Theoretical reflections of complexity theory concepts and principles in understanding multiple vulnerabilities: an in-depth analysis

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Abstract: **This baseline paper draws from the complexity theory to troubled learners' facing multiple vulnerabilities as plural, diverse and may be encountered simultaneously. We argue that society usually views vulnerability as a singular, easily describable and understood phenomenon. It begins with discussing the brief overview of the themes and theory, exploring literature that supports the need for complexity theory in mitigating multiple vulnerabilities. The components of the complexity theory are discussed and literature on how they can best be set to utilise the theory is explored are also discussed with an aim to unveiling how they can better be addressed in the context of applying the theory in mitigating multiple vulnerabilities.**

Keywords**: asset-based approach, multiple vulnerabilities, rural learning ecologies, mitigating, learner**

I. INTRODUCTION

Complexity is a phenomenon existing in biology, geography, mathematics, physics, and group structures (Ni & Branch, 2009; Turner & Barker, 2019). Deogratias (2018) argues that using complexity theory in understanding a context, ideas from every individual are respected, and everyone is open-minded enough to listen to each other and articulate ideas into meaningful learning. Since a complex entity is a unique phenomenon (Ni & Branch, 2009), it is vital for the rural learning ecologies members to understand the relationships that exists within, and the relationships between, themselves and the environment. This was among the best methods of gaining meaning, and making important, difficult decisions within the complex entity. For these and other reasons, we bring in the concepts and principles of complexity theory in understanding complex situation that arises in rural learning ecologies, and then a solution would consequently beidentified to minimise the complex situation. This is because, in complexity theory, an individual first senses and reacts to the environment, thereby charging itself proactively to suit the changing environment. The process is self-motivating because it is continuously leading to the individual's change of behaviour to suit the environment (Morrison, 2008, 2010). In this case, the ideas drawn from complexity theoryare helpful to rural learning ecologies members in order to sense and find ways to survive the harsh environment they live in. The paper takes a central approach to the founding origins and views of complexity theory, which are path dependency, emergence, adaptation, and self-organisation through working together. These offer significant understandings and methods of mitigation of multiple vulnerabilities in rural learning ecologies, mainly by empowering people through interactions, networking, connectivity, and relationships. The paper presented ideas, definitions, and principles of complexity theoryand introduced tools and methods used in complexity theoryto understand multiple vulnerabilities in rural learning ecologies. The assessment also included complexity theorysuccess and relevance to the process.

II. MULTIPLE VULNERABILITIES IN ZIMBABWE

We argue that multiple vulnerabilities in Zimbabwe can be as a result of socio-economic, cultural, political and psychological factors depending on where and to whom. According to Munyati (2006, 6) "A vulnerable child is one who is living under difficult circumstances which include learners; living in the poor households, with sick parents, in child-headed households, on old frail or disabled caregivers, and in households that assume additional dependency by taking in orphanedlearners".For the purpose of developing this paper, learners facing multiple vulnerabilities have been defined as all groups who are at greater risk of poorer educational outcomes either through life circumstances or events that occur in learners' lives which can affect their educational outcomes. Thus, when we say multiple vulnerabilities, we mean the problems learners face that go beyond simply to affecting the child's psychological and emotional development and their need for social interaction. These are likely to disadvantage learners in their cognitive and behavioural development as they grow. Adding to that, the child must be provided with affection, self-esteem, spiritual care, daily care, socialisation, recreation and education (Chinyoka 2013).The absence of these, to learners attending school, will expose learners to multiple vulnerabilities (Magampa 2014; Pillay 2018).Furthermore, Zimbabwe's fragile economic and political situation has and is leading to an increased deprivation and causing some learnersto be more exposed to multiple vulnerabilities (UNESCO 2017a; UNESCO 2017b). We further argue that the increased lack of basic needs of already vulnerable learners leads to multiple vulnerabilities. This has exposed most learners to sexual

harassment, forms of cultural practices, and all forms of abuse, lack of school fees, child labour, early marriages and early pregnancies in Zimbabwe. Political and economic meltdown has resulted in reduced external assistance by the government; highest dropouts are being experienced in Zimbabwe leading to early marriages and promiscuous behaviour by learners (UNESCO, 2017a; UNESCO, 2017b; ZimVac, 2019). Basing on the above arguments, we, therefore, conclude that these are the multiple vulnerabilities learners in Zimbabwe.

