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Reframing Educational Leadership Research in the 21st Century

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Abstract

Hallinger and Heck (1997) argued that '(instructional) leadership (should be looked at) as an 'adaptive process rather than a unitary independent force' and allows for the possibility that 'causal relationships may be multi-directional, change over time and even be non-linear' (p. 168). The rationale to consider Instructional Leadership practices in schools as an 'adaptive process' is supported by the fact that schools are social, open and dynamic systems. Schools are subjected to continual changes to meet shifting policies, social, economic, and technological forces in its environment.

Almost two decades have past but interest and research in Instructional Leadership is still strong. However, these two decades have not fulfilled the call to look at Instructional Leadership as an 'adaptive process.' This was confirmed in a number of reviews of Instructional Leadership research (Southworth, 2010, Hallinger 2010, Hallinger & Chen, 2015, Walker & Qian, 2012, Ng, Wong, & Thanh, 2015). The review pointed to studies that predominantly adopted conventional social science research methodologies, specifically analytical tools such as descriptive, causal factor, correlational and advance modeling. These methods have constraints and limitations among which are: variable-based linear models measures are treated as 'rigorously real' measures of social reality, individuals use rational deduction (ignoring the value premise of decision making) and individuals are treated as independent and individualized.

Clearly, the conventional analytical tools are insufficient to explain the complex school system. Characteristics of the school system such as emergent behaviour, self-organization and nonlinearity could not be understood well using conventional social science formulas or statistics. This paper proposes and illustrates how complexity science research approaches can be applied within the social system to address complex Instructional Leadership questions. Complexity science is an interdisciplinary approach to science that studies how relationships between agents (individuals) give rise to collective behaviors of a system and how the system interacts and forms relationships with its environment. The analytical tools available in complexity science such as social network analysis, causal loop dynamic modeling, agent-based modeling, etc. provide the possibility to ask different research questions. Hence, reframing Instructional Leadership

research through the lens of complexity science provides the most viable approach to understand the adaptive process and dynamic system of schools.

Educational leadership research has come of age. From its' fledgling start in 1960s under the overarching research agenda of Educational Administration for school improvement, the focus shifted to leadership research from the early 1990s (Boyan, 1981; Griffiths, 1959, 1979, Day, Sammons, Leithwood, Hopkins, Harris, Gu and Brown, 2010; Southworth, 2002; Witziers, Boskers and Kruger, 2003; Gronn, 2002; MacBeath and Cheng, 2008; Mulford and Silins, 2003). Since then, educational leadership as a respected field, began to flourish by early 2000s (Hallinger, 2013; Robinson, Lloyd and Rowe, 2008; Walker and Dimmock, 2000). From 1980s to present, the body of knowledge on educational leadership has grown tremendously to produce three distinctive educational leadership theories – Instructional Leadership, Transformational Leadership and Distributed Leadership. While it is undisputed that educational leadership research has indeed been productive, there is a sense that we are approaching a narrowing labyrinth of researchable questions in particular to the first two educational leadership research theories. The evidence of this is implied in the concerted call to expand and situate educational leadership research in non-Western societies (Dimmock, 2000; Dimmock and Walker, 2005; Hallinger, 2011; Hallinger, Walker and Bajunid,2005). This call is valid in that there is limited contribution to substantive theory building from non-Western societies. However, it also implies that Western societies' focused in educational leadership has reached an optimum phase in publications and knowledge building. In our view, a more pertinent reason to rethink educational leadership research is based on the epistemological questions we have on the social science research paradigm that has been the foundation of educational leadership research.

This paper has three goals. The first is to map the data analytical methods used in educational leadership research over the past thirty years (1980–2016). The investigation covers the research methodologies used in Instructional Leadership, Transformational Leadership and Distributed Leadership. The purpose is to establish the types of data collection and analyses methods used to contribute to the development of our current body of knowledge on educational leadership.

Educational leadership studies are done in the social context of the school. This context involves complex social interactions between and among leaders, staff, parents, communities, partners and students. In the last decade, there is consensus among scholars that schools have evolved to become more complex. Complexity of schools is evident in the rise in accountability and involvement from an expanding number of stakeholders involved such as politicians, clinical professionals who diagnose learning disabilities of students, communities and educational resource providers (training and certifying institutions). The relationships among stakeholders are nonlinear and discontinuous, so even small changes in variables can have significant impact on the whole system. Therefore, the second goal is to determine if the current methodologies adopted for the past three decades are still adequate to inform us of the complex interaction patterns, influence, interdependencies and behavioral outcomes that are associated with the social context of the school.

The third goal is to explore potential alternative methodologies in the study of educational leadership. These alternative methodologies are gleaned from more recent developments of research methodologies used in other fields. These fields such as health, development of society among others have similarities with the study of educational leadership. The common link are the social contexts and the systems influence involving the spectrum of interactions, change and emergence. We will look at published empirical research and associated theories that look at influence, interdependencies, change and emergence. The hope is that these alternative methodologies will enable us to reframe how educational leadership research can move forward.

Three questions guide the presentation of this paper:

- What are the data sources and analytical methods adopted in Educational Leadership research?
- What is the current landscape of schooling and how does it challenge current educational leadership research methodologies?
- What are some possible alternative research methodologies and how can they complement current methodologies in educational leadership research?

This paper proposes to reframe educational leadership studies in view of new

knowledge and understanding of alternative research data analytical methods. It is not the intent of the paper to suggest that current research methodologies are no longer valid. On the contrary, the corpus knowledge of current social science research methodologies learned and practiced through the past three decades cannot be dismissed lightly. Instead in proposing to reframe educational leadership studies, the main purpose of this paper is to explore and propose complementary research methodologies that will open up greater opportunities for research investigation.

What are the dominant methodologies adopted in Educational Leadership research?

Educational leadership research adopts a spectrum of methods that conform to the characteristic of disciplined inquiry. Cronbach and Suppes (1969) defined disciplined inquiry as "conducted and reported in such a way that the argument can be painstakingly examined' (p. 15). What this means is that any data collected and interpreted through reasoning and arguments must be capable of withstanding careful scrutiny by another research member in the field.

