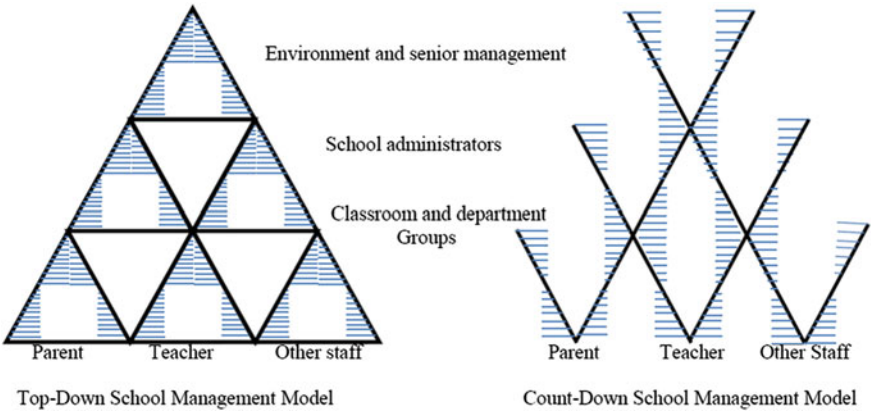

Fig. 4.1 Comparative view of two distinct school management models

4.14.3 The Top-Down School Management Model

In management and organizational arenas, the term "top-down" is used to indicate how decisions are made and executed. The power, authority and orders normally trickle down the system coming from the top of the hierarchy. And all actions taken within the system must go through the vetting system of the ones who hold power in the organization. Schools being key social systems and organizations thus, fall prey to the same description.

A "top-down" approach according to Wikipedia, the free encyclopedia, is one where an executive, decision maker, or other person or body makes a decision. This approach is disseminated under their authority to lower levels in the hierarchy, who are, to a greater or lesser extent, bound by them. For example, a structure in which decisions either are approved by a manager, or approved by his or her authorized representatives based on the manager's prior guidelines, is top-down management.

The model is based on one of the Pythagorean forms; the pyramid as reflected in the Fig. 4.2:

- In the model represented by Fig. 4.3 there is a certain and clear structure of power and authority in the school management system.
- Also, parents, teachers and other employees are at the foot of the structure and thus having to respond to the school administrators and senior management of the school
- Accountability lies with the top administration of the school
- Decision making is largely vested with the top administrators
- All decisions taken at lower levels have to be vetted by top administration
- The number of those with authority in the school is largely limited as represented by the narrowness of the pyramid at the higher levels

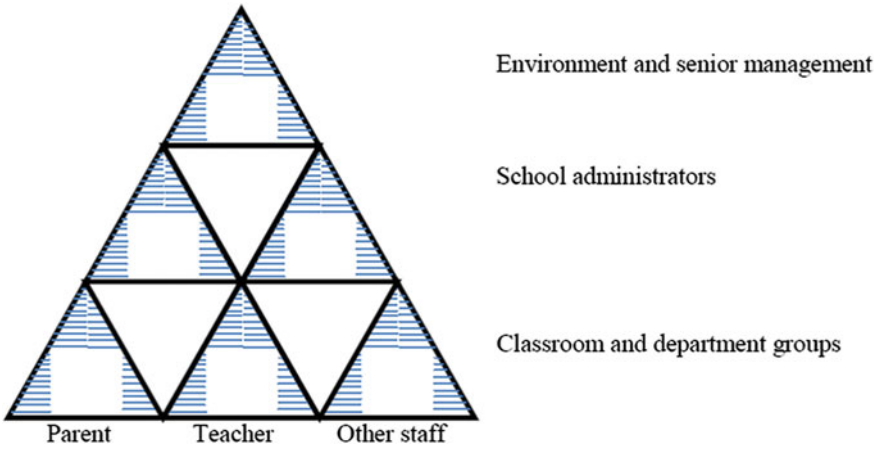

Fig. 4.2 The top-down school management model (conventional model of the pyramid)

- Those with less or no authority and power in the school is high as represented by the wideness of the pyramid at the lower levels

It is however important to note that this kind of model is now outdated as it curtails creativity and transformation in the school system for betterment.