III. COMPLEXITY THEORY AND ITS UNDERLYING PRINCIPLES

Complexity theory encompasses a body of knowledge aimed at analysing complex systems (Morrison 2010; Ni and Branch 2009). Life and education are certainly classified as a non-linear, dynamic, natural, and social system (complex); therefore, it needs a deeper understanding how it affects lives of learners facing multiple vulnerabilities in Zimbabwe. In complexity theory, the system's internal organisation does not respond to one specific category of environmental problem but is capable of selectively interacting with all in its environment (Levy 1994). In other words, the system itself decides what information it will interact with and what meaning it will assign to it. As a complex system is an adaptive, learning system; we argue that the child's understanding of the environment is changeable in the light of interactions and received information (Mason 2008; Morrison 2010). Due to its capacity to learn, a child is capable of resisting change, it can make decisions as to whether to react to environmental stimuli. This decision could be based, but not necessarily, on whether it understands the information. Rather than parts, complexity theory emphasises wholes, relationships, open systems, and use of the environment as a tool to survival (Capra and Luisi 2014; Davis and Sumara 2007). We view complexity theory as that emphasises working together in finding solutions to the problem learners face using what is in the environment in order to survive. In this paper using the complexity theory principles, we strive for a holistic change in learners facing multiple vulnerabilities that they may *evolve and adapt* within the same learning environment they live in. In multiple vulnerabilities settings, the child as an organism who lives in the environment faces multiple vulnerabilities as a result of political, cultural socio-economic and psychological issues. The child needs to *change, evolve and adapt* in the interest of survival (Cillier 2010). Applied to learners facing multiple vulnerabilities, this body of understanding gives us a powerful tool for creating new insights that learners may change, evolve and adapt in the learning environments in which he/she lives in the interest of survival. A concurrence by Capra (1996) that one is a member of a web of life problems, who relates within the networking environment, makes us believe that complex situations are there in life. The child as an organism needs to find solutions to these problems within the environment they live in. In other words, one's pile of problems may result in more complex and multiple consequences and a wholesome complex way of solving things in the quest for survival. An entity may not survive well if it fails to find solutions to the problems it faces (Davis and Sumara 2007; Turner and Barker 2019). This is why we argue that the system may not fully survive if a holistic person is not created in finding solution to the problems it faces. Complexity theory is a theory of activity, proactivity and reactivity all together, not simply of passivity (Morrison 2010).

Complexity theory posits that systems begin as collections of individual actors who organise themselves and create relationships within the environment they live. Relationships form in response to positive or negative feedback they get from the environment, though a degree of randomness is inarguably involved as well. New structures and behaviours then emerge as the actors act and react to each other, environment and the individual (Haffeld 2012). As a result of individual interactions, and often the emergent result is more than, or qualitatively different from, the sum of individual actions, value is created (Morrison 2010). This can only be achieved through a 'complex adaptive system' (CAS) creating a wholesome individual. A CAS is defined as "one whose component parts interact with sufficient intricacy that they cannot be predicted by standard linear equations. So many variables are at work in the system that its overall behaviour can only be understood as an emergent consequence of the holistic sum of all the myriad behaviours embedded within" (Levy 1993, 34). This CAS is manifested by several principles such as path dependency, emergence, self-organisation and adaptationwhich we indulge below.

IV. TRANSFORMING LEARNERS THROUGH THE LENS OF COMPLEXITY THEORY

In this section, we interrogate the use of complexity theory and its principles in multiple vulnerabilities environments. This is done through a discussion of basic principles of the theory in relation to the Zimbabwean situation.

Path dependency and its capabilities in multiple vulnerabilities context

Path dependences are outcomes predicated through combined activities taking place over specified periods (Peirson, 2004; Cilliers; 2011). Prigogine (1997) defines path dependency as the way in which individuals find themselves perpetuating certain behaviours due to the circumstances they face within the environment. Depending on the situation, the behaviours they develop may be maintained and the individual can depend on those behaviours to survive the environment in future. Due to environmental changes at a later stage, it is difficult for individuals to adapt as they may be trapped in old behaviours (Ferreira, 2001; Fong, 2006; Morrison, 2008). However, the individual will have to think of other behavioural patterns in order to survive. The paper unlocks the ongoing dependency activities (being recipients) in order to nurture independency (using the environment) through the lens of complexity theory. Rural learners need to depend on the environment in order to avoid becoming recipients of