This section looks at the disciplined inquiry methods adopted and implemented in the past thirty years that have contributed to the current body of knowledge on educational leadership and management. The pragmatic rationale to impose a time frame for the review is that instructional leadership was conceptualized in 1980s followed by transformational leadership and in recent years, distributed leadership. The purpose of the review is to identify, if possible, all the quantitative and qualitative methods adopted.

Instructional leadership became popular during the early 1980s. There are two general concepts of instructional leadership – one is narrow while the other is broad (Sheppard, 1996). The narrow concept defines instructional leadership as actions that are directly related to teaching and learning, such as conducting classroom observations. This was the earlier conceptualization of instructional leadership in the 1980s and was normally applied within the context of small, poor urban elementary schools (Hallinger, 2003; Meyer and Macmillan, 2001). The broad view of instructional leadership includes all leadership activities that

indirectly affect student learning, including school culture and timetabling procedures, by impacting the quality of curriculum and instruction delivered to students. This conceptualization acknowledges that Principals as instructional leaders have a positive impact on students' learning but this influence is mediated (Goldring and Greenfield, 2002; Leithwood and Jantzi, 2000; Southworth, 2002). A comprehensive model of instructional leadership was developed by Hallinger and Murphy (1985, 1986). This dominant model proposes three dimensions of the instructional leadership construct: defining the school's mission, managing the instructional program, and promoting a positive school-learning climate. Hallinger and Heck (1996) in their comprehensive review of research on school leadership concluded that instructional leadership was the most commonly researched. The authors' focused review found that over 125 empirical studies employed this construct between 1980 and 2000 (Hallinger, 2003). In the last decade, instructional leadership has regained prominence and attention in part because of the lack of empirical studies in non-Western societies. It can also be inferred from the notion that leadership in curriculum and instruction still matters and remains the core business of schools.

Transformational leadership was introduced as a theory in the general leadership literature during the 1970s and 1980s (e.g. Bass, 1997; Howell and Avolio, 1993). Transformational leadership focuses on developing the organisation's capacity and commitment to innovate (Leithwood and Duke, 1999). Correspondingly, transformational leadership is supposed to enable change to occur (Leithwood, Tomlinson and Genge, 1996). Amongst the leadership models, transformational leadership is the one most explicitly linked to the implementation of change. It quickly gained popularity among educational leadership researchers during the 1990s – in part because of reports of underperforming schools as a result of top-down policy driven changes in the 1980s. Sustained interest during the 1990s was also fueled by the perception that the instructional leadership model is a directive model (Hallinger and Heck, 1996). In a pointed statement of the extent of instructional leadership research, Hallinger (2003, p. 343) emphatically note that "The days of the lone instructional leader are over. We no longer believe that one administrator can serve as the instructional leader for the entire school without the substantial participation of other educators". From the beginning of 2000, a series of review studies comparing the effects of transformational leadership and instructional leadership, the over prescriptivity of findings, limited

methodologies adopted and lack of international research contributed to the waning interest in transformational leadership (Robinson, Lloyd, & Rowe, 2008).

Interest in distributed leadership took off at around 2000. As observed by Harris (2005), Gronn (2002) and Spillane, Halverson and Diamond (2004) - are leading the current debate on distributed leadership. Gronn's concept of distributed leadership is a "purely theoretical exploration" (p. 258) while Spillane's and his various colleagues' work is based on empirical studies which are still ongoing. When Gronn and Spillane first proposed their conceptions of distributed leadership, what was revolutionary was a shift from focusing on the leadership actions of an individual as sole agent to analyzing the "concertive" or "conjoint" actions of multiple individuals interacting and leading within a specific social and cultural context (Gronn, 2002, Bennett, Wise, Woods and Harvey, 2003, Woods, 2004, Spillane, 2005). In addition, Spillane, Diamond and Jita (2003) explicitly relate their concept of distributed leadership to instructional improvement which therefore catalyzes the interest among researchers to explore the constructs in school improvement/effectiveness. From 2000 to 2016, a focused search on empirical studies that employed the constructs of distributed leadership yielded over 97 studies.

This review adopted a combined search on the three educational leadership theories in schools using the following search parameters:

- Keywords in database search: AB "instructional leadership" OR AB "transformational leadership" OR AB "distributed leadership"
- Limiters: Full Text; Scholarly (Peer reviewed) Journals; Published Date: 1980 – 2016
- Narrow by Methodology: quantitative study
- Narrow by Methodology: qualitative study
- Search modes: Find all search terms
- Interface: EBSCOhost Research Databases
- Database: Academic Search Premier; British Education Index; Education Source; ERIC

The search found over 672 empirical studies employed the constructs of instructional leadership, transformational leadership and distributed leadership. As the purpose of the review is to identify all quantitative and qualitative

methods adopted, only this information is extracted. The researchers carefully read the relevant sections of the 672 studies pertaining to methodologies and extracted this information in the following tables.

Table 1: Instructional Leadership, Transformational Leadership, Distributed Leadership Quantitative Methods

Data Source: Questionnaire Survey	
Types	**Specific Analytical Methods**
Basic Statistics	Frequency Distribution; Mean; Median; Standard Deviation; t-Test
Analysis of Variance	Analysis of Covariance; Analysis of Variance; One-Way ANOVA; Two-way ANOVA
Association and Correlation	Correlation; Regression
Causal modeling	Dependent Variable; Independent Variable; Path Analysis; Structural Equation Modeling
Factor Analysis	Exploratory Factor Analysis; Factor Analysis; Confirmatory Factor Analysis; Oblique Rotation; Rotated Factor
Linear and Multilevel Analysis	Generalized Linear Model, Hierarchical Generalized Linear Model; Hierarchical linear modeling;
Multilevel Regression	Multicollinearity; Multiple Regression Analysis; Interaction Effect

Table 2: Instructional Leadership, Transformational Leadership, Distributed Leadership Qualitative Methods

Data Source	Specific Analytical Methods:
One-on-one interview	● Thematic analysis ("coding and then segregating the data by codes into data clumps for further analysis and description) ● discrepancy theme
Focus group interview	● Characteristics
Document search (e.g. writing samples, email correspondence, and district literature)	● Descriptive
Field notes	● Factors
Classroom Observations	● Roles
Semi-structured interviews	● Nature
Artifacts	● Content analysis
Shadowing	● Causal sequence
interview protocols (for multiple case studies)	● Interactions but also in social, cultural, and institutional discourses
Interpretive description	● Structured coding scheme derived from the conceptual framework
Topic-oriented	● Exploratory analysis
The Voices from the Field	● Phenomenology and constant comparative methods
Cross-cultural comparative studies	● Comparative analysis: finding common themes, and contrasts
Portfolios	● Detailed analytical memo
Micropolitical analysis	● Vertical analysis: analyzing participants' voices separately; and ● Patterns and elucidating the differences among participants' voices.