Indeed Raye (2012) opines that top-down hierarchies are typically characterized by command-and-control systems of authority that create harmful stress and internal competition for advancement within organizations. The pervading perception is of "limited room at the top," where positions of authority become scarce resources. Accordingly therefore, in this kind of model or system, members withhold or hoard information by focusing competition energy internally rather than externally, creating silos of information and causing the negative stress reflected in absenteeism and higher healthcare costs. Voluntary turnover creates brain drain as creative individuals tire of internal politics and seek more harmonious work environments.

In fact it is important to recall at this level that according to Mandelbrot (1983), the triangular shapes of top-down hierarchies are non-random and limited, which may explain why top-down organizations typically grow through acquisitions rather than by expanding from within.

Management in the 21st century therefore has accordingly taken a new orientation. It is increasingly founded on the ability to cope with constant change and not stability in the system per se since stability is unpredictable and hard to guarantee at any moment in time, management is also organized around networks and not hierarchies, it is equally built on shifting partnerships and alliances and not self-sufficiency, and constructed on technological advantage and not bricks and mortar (Carnall 2003 cited by Jamali 2004:104). Moreover it is also important to note that new organizations (to which educational institutions ascribe) are networks of intricately woven webs that are based on virtual integration rather than vertical

integration, interdependence rather than independence, and mass customization rather than mass production (Greenwald 2001 cited by Jamali 2004:104).

4.14.4 The Count-Down School Management Model

The second model is influenced by Fractal systems. In the construction of administrative organization, the fractal of organ setup, the fractal of institutional components and their running, the fractal of functional direction, all of them will establish logic premises and valid preconditions for fractal theory penetrating the discipline of administrative organization as well as upcoming application of the theory to governance (Raye 2012). What is being proposed in this paper though is "a school management model based on fractals". In some way or other, differentiating traditional pyramided bureaucracy or linear mechanism and so-called flat organization in knowledge economy, this kind of nonlinear organizational fashion is provided with the property of self-similarity, iteration, self-organizing, dynamic process, simple regularity in complexity, etc.

The second model thus is reflected in the Fig. 4.3:

In the fractal based school management model in Fig. 4.3 therefore;

- The normal pyramid structure is extended i.e. more fractal pyramids emerge and evolve
- There are many pyramids within the model but signifying different aspects of leadership
- There are no linear settings in the school management or leadership model and thus outer definitive lines are excluded from the model in particular (Leadership cannot easily be limited in terms of spectrum)
- The hierarchies of power are distributed throughout the model and in different directions

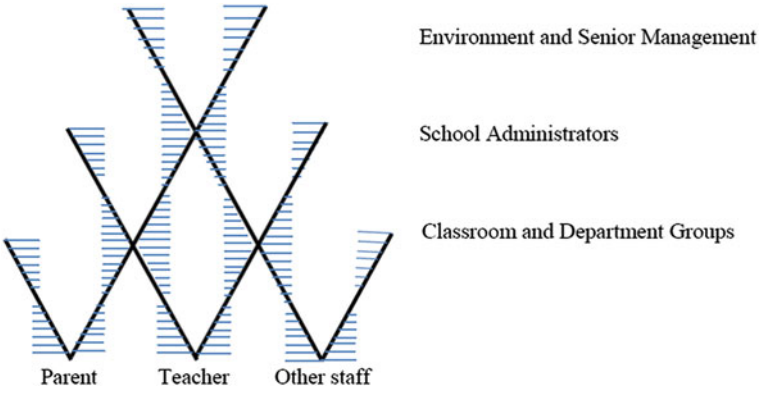

Fig. 4.3 The Count-down school management model (fractal based management model)

- In order for central or core leaders to make big-picture decisions, they obtain information about what is happening at the edges of their organization.
- School administrators respond to parents, teachers and other employees
- There are a lot of inter-relationships in the school management system as the pyramids seem to cross over to different directions
- There is no one at the foot of the model (what matters is direction and position of individuals)
- Authority, power and decision making lies everywhere in the system and the only noticeable difference being the amount and impact of the power one possesses
- School administrators are a moderating variable in management affairs between the environment alongside senior management and the parents, teachers as well as other employees. According to Max Depree, '*The first responsibility of a leader is to define reality, the last is to say thank you; in between the leader is a servant*' (Forbes magazine)
- System management moves either side or direction of the management spectrum i.e. no specific lower level or higher level as in conventional structures
- Power is born out of many centers and flows anywhere
- Ideas of school management can trickle in from various angles
- There is no monotony of doing work and executing processes in the school system

Given advances in knowledge and science, this kind of model is the way to go as it allows flexibility and calls for emergence of transformation drives in the school management system.