support in times of need. As the rural learning ecology changes over time, learners should not continue in their old behaviour state (dependence syndrome), instead, they should adapt to changes. If the ecology (external support) continues to be successful over a long period, people can find themselves depending on it, losing self-control to support themselves in the environment (Deogratias, 2018; Morrison, 2010). The dependence syndrome breeds weaknesses and complacency, as people tend to forget how to adapt to new ways of survival. We argue that lack of funding from external supporters can causes more complex and individuals locked into the set of behaviour. Applied to Zimbabwean context, learners who always receive assistance from external support may find themselves locked in old behaviours of dependence syndrome. Learners, who depend on help and is always in a comfortable and suitable position in life, move to *equilibrium* state, dies or moves towards *entropy* (Fong, 2006; Morrison, 2010). Morrison (2008) argues that if the ecology falls short of basic needs and wants (the external support), learners in multiple vulnerabilities environments go into a *disequilibrium* state and discover ways to operate. They actively construct their own meanings and understandings relative to their prior and existing knowledge and practices, especially when they are positioned into a *disequilibrium* state (Morrison, 2005; 2006; Ni & Branch, 2009; Tuner & Barker, 2019). The learners should, therefore, respond to the ecology by using the locally available assets and by reconfiguring themselves in order to survive/self-organise. The learners must develop a survivalist mentality. If the external ecology is harsh, they adjust their internal ecology (the brain) to cope with the fluctuating ecologies. We believe survival skills can only be achieved through the utilisation of assets in the environment they live in under the lens of complexity theory. Complexity theory incorporates concepts that may offer considerable leverage in understanding multiple vulnerabilities, needs, and demands, and provides a link between micro and macro assistance needed by changing the learner in the environment. We are aware that in complexity theory, the learners are the ones who are active in order to adapt (Tchiang, 2006sta). Some guidance is needed during that period to get those surprising behaviours patterns in order. There is need to unlock *dependence behaviour*, moving to an approach that caters for the holistic learner rather than to the problems, they face. Leaving them in their old behaviour, at that point (Deogratias, 2018; Morrison, 2010), the individuals maybe stake, failing to cope up to a new challenge, resulting in increasing crises.

Emergence and its capabilities in multiple vulnerabilities context

In complexity theory, emergence is well-formulated aggregate behaviour arising from localised, individual behaviour (Cilliers, 2006, 2011). According to Morrison (2010), emergence is an act resulting from actively being involved in a complex situation. He further explains that entities are determinant to create change in themselves. To be able to emerge, individuals need to (i) *self-organised criticality*, the need to realise a need change. Applied to rural learners, an individual needs to emerge from the dependence path they are locked.

To be able to emerge, there is a need for both (ii) an *intrapersonal* and (iii) an *interpersonal* dialogue within an individual. Intrapersonal assessments, for example, refer to our evaluation of a learner's work; *between the lines* insights into what they are saying and doing (behaviour); and our literal sensing of what is written about and by them. Interpersonally, may be our dialogue both with academic colleagues and, at times, with learners (Cilliers, 2011; Tuner & Baker, 2019). These dialogues give us *feedback* too about the reality in behaviour and the needs of the person. Reality is emergent because it is constructed through interaction and dialogue (Stacey, 2001), which should involve good relationships and an exchange of information. We argue, the process of creative emergence causes disequilibrium, which is important and helps an individual to connect with other important individual for feedback purposes (Morrison, 2010; Stacey, Griffin & Shaw, 2000).

Additionally, for a learner to be creative, imaginative, and adaptive, they need to undergo a state of (iv) *disequilibrium* because it triggers thinking and emergence into an adaptive life skill. In respect of capabilities, we argue that emergent conditions allow the learner to self-organise themselves. Creating relationships is curial to create new actions that can be useful in life (Deogratias, 2018; Eppel, 2017; Morrison, 2010). A learner in rural settings needs to emerge away from the dependence path towards the independence way of living. Staying away from equilibrium (dependence syndrome) implies the learner should be in a disequilibrium situation (described as order-disorder transitions). In order to emerge from the state they are in involves progression to another state in order to survive (Arévalo & Espinosa, 2014;Martin, McQuitty & Morgan, 2019). As Gould (2010) observes, emergent states should not be abrupt. Instead, they should be prepared for with the environment in mind to ensure higher survival probabilities.