The range of quantitative and qualitative research methodologies and analytical tools found in the review could be categorized as follows:

- Quantitative Analyses
  - Univariate Analysis
    The analyses that refers to a single variable represented by frequency distribution, mean and standard deviation

- Bivariate Analysis
  This type of analysis examines how two variables are related to each other represented by ANOVA, Pearson product moment correlations, correlation and regression.

- Multivariate Analysis
  These are statistical procedures that are used to reach conclusions about associations between two or more variables. Representations of inferential statistics include regression coefficients, MANOVA, MANCOVA, two-group comparison (t-test), factor analysis, path analysis, hierarchical linear modeling and others.

- Qualitative Analyses

  - Content analysis
    Content analysis is the systematic analysis of the text by adopting rules that can separate the text into units of analysis such as assumptions, effects, enablers and barriers. The text is obtained through document search, artifacts, interviews, field notes, observations. The transcribed data is converted into protocols followed by categories. Coding schemes are then applied to determine themes and their relationships.

  - Hermeneutic analysis
    This type of analysis is where researchers try to interpret the subjective meaning of a given text within its socio-historic context. Methods adopted extend beyond texts to encompass all forms of communication, verbal and non-verbal. An iterative analyses method between interpretation of text and holistic understanding of the context is adopted in order to develop a fuller understanding of the phenomenon.

  - Grounded theory analysis
    This is an inductive technique of interpreting recorded data about a social phenomenon. Data acquired through participant observation, in-depth interviews, focus groups, narratives of audio/video recordings and documents are interpreted based on empirical data. A systematic coding technique involving open coding, axial coding and selective coding is rigorously applied. These coding techniques aimed to identify key ideas, categories, causal relationships among categories and finally arriving at theoretical saturation where additional data and analyses does not yield any marginal change in the core categories.

The authors were curious to see if current research methodologies adopted are also reinforced and transmitted by the research courses offered by top universities. A search was conducted that specifically looked at graduate research courses taught in Educational Leadership and Management. The following search parameters were used:

- Identify top 20 universities that offer graduate courses in educational leadership and management.
- QS ranking of universities is chosen over Times Ranking because QS ranking is sorted by subject: Education and searchable by Educational Leadership.
- Representation of Western and Eastern Universities in order to provide a representation of universities globally.

The review is presented in the Table 3 in the following page. Table 3 is remarkably similar to Tables 1 and 2 but with more details of the topics in educational leadership research methodologies. Summary of the above reviews strongly suggests that current research methodologies adopted in educational leadership studies are reinforced by research courses taught at the top universities. This suggests that knowledge in research and research practice has continued as a transmission-based form. Indeed the transmission and application of research skills is a critical and essential component of graduate programmes. This transmission of knowledge and practice is strengthened through the enshrined supervisor-supervisee relationship where cognitive modeling takes place through discourse, reflection, guidance and inquiry. The one-to-one supervision has a very powerful effect of instilling expectations, cultivating habits and shaping practices that contribute to a competent researcher identity. What must be noted is that the transmission-based form has emanated from and continued in the paradigm of the social science.

Table 3: Research Courses in Educational Leadership Taught in Top 20 Universities

Quantitative courses	Qualitative courses	Universities
• Basic descriptive measures summarizing data using statistics such as frequency, mean, variance; • Random sampling and sampling error • Hypothesis tests for continuous and categorical data • Modelling continuous data using simple linear regression • General linear model--regression, correlation, analysis of variance, and analysis of covariance • Multiple linear regression including categorical covariates and interaction effects, factorial ANOVA, ANCOVA, MANOVA, MANCOVA, partial and semi-partial correlations, path analysis, exploratory factor analysis and confirmatory factor analysis. • Basic statistical inference including confidence intervals and hypothesis testing; multiple linear regression including categorical variables and interaction effects • Structural equation modeling • SEM with observed variables • SEM with latent variables • Maximum likelihood estimating, goodness-of-fit measures, nested models • Binary and multinomial logistic models • Instrument reliability and validity	• Content analysis • Ethnography • Critical ethnography • Pragmatic qualitative research • Phenomenological analysis • Discourse analysis • Analysis of visual materials • Policy documentary analysis • Historical documentary analysis • Classroom ethnography, • Survey • Grounded theory • Action research • Participatory research • Bibliographic analysis • Institutional ethnography • Narrative • Observation and interview • Interviews • Oral history • Arts-based research • Critical transnational ethnography • Hermeneutics • Phenomenology, • Semiotics • Crystallization	The UCL Institute of Education Harvard University Stanford University University of Cambridge The University of Melbourne The University of Hong Kong University of Oxford University of California, LA (UCLA) The University of Sydney Nanyang Technological University University of California, Berkeley (UCB) Columbia University University of Michigan University of Wisconsin-Madison The Hong Kong Institute of Education Monash University University of Toronto University of British Columbia Michigan State University The Chinese University of Hong Kong

Social Science Disciplined Inquiry in Educational Leadership: Limitations

The range of methodologies and analytical tools reviewed above are social science disciplined inquiry methods. Social science is the science of people or collections of people, such as groups, firms, societies, or economies, and their individual or collective behaviors. Social sciences can be classified into disciplines such as psychology (the science of human behaviors), sociology (the science of social groups), and economics (the science of firms, markets, and economies). This section is not intended to wade into epistemological and ontological debates within the social sciences. It is also not possible to have an in-depth discussion of social science methodologies within the constraints of this paper. The focus is to highlight ongoing discussions of limitations of social science research that fits the purpose of the paper.