Important to note about Fractal leadership models is that:

- There are no top down hierarchies
- There is no scale of power since even a smaller spectrum of power or authority has a similar impact on the system
- Everyone has a level of authority to preside over
- Everyone is equally responsible to the organization
- Everyone is equally accountable to the organization
- Work is distributed equally
- All levels have a desirable number of members
- Everyone reports to another
- There is no over-dependency syndrome
- Everyone acts and reacts upon another
- Self-supervision or peer supervision is highly promoted

Generally therefore, as claimed by Raye (2012), in top-down hierarchies, systemic issues such as internal competition, unwanted turnover, and unhealthy workers are commonplace, whereas fractal organizations are distinguished by happy, healthy employees because of their emphasis on positive information flows and relationship structures that create best outcomes. In keeping with Raye's view,

we realize that these are often the organizations voted "Best Places to Work," as their members share a purpose and core values that unite their efforts and create the pattern of integrity or self-similarity that characterizes a fractal organization.

Raye also contends that the members in such organizations always feel appreciated for their efforts and supported by their workplace family, which boosts health naturally (the old adage goes that 'a happy heart is a healthy heart')

It is therefore being argued that the school management model proposed can go a long way in changing the status-quo and transforming not only school management but the education system as a whole. Dwelling on the viewpoint of Herghiligiu et al. (2013) on the conceptual framework for the environmental decision making, it is hereby opined that the most important benefits of the proposed school management model built on the principles of fractal philosophy are:

- School management decisions can be generated based on a series of aspects relevant for this process and involving all stake holders
- Information redundancy concerning school management data can be eliminated
- The storage space and costs necessary for school management data, information and reports is reduced since everyone is virtually information in a way and at the same time has information about the school
- The analysis and coding process of school management data is simplified
- The response time for the management decision diminishes
- The number of connections established during the management decision process is reduced
- School management decision methodologies can be developed with a particular character in order to streamline the process

For this to work though, there must be a fundamental change to which Garmston and Wellman (1995) claim that shifting decision making authority to the people most influenced by the decision is the way to go since Schools, like weather systems, are nonlinear systems that change radically with the unfolding and refolding of feedback into themselves.

To them this is based on 5 states; efficacy, flexibility, craftsmanship, consciousness and interdependence, while to Raye (2012) other critical states such as; frontline members, centered power systems, Interconnection, democracy and collective decisions are profound. Sandkuhl and Kirikova (2011) meanwhile highlight the following states; flexibility, robustness and easy adaptation. We must thus seek patterns of order beneath the surface chaos and search for structures and patterns of interaction that can transform systems.

In the paper therefore, the major focus was on educational management and specifically school management where in an innovative model premised on fractals was proposed and justified. There is no gain saying therefore, that with such innovation being adopted in the school systems, management and leadership would go a long in realizing the expected transformation deemed worthwhile in the contemporary educational and global movements.

4.15 Conclusions and Recommendations

In the near future educational management and administration should expect, just like economics, to introduce mathematic models and symbolic analysis to get rid of the fault of obscurity and coarseness so as to help in development and maturity because as put and argued by Yan-zhong (2005), it is imperative to go further into discussion and research of public service and governance for deep-going and sustainable societal harmony. There is nowhere more critical in trying to achieve this than the school system. This thus goes without saying that incorporating fractals into the process of developing school management (leadership) models is long overdue. The proposed model is thus a ground breaking move in the right direction.

Topper and Lagadec (2013) also contend that a lot remains to be done to test the feasibility of the fractal approach, to assess what it can bring to the field, and last but not least, to detect the limitations of this line of thought. They also lay claim that we are only at the beginning of the intellectual brainstorming required by the age of mega crises. On the research agenda, therefore, as a consequence of the paper in question, it is being modestly pleaded that research projects, case studies, training methods, operational guidelines, theoretical lines of thought, seminars and workshops be launched to shed some additional light and to promote innovative knowledge in the field of emerging educational and school management crises.

We should not fear nor despair by holding back and giving into self-disbelief. We should believe that in the event of school management crisis we can reconceive the system by designing models that are transformation laden and relevant for the contemporary times. After all, it is known that tackling the unknown is the very object of research and theory. The proposed model in the study is thus deemed ground breaking indeed.

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