Self-organization and its capabilities in multiple vulnerabilities context

In complexity theory, self-organisation is the ability of an individual to arise from a locked state in the environment and respond to the stimuli (Kauffman, 1995; Morrison, 2010). If the brain is re-activated, a learner is able to survive the complexity they face in life. It is not dispute that if the external environment is harsh, they make the internal environment (the brain) adjust and develop in order to survive those changing environments. Self-organisation contributes to such changes involved through the use of the internal environment. If the internal environment operates effectively, the individual is able to adapt, learn, communicate and give required feedback (Cilliers, 2006; Cilliers; 2011). When the internal environment scans the external environment, it can make decisions that improve the odds of survival in those changing external environments. Change is a basic need for an

individual to survive (Morrison, 2006, 2010). Thus, we argue that complexity theory provides fertile ground for considering how individuals can learn new behaviours and adaptations to changing environments. What is important is to let learners use the environment to adapt and to evolve in positive ways by exchanging positive feedback and communication through self-organisation.

In support of its capabilities, we argue that the ability of enabling learners to learn and adapt is the basis for the emergence of complex self-organised structures (Holland, 2014, Mayfield, 2013). In learner's multiple vulnerabilities environments, an individual needs to discover learnings from personal observation in order to survive in a complex environment. Holland (2014) emphasises that building blocks, tagging, and internal models are central to self-organisation. By *building blocks*, learners are able to build on their experiences by using behaviours that work well in one setting to refine their adaptation in another similar setting. By *tagging*, learners are able to identify and discriminate among the regularities in their environment (Holland, 2014; Wilson, 2017). By *internal models*, based on their inheritance and learning, learner construct a set of imperfections, usually implicit, conditional expectations about the likely outcome of alternative actions and so are able to choose appropriately self-interested actions. Thus, to self-organise themselves, the learners identify the best solution from the environment to ease their multiple vulnerabilities. The learner should not be obliged to believe that this be the perfect solution to the problems they face. Rather they should search for more meaningful information so they may develop an appropriately self-interested action within the environment. The learner should not be satisfied with the outcome present, rather they should continually *search* for meaning and solutions in order to survive and adapt in the environment. Self-organisation is ultimately a process for learner advancement, without it, there is no evolution (Cilliers; 2011).

Adaptation and its capabilities in multiple vulnerabilities context

Having self-organised, the learner has to adapt to the situation in which they live (Holland, 2014; Mayfield, 2013). The adaptation means changing your system over a specified period of time to be compatible with the changing environment. The time taken to adapt depends on motivation causing change (Marchi, Erdmann & Rodriguez, 2014). There must be some confusion for the individual to make the right decision. When the confusion state begins, the learners understand their current environment and decision to make. If they continue in such a state, they find patterns of behaviour they are able to make, important decision needed in order to survive and adapt. Because these forms help them survive in more and more situations, the patterns become habitual (Bondarenko & Baskin, 2016; Holland, 2012). Complexity theory here embraces the processes of *evolution* and *adaptation* for species to survive in an environment. We believe survival skills can only be developed through the utilisation of assets in any environment. Therefore, we felt that interactions of complexity theoryare vital in changing the learner in multiple vulnerabilities settings to be creative and evolve in the process of co-evolution.

In summary, Morrison (2010) admits that individuals change and adjust to micro and macro-societal change through path *dependency*, *emergence*, *self-organisation and adaptation*, which are a part complexity theory. These processes occur through learning from the environment. This study specifically linked the learner and the need to locate individual acts within multiple vulnerabilities. The following subsection will deliver illustrations on how complexity theorywas used in other similar situations.

V. COMPLEXITY THEORY AND MULTIPLE VULNERABILITIES IN LEARNING ECOLOGIES RURAL

Firstly, complexity theoryis a *holistic and interactionist* approach. In Fong's (2006) research, complexity theorytakes a complete and interactionist approach to understanding the change in behaviour of individuals when applied. In her argument, Fong stresses that the activities done by participants during her research were self-organised and would allow individuals to change their behaviours. Fong discovered that *openness* and *collegiality* were key results when complexity theorywas applied. There was improvement of the *inter-relationships* among individuals involved as they self-organised during development activities (Fong, 2006; Hasan, 2014; Snyder, 2013). If similar activities are applied to learners in rural ecologies, they may also develop holistically through an interactionist approach with other individuals in the environment. By allowing learners to be actively involved in sharing what they face in life with significant others, this helped learners to emerge from the situation, self-organise themselves, and adapt in order to survive. Learning of new behaviour takes place through the sharing of information within the environment. Therefore, in this instance of learning, as the learner gains experience, they learn new rules that can change their lives. We believe that learners may move from dependence syndrome to independence status when we call for *inter-relationship* with other individualsfrom the environment they live in, utilising the assets available to them.