Educational leadership is not a discipline by itself but a field of study. It is a field of study that involves events, factors, phenomena, organizations, issues, people and processes related to leadership in educational setting. This field of study adopts social science inquiry methods. The reviewed of research methodologies as depicted in Tables 1 and 2 strongly suggests that educational leadership research subscribed to the functionalist paradigm (Bhattacherjee, 2012). The functionalist paradigm believes that social order or patterns can be understood in terms of their functional components. Therefore the logical steps will involve breaking down a problem into small components and studying one or more components in detail using objectivist techniques such as surveys and experimental research. It also encompasses an in-depth investigation of the phenomenon in order to uncover themes, categories and sub-categories.

Educational leadership studies using quantitative methods aimed to minimize subjectivity. Hence the constant advocacy of good sampling techniques and large sample size in order to represent a population where the sample is reported by mean, standard deviation and normal distribution among others. Qualitative methods rest upon the assumption that there is no single reality for events, phenomena and meaning in the social world. Adopting a disciplined analytical method based on dense contextualized data in order to arrive at an acceptable interpretation of the complex social phenomena is advocated. The following section will discussed several common limitations of social science research.

Population, sampling and normal distributions

From the review, social science quantitative and qualitative methods in educational leadership research can be inferred to subscribe to the goal of identifying and analyzing data that can inform about a population. The researcher aims to collect data that either maximize generalization to the population in the case of quantitative methods or provide explanation/interpretation of a phenomenon that represents a population in the case of qualitative methods. In most cases, definitive conclusions of a population are rarely possible in social sciences because data collection for an entire population is rarely achieved.

Therefore, researchers apply sampling procedures where the mean of the sampling distribution will approximate the mean of the true population distribution which we have come to know as normal distribution. This concept has set the parameters of how we analyze data over many years. We have accepted that most data ought to be near an average value, with a small number of values that are smaller, and the other extreme where values are larger. To calculate these values, the probability density function (PDF), or density of a continuous random variable, is used. It is a function that describes the relative likelihood for this random variable to take on a given value.

A simple example would explain this. If we randomly select 20 school principals and arrange them in a room according to their heights. We would most likely see a normal distribution with a few principals who are shorter than many others on the left, the majority in the middle and a few principals who are the tallest on the right. This has come to be known as the normal curve or probability density function.

Most quantitative research involves the use of statistical methods presuming independence among data points and Gaussian 'normal' distributions (Andriani and McKelvey, 2007). The Gaussian distribution is characterized by its stable mean and finite variance (Torres-Carrasquillo, Singer, Kohler, Greene, Reynolds and Deller, 2002). As in the example above, supposedly the shortest principal is 1.6m. If we ask a question, 'What is the probability that a principal in the line is shorter than 1.5m? The answer would be '0'. From the total principals in the

room there is no chance to find someone who is shorter than 1.6m. But if we ask, 'What is the probability that a principal in the line is 1.7m? Then the probability could be 0.2 (i.e.10% or 2 persons). Hence this explains the finite variance – which is dependent upon the sample size. Normal distributions assume few values far from the mean and therefore, the mean is representative of the population. Even the largest deviations, which are exceptionally rare, are still only about a factor of two from the mean in either direction and are well characterized by quoting a simple standard deviation (Clauset, Shalizi and Newman, 2009). This property of normal curve, in particular the notion that extreme ends of both variance are less likely to occur, has significant implication as will be discussed.

Is the normal distribution the standard to determine acceptable findings in educational research? One possible answer is a study done by Micceri (1989). His investigation involved obtaining secondary data from 46 different test sources and 89 different populations that have done psychometric and achievement/ability measures. He managed to obtain analyzed data from 440 researchers. He submitted these secondary data to analysis and found that they were significantly non-normal at the alpha .01 significance level. In fact, his findings found that tail weights, exponential-level asymmetry, severe digit preferences, multimodalities, and modes external to the mean/median interval were evident. His conclusion was that the underlying tenets of normality-assuming statistics appear fallacious for the psychometric measures. Micceri (1989, p. 16) added that 'one must conclude that the robustness literature is at best indicative.'

In another well cited article in the Review of Educational Research, Walberg, Strykowski, Rovai and Hung (1984 p. 87) states that "considerable evidence shows that positive-skew distributions characterize many objects and fundamental processes in biology, crime, economics, demography, geography, industry, information and library sciences, linguistics, psychology, sociology, and the production and utilization of knowledge." Perhaps the most pointed statement made by Walberg et al., that "commonly reported univariate statistics such as means, standard deviations, and ranges – as well as bivariate and multivariate statistics…and regression weights – are generally useless in revealing skewness" is worthy to note.

What are the implications and limitations of the normal distribution in the population? There are at least two limitations. First, reliance on normal distribution statistics puts a heavy burden on assumptions and procedures. The procedures of randomness and equilibrium have powerful influences on how theories are built and also determine how research questions are formulated. In other words, findings may be rejected that could otherwise be informative because they do not meet the normal distribution litmus. The explanation of the normal distribution suggests that events/phenomenon at both extreme ends of the normal curve is highly unlikely– hence, we typically reject the findings. The real world phenomena, example social networks, banking networks, world-wide web networks, has been established that events at the tails are more likely to happen than in the normal distribution (Mitzenmacher, 2004).

Second, independent variables contributing to a normal distribution assume that the variables are static. The reality is that in education (and educational leadership) the variables are dynamic. This dynamic function comes from the past and even future environmental and individual influences. An example is that initial advantages of university study (past influence), work with eminent researchers (preferential attachment), well funded research projects, publication opportunities (environmental influence) combine multiplicatively over time that cumulate to produce highly skewed number of publications. The distribution would not conform to the normal curve for researchers when past influence, preferential attachment and environmental influences are taken into consideration. At the moment, the large majority of reviewed studies using inferential statistics of means, standard deviations does not account for such dynamic influences upon the variables. Is there an alternative that could complement this limitation? Many real world networks (world-wide web, social networks, professional networks etc.) have what is known as long-tailed distribution instead of the normal distribution. The latter section will examine power laws distributions and fractals as possible alternative to normal distribution in educational leadership research.

Linearity in a predominantly closed system

The dominant analytical tools adopted in educational leadership research involved relational and associational analyses of the effects of leadership actions and interventions in the school. The focus is on identifying variables, factors and their associations in providing explanations of successful practices. The central concept of relations is based on linearity. Linearity means two things: proportionality between cause and effect; and superposition (Nicolis & Prigogine, 1989). According to this principle complex problems can be broken down into simpler problems, which can be solved individually. That is, the effects of interventions can be reconstructed by summing up the effects of the single causes acting on the single variable. This then, allows us to establish causality efficiently.

However, this assumption forces researchers to accept that systems are in equilibrium. The implication is that the number of possible outcomes in a system is limited (because of the limited number of variables within a closed system). A second implication is that introduction of an intervention from the school leader that results in instability is short compared with the equilibrium time of final outcome. Hence we measure effects or establish relationships and accept its data value as true indicative of the cause of intervention. For this to be true, the many variables in the school (as a closed system) must be assumed as independent data points; otherwise we could have interdependence, possible mutual causality and the occurrence of possible external influences (like political change, economic change) in the larger system.

An example to illustrate this would be useful. The goal of school leadership is improving student achievement. Student achievement is demonstrable, even though there are considerable differences of opinion about how to define improvement in learning/achievement (Larsen-Freeman, 1997). This is because much research assumes that the classroom is a closed system with defined boundaries, variables, and predictable outcomes. This mechanistic, linear view neglects students as active constructors of meaning with diverse views, needs, and goals (Doll, 1989). To draw the association directly that teachers' pedagogy results in learning is debatable. Luo, Hogan, Yeung, Sheng and Aye (2014) found that Singapore students attributed academic success mainly to internal

regulation (effort, interest and study skills), followed by teachers' help, ability, parents' help and tuition classes. While the study appears to support linearity and attribute students' academic success to identified variables, there is still much less certainty on other aspects. An example would be the interaction effects among the variables. We could not account for the interactions among students using generalized linearity – how they motivate each other, how they compete and derive the drive to perform. Students and teachers in the classroom interact in an open, nonlinear, and chaotic system with unpredictable direction. Researchers studying student achievement tend to seek to reduce and consolidate variables to discover order, and we deny irregularity.

Due to its simplicity, linearity became almost universally adopted as true measures in educational leadership research. School improvement, student learning, staff capacity, efficacy are much more complex than directly assigned proportionality between factors and outcomes and identifying superposition. Cziko (1989, p. 17) asserted that 'complex human behavior of the type that interests educational researchers is by its nature unpredictable if not indeterminate, a view that raises serious questions about the validity of quantitative, experimental, positivist approach to educational research.' In general school improvement ought to include a non-linear cognitive system or processes and that research questions cannot be simplified to find answers from regression models alone – particularly research questions that involve non-specified outcome variables. For instance, school success other than internal variables and factors also simultaneously include influences by changes in government policies, and conflicting demands of multiple stakeholders (e.g. economic and societal-related stakeholders). Relying only on the linearity within a closed system will limit our understanding on such interdependency and mutual influences. Hence, a holistic and more complete understanding of social phenomena such as why are some school systems in some countries more successful than others, require an appreciation and application of research methods that includes the elements of an open and closed system. We shall discuss the alternative to linearity – nonlinear, emergence and self-organization as an alternate view of reality.

Explanatory, explorative and descriptive research (after intervention) and not predictive and change

One of social science research's aims is to understand subjectively meaningful experiences. The school of thought that stresses the importance of interpretation as well as observation in understanding the social situation in school is 'interpretivism'. This has been seen as integral to the qualitative research methodologies and analytical tools adopted in educational leadership research. The interrelatedness of different aspects of staff's work (teaching, professional development), interactions with students (learning, guidance etc.), cultural factors and others are a very important focus of qualitative research. Qualitative research practice has reflected this in the use of explanatory, explorative and descriptive methods which attempt to provide a holistic understanding of research participants' views and actions in the context of their lives overall.

Ritchie, Lewis, Nicholls and Ormston (2013) provide clear explanations of the following research practices: Exploratory research is undertaken to explore an issue or a topic. It is particularly useful in helping to identify a problem, clarify the nature of a problem or define the issues involved. It can be used to develop propositions and hypotheses for further research, to look for new insights or to reach a greater understanding of an issue. For example, you might conduct exploratory research to understand how staff react to new curriculum plans or ideas for developing holistic achievement, or what teachers mean when they talk about 'constructivism, or to help define what is meant by the term 'white space'.

A significant number of qualitative studies reviewed in this paper are about description as well as exploration – finding the answers to the Who? What? Where? When? How? and How many? questions. While exploratory research can provide description, the purpose of descriptive research is to answer more clearly defined research questions. Descriptive research aims to provide a perspective – of a social phenomenon, a set of experiences.

Explanatory research addresses the why questions: Why do staff value empowerment? Why do some staff perceive the school climate negatively and others not? Why do some students have higher self-motivation and others less? What might explain this? Explanatory – in particular qualitative research answer these types of questions, to allow us to rule out rival explanations and

come to a conclusion, to help us develop causal explanations.

An obvious limitation of explanatory, explorative and descriptive educational leadership research is that these are done after an intervention or that we are looking at outcomes. If research could look into before intervention, then two reasonable questions to explore would be:

- Will an intended school vision/policy have the desired positive reception among staff?'
- How can you predict what kind of reception or perception staff might have?

The answer will be useful for school leaders to initiate intervention measures before serious damage has been done. It would be most useful extrapolating it to the larger system where policy makers are interested to predict likely outcome of the policy before its implementation. In this kind of research, one of the examples is development of models or known as modeling or simulations. Computer simulation/modeling is known as the third disciplined scientific methodology. The latter section on alternative methodologies will discuss this concept.

In summary of the limitations of current methodologies in educational leadership is concisely captured by Leithwood and Jantzi (1999): Finally, even the most sophisticated quantitative designs used in current leadership effects research treat leadership as exogenous variable influencing students, sometimes directly, but mostly indirectly, through school conditions, moderated by student background characteristics. The goal of such research usually is to validate a specific form of leadership by demonstrating significant effects on the school organization and on students. The logic of such designs assumes that influence flows in one direction— from the leader to the student, however tortuous the path might be. But the present study hints at a far more complex set of interactions between leadership, school conditions, and family educational culture in the production of student outcomes. (p. 471).