Secondly, Tong (2006) found that in Hong Kong schools, there was great change in behaviour among students who had difficult in understanding English. The interrelationship activities helped students to self-organise themselves through openness and providing feedback to each other. Tong's study illustrated that leaders need to give chances to learners to solve their problems through interaction with the environment. We argue that the involvement of parents/guardians, teachers, headmaster/principal, NGOs, social workers and faith-based representatives as *facilitators* enables learners to emerge with solution to multiple vulnerabilities they face. For learners to emerge well in the harsh environment they live, they need to move towards a level of *disequilibrium* through active participation and involvement of assets within the environment for survival

(Morrison, 2008, 2010). This is active participation in learning by letting learners discover solutions to the problems they face. This active participation is known as creative emergence. It involves determined individuals who actively participate in order for change to take place and this rests upon the willingness of the organism/individual (Cilliers, 2011; Stacey, 2001). That way of thinking drove us to the application of complexity theory to find ways to mitigate multiple vulnerabilities learners face in rural learning ecologies. We argue for complexity theory as it advocates working together through interaction and dialogue resulting in an individual recovering from a difficult situation and survive.

Concisely, complexity theory redefines *the basics* of assisting an individual to initiate change away from *controlled assistance* towards a discovered, inter-disciplinary, and emergent and adaptive way of problem solving. Additionally, complexity theory proposes for change by utilising the local and institutional assets within the environment, through *learner-centredness* and experiential and active participation (Morrison, 2010). In other words, complexity theoryemphasises the skill development process (learner-centredness) rather than helping the learner in need, as it advocates for the active participation of learners facing multiple vulnerabilities. Emergence and self-organisation require room for development; active participation is vital to success and progression in life for learners in rural learning ecologies.

VI. CHALLENGES OF COMPLEXITY THEORY IN EDUCATION

Just as with any other theory, complexity theoryexhibits both strengths and weaknesses and is open to critique (Morrison, 2008; Radford, 2006). The framing of a lasting strategy was necessary and needed in order to develop long-term plans to affectively alleviate multiple vulnerabilities. Behaviour prediction is difficult especially in an unstable economic environment (Morrison, 2008, 2010). For this reason, the theory undermines its potential use as it cannot offer a guarantee behaviour trend regarding what will happen in future (Morrison, 2008; Radford, 2006) if the environment in which the agent lives changes due to political, cultural, economic, and social reasons. Changes into the above results in change in agent behaviours, thus it is difficult to predict the future behaviour related to the future problem. Stacey (2001) resolves that although temporary behaviour can be foreseeable, individuals can be unpredictable and as such, it is difficult to foretell the definite lasting consequences of their actions. Consequently, the connection between uncertainty and time is unpredictable. However, the collaboration of complexity theoryand other theories like asset-based approach help to determine specific assets/resources to be used to lessen the continuing consequences of their behaviour.

Many practitioners remark that complexity theoryis conceptually interesting but is often difficult to apply in practice. Complexity theory rejects positivism and linear causality (Morrison, 2008, 2010). This is because most researchers align themselves with postmodernism (reality) and are positive about what life is (Ni & Branch, 2009). Complexity theory here is inadequate to explain multiple vulnerabilities because it do not offer guarantees about how things would work in the future. There is need for a theory that describes and prescribes specific behaviour and strategies to guarantee the effects on future contents. For these reasons, this can be addressed by acknowledging the value of other concepts like the asset-based approach that concentrates on the use of local assets in finding solutions to the problems faced. Thus, complexity theoryis assumed that the character of reality is non-linear and the results would be positive.

VII. CONCLUSION

The paper discussed how the complexity theory can effectively be used to mitigating multiple vulnerabilities in Zimbabwe. Through literature and other findings by other researchers, complexity theory was found to have the potential to contribute in contexts where learners have to be practical in finding solutions to their problems. The paper did not ignore some possible obstructing factors towards realising the complexity theory in mitigating multiple vulnerabilities within the Zimbabwean situation. However, it takes note of the positive results it can yield in helping the child who is facing multiple vulnerabilities. We believe its full application can make a positive difference in the lives of learners. Thus, the writers argue for its applicability in the Zimbabwean contexts for its positive effects on learners facing multiple vulnerabilities as reflected through the discussion.

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