What is the current landscape of schooling and how does it challenge current educational leadership research methodologies?

Complexity of Schools: Systems and Structures

Murphy (2015) examined the evolution of education from the industrial era in the USA (1890 – 1920) to the post industrial era from the 1980s. He concluded that post-industrial school organizations have fundamentally shifted in roles, relationships, and responsibilities. The shift is seen in blurring of distinctions between administrators and teachers; general (expanded) roles instead of specialization where specialization is no longer held in high regard as compared to the industrial era, greater flexibility and adaptability. In terms of structures, the traditional hierarchical organization structures are giving way to structures that are flatter.

This shift in roles, relationships, and responsibilities has also contributed to the increasingly complexity of schools. The involvement (direct and indirect) between and among a growing circle of stakeholders within the school and between government, employers, and communities clearly support the view that schooling is no longer seen as a closed system. It is both a closed and open system (Leithwood and Day, 2007; Darling-Hammond, 2010; Hargreaves and Shirley, 2009). Leithwood and Day (2007), state that "Schools are dynamic organizations, and change in ways that cannot be predicted" as they reviewed leadership studies from eight different countries. Open systems are "a system in exchange of a matter with its environment"(Von Bertalanffy, 1968, p. 141). Schools as an open system are therefore seen as part of a much larger network rather than an independent, self-standing entity.

Thus, to understand the processes extant within the school, it is critical to study interrelationships between those entities and their connections to a whole system. The interrelationships among stakeholders are nonlinear and discontinuous, so even small changes in variables can have significant impact on the whole system. This notion of small change leading to global change is reflected in the example of the current 'world class education system' movement. From countries as diverse as United Arab Emirates, Brazil, Hong Kong, Singapore, Vietnam, Australia and the United States of America, a common theme found in

the education reform documents is the phrase 'world-class education.' The phrase 'world-class education' has become widely associated with comparative results on international tests such as Trends in International Mathematics and Science Study (TIMSS), Programme for International Student Assessment which purports to measure certain aspects of educational quality. Indeed the phrase is frequently used by countries that have attained high scores in these international tests as a strong indicator of being world-class. This seemingly small aspect of change (comparing of achievement in Mathematics and Science) has impacted developing and developed nations in reforming their education system and call their ongoing education reform as moving towards a 'world class education system.'

Thus, interrelationships in an open system require sophisticated analyses of their systemic nature. A reductionist and linear sequential relationship investigation would not be the sufficient to inform us to bring about further change.

Shared and Distributed Leadership

At the turn of the century, educational leadership scholars began to focus on shared leadership which was then conceptualized as distributed leadership. Spillane and colleagues argue that leadership is "stretched over" the practice of two or more leaders in their interactions with followers (Spillane *et al.*, 2004); it occurs "in between" people, between leaders, and between leaders and their followers (Spillane, Camburn, Lewis, & Pareja, 2006, p. 16). Spillane, et al., (2006) argues that the influence of distributed leadership is more than the sum of the individual leaders' actions because of their interactions in carrying out a particular leadership activity: one plus one leader is more than just adding the individual effort of two leaders.

Thus, Spillane, Halverson and Diamond (2001) argue that leadership is distributed in the "interactive web of actors [leaders and followers], artifacts [tools] and the situations" (p. 23). People with access to different knowledge and expertise work interdependently and reciprocally in performing leadership. Based on such a concept of leadership, the unit of analysis is not individual leaders but leadership activity, which is distributed over multiple leaders, followers and the situation (Spillane, 2005).

A core function of leadership - distributed leadership included, is decision making. A review of literature looks at forms of decision making from the larger system and also at the school organization is discussed. The most popular discussion of decision making in the 21st century emanate from the concept of decentralization. Decentralization includes delegating responsibilities, practice of distributed leadership, practice of distributed/shared instructional leadership (Nguyen, Ng and Yap, in-press; Lee, Hallinger and Walker, 2012; Spillane, Halverson and Diamond, 2001).

Glatter and Kydd (2003) identified two models of decentralization which have important implications for the school leaders: Local empowerment and School empowerment. In local empowerment, the transfer of responsibilities from the state to the districts, including schools with reciprocal rights and obligations. Therefore, school leaders are expected to play a greater role in leadership beyond the school borders. In the aspect of school empowerment or autonomy, decision making by the school has been a consistent movement since the 1980s. Increase in autonomy required the school leaders to make budgetary, professional capacity development, design of school building, and many more aspects.

How might national and state policy frameworks (including curriculum and assessment, school quality and improvement) successfully engage and interact with key activities and characteristics of the school (including learning focus, structure, culture, decision making capacity)? What considerations must be taken when formulating policies of curriculum and implementation of policies within the classroom (class size, teaching approaches, and learning resources)? How do we optimize the capacity and work of school leaders to influence and promote effective learning? In distributed leadership, how might we be informed of the processes of influence beyond relying on interpretive and explanatory qualitative studies? Leithwood and Levin (2005) conclude that any attempt to design and carry out a comprehensive analysis of the ways in which leaders influence and promote successful outcomes through their decision making will require specific methods and procedures beyond the traditional research methods. In particular, distributed leadership research stands to gain the most if we adopt relevant research methodologies that can inform us of the effects of leadership activities.

What are the alternatives to current social science methodologies for Educational Leadership?

As stated in the earlier section, it is important to ensure that any alternative research methodologies proposed must adhere to the characteristic of disciplined inquiry. To further expand on this characteristic, Cronbach and Suppes stated that "Disciplined inquiry does not necessarily follow well established, formal procedures. Some of the most excellent inquiry is free-ranging and speculative…trying what might seem to be a bizarre combination of ideas and procedures…" (1969, p. 16).

Drawing from the statement by Cronbach and Suppes, there are two other important points about disciplined inquiry that must be addressed here. First, disciplined inquiry is not solely focus on establishing facts. The methods of observation and inquiry is critical if we were to state the facts. Establishment of facts can be done through a selection of observations and/or data collection methods. This point is not meant to raise the philosophical argument of positivism and post positivism although it may be implied. Rather, from a pragmatic perspective and to adhere to the characteristic of disciplined inquiry, we are proposing that one should be opened to different types of observations and data collection methodologies as long as the definition of disciplined inquiry is adhered. To further support this view, it must be understood that the field of educational leadership is not a discipline by itself. As in any field of study, one should not be limited to a single discipline to dictate and direct the study. Instead, procedures and perspectives of different disciplines such as biology, chemistry, economics, geography, politics, anthropology, sociology and others can be brought to bear on the research questions that we can investigate.

Brief Introduction to Complexity Science from the Educational Leadership Perspective

Complexity appears in the twentieth century in response to criticism of the inadequacy of the reductionist analytical thinking model in helping us to understand systems and the intricacies of organizations. Complexity science does not refer to a single discipline. Like social science, a family of disciplines (psychology, sociology, economics, etc.) adopts methodologies to study

social-related phenomena in the disciplines. Complexity science includes the disciplines of nonlinear dynamical systems, network, synergetics, and complex adaptive systems and others.

The cornerstone concept of complexity science is the complex system. Complex systems have distinctive characteristics of self-organization, adaptive ability, emergent properties, nonlinear interactions, dynamic and network-like structures (Cilliers 2001; Bar-Yam, 2003; Capra, 1996). By looking at the complex system of an organization, leadership should consequently be viewed in a different light. A complex system is a functional whole, consisting of interdependent and variable parts. In other words, unlike a conventional system (e.g. an aircraft), the parts need not have fixed relationships, fixed behaviours or fixed quantities, thus their individual functions may also be undefined in traditional terms. Despite the apparent tenuousness of this concept, these systems form the majority of our world, and include living organisms and social systems, along with many inorganic natural systems (e.g. rivers).

The following is a brief introduction of key concepts of complexity science. These concepts are also the methodological assumptions for complexity science:

a. Emergence

Emergence is a key concept in understanding how different levels in a system are linked. In the case of leadership, it is about how influence happen at the individual, structure and system levels. These different levels exist simultaneously and one is not necessarily more important than the other, rather they are recognized as co-existing and linked. Each level has different patterns and can be subject to different kinds of theorization. Patterns at 'higher' levels can emerge in ways that are hard to predict at the 'lower' levels. The challenge long-acknowledged in leadership research is how do different levels interact and affect school outcome or school improvement. This question of the nature of 'emergence' has been framed in a variety of ways including those of 'macro-micro linkage', 'individual and society', the 'problem of order' and 'structure, action and structuration' (Giddens, 1984). In this paper, Giddens' (1984) explanation of emergence as the relationship between the different levels through the 'structure and agency' is adopted.

Giddens stated that the term structure referred generally to "rules and resources." These properties make it possible for social practices to exist across time and space and that lend them "systemic" form (Giddens, 1984 p.17). Giddens referred to agents as groups or individuals who draw upon these structures to perform social actions through embedded memory, called memory traces. Memory traces are thus the vehicle through which social actions are carried out. Structure is also, however, the result of these social practices.

b. Non-linearity

Non-linearity refers to leadership effects or outcomes that are more complicated than being assigned to a single source or single chain of events. Influence and outcome are considered linear if one can attribute cause and effect. Non-linearity in leadership however, means that the outcome is not proportional to the input and that the outcome does not conform to the principle of additivity, i.e., it may involve synergistic reactions in which the whole is not equal to the sum of its parts.

One way to understand non-linearity has often referred to how small events lead to large scale changes in systems. Within the natural sciences the example often cited (or imagined) is that of a small disturbance to the atmosphere in one location, perhaps as small as the flapping of a butterfly's wings, tipping the balance of other systems, leading ultimately to a storm on the other side of the globe (Capra, 1997).

c. Self-organization

Self-organization happens naturally as a result of non-linear interaction among staff in the school (Fontana and Ballati, 1999). As the word describes, there is no central authority guiding and imposing the interactions. Staff adapt to changing goals and situations by adopting communication patterns that are not centrally controlled by an authority. In the process of working towards a goal (for example solving a leadership problem), self-organizing members tend to exhibit creativity and novelty as they have to quickly adapt and to find ways and means to solve the problem and achieved the goal. This particular phenomenon is most observed in distributed leadership (Yuen, Chen and Ng, 2015; Ng and Ho, 2012). As a result of interactions among

members, the emergence of new patterns in conversation happens. This is an important aspect of self-organization. When there are no new patterns in conversations, there is no new idea and no novel ways to solve problems. It must be noted that new patterns of conversation depend upon the responsiveness of its members towards each other and their awareness of each other's ideas and response. As a result of the behavior of interacting members, learning and adaptation or novel ways of solving problem emerge.

As stated, complexity science is interdisciplinary and as such, there are multiple methods and ways to study complexity phenomena. It is impossible to delve into these methodologies in a meaningful manner in one paper. The following are established methods used in studying complex systems:

Table 4: A Short Description of Other Complexity Theory Research Tool (From Wikipedia)

Methods	Definition
Agent-based modeling	An agent-based model (ABM) is one of a class of computational models for simulating the actions and interactions of autonomous agents (both individual and collective entities such as organizations or groups) with a view to assessing their effects on the system as a whole. It combines elements of game theory, complex systems emergence, computational sociology, multi-agent systems, and evolutionary programming. Agent-based social simulation (or ABSS) consists of social simulations that are based on agent-based modeling, and implemented using artificial agent technologies. Agent-based social simulation is scientific discipline concerned with simulation of social phenomena, using computer-based multi-agent models. In these simulations, persons or group of persons are represented by agents. Source: https://en.wikipedia.org/wiki/Agent-based_model
Network (social) analysis	Social network analysis (SNA) is the process of investigating social structures through the use of network and graph theories. It characterizes networked structures in terms of nodes (individual actors, people, or things within the network) and the ties or edges (relationships or interactions) that connect them.

	Examples of social structures commonly visualized through social network analysis include social media networks, friendship and acquaintance networks, kinship, disease transmission, and sexual relationships. These networks are often visualized through sociograms in which nodes are represented as points and ties are represented as lines. Source: https://en.wikipedia.org/wiki/Social_network_analysis
Dynamical systems theory	Dynamical systems theory is an area of mathematics used to describe the behavior of complex dynamical systems, usually by employing differential equations or difference equations. This theory deals with the long-term qualitative behavior of dynamical systems, and studies the nature of, and when possible the solutions of, the equations of motion of systems that are often primarily mechanical or otherwise physical in nature, such as planetary orbits and the behavior of electronic circuits, as well as systems that arise in biology, economics, and elsewhere. Much of modern research is focused on the study of chaotic systems. Source: https://en.wikipedia.org/wiki/Dynamical_systems_theory
Multi-agent modeling	A multi-agent system (M.A.S.) is a computerized system composed of multiple interacting intelligent agents within an environment. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve. Intelligence may include some methodic, functional, procedural approach, algorithmic search or reinforcement learning. Source: https://en.wikipedia.org/wiki/Agent-based_social_simulation

The intent of the paper is to challenge current social science methodologies and analytical tools to inform educational leadership research. The following section will highlight one of the methods used in complexity science research that provides an alternative to the limitations identified in current research methodologies in educational leadership research.

Social Network Analysis as an alternative to Normal Distribution and Linearity

Social Network Analysis (SNA) (Scott, 2011; Wasserman and Faust, 1994) focuses on relational structures that characterize a network of people. These relational structures are represented by graphs of individuals and their social relationships; and structural indexes which analyze the network of social relations on the basis of characteristics such as neighborhood, density, centrality, cohesion and others.

Social network analysis (SNA) method has been used to investigate educational issues such as teacher professional networks (Baker-Doyle and Yoon, 2011; Penuel, Riel, Krause, & Frank, 2009), the spread of educational innovations (Frank, Zhao and Borman, 2004), and peer influences on youth behavior (Ennett, Bauman, Hussong, Faris, Foshee, Cai and DuRant, 2006).

The following table provides examples of the types of data collected, analytical methods and analytical tools used in social network:

Data	Types and Methods
What types of data are collected for social network?	● Social bonds (interpersonal ties, friendship, family networks) ● Organizational links (connection between residents and community organizations) ● Media connection (specific media that residents and organizations rely upon for news) ● Identify boundaries ● Clarify and design questions ● "actually existing social relations" ● "perceived relations" ● Dynamism: "Episodic" relations or "typical"/"long term" ties
Methods used to collect such data	● Surveys ● Interviews ● Facebook, LinkedIn ● Data mining (internet, emails) ● Archival data ● Observations
Analytical tools	● Netlogo ● Netdraw ● UCINET ● NodeXL ● Gephi ● PAJEK ● SPAN ● STATNET

For the purpose of this paper, we will use a specific study that applied the social network analysis and also present evidence of long-tailed distribution. This is a distinctive digression from the traditional social science study and the normal distribution associated with it.

a. Study:
Mining Email Social Networks (Bird, Gourley, Devanbu, Gertz, and Swaminathan, 2006)

b. Brief Overview:
Communication & Co-ordination activities are central to large software projects, but are difficult to observe and study in traditional (closed-source, commercial) settings because of the prevalence of informal, direct communication modes. Open-source software projects, on the other hand, use the internet as the communication medium, and typically conduct discussions in an open, public manner. As a result, the email archives of OSS projects provide a useful trace of the communication and co-ordination activities of the participants.

c. Research Questions:
- What are the properties of the social network of developers?
- Are developers who send a lot of messages on the mailing list also very active in source code changes?
- Do developers play a different role than non-developers in the social network?
- Do the most active developers have the highest status among developers?

d. Data Extraction Method:
Data were gathered by parsing the email activity on the Apache HTTP Server Developer mailing list. A total of 101,637 messages out of 102,611 messages in the mailing list were subjected for data analysis.

The analyzed data is as presented:

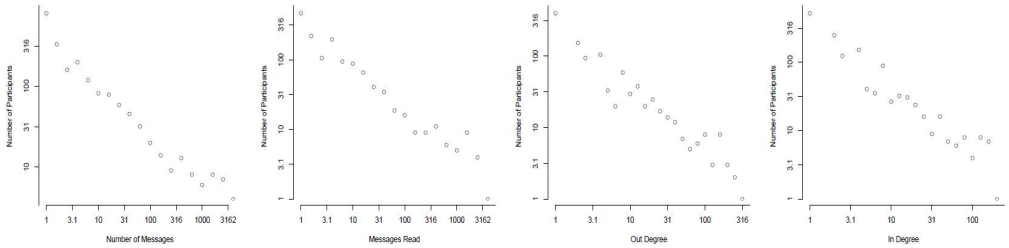

Figure 1: Note that all diagrams are log-log scale. Reading left to right: first, the distribution of people vs. number of messages they sent; next, vs. the number of reply messages they received. Note that a few people account for the bulk of the sending & reply activity. The next two indicate the structure of the social network. First, the out-degree in the social network; finally, vs. the in-degree in the social network. Out degree is an indication of status, as it indicates the number of different people who replied to the ego's messages. In-degree indicates the number of different people whose messages ego responded to. All distributions show power-law character. The degree distributions show small-world character of the email social network.

The data were also analyzed using social network measures. In network analysis, indicators of centrality identify the most important vertices within a graph. Two separate measures of degree centrality, namely in-degree and out-degree are used. In-degree is a count of the number of ties directed to the node (agent/individual) and out-degree is the number of ties that the node (agent/individual) directs to others. When ties are associated to some positive aspects such as friendship or collaboration, in-degree is often interpreted as a form of popularity, and out-degree as gregariousness.

e. Conclusion

The study introduces social network analysis and the evidence of long-tailed distribution. The evidence from social network measures in the above research suggests that "developers who actually commit changes, play much more significant roles in the email community than non-developers." What this conclusion allude to is that knowledgeable and active developers who demonstrate their ability through actively responding and making changes (out-degree) based on feedback are more often contacted by email queries from users.

An in-depth discussion on the centrality concept of social network and long-tailed distribution in a separate paper will hopefully provide further basis for educational leadership researchers to consider adopting the methodology.

How does social network analysis contribute to educational leadership research?

The usefulness of social network analysis is reflected in a study conducted by the authors on instructional leadership practices in primary schools in a centralized system where hierarchical structures are practiced (Nguyen, Ng, Yap, to be published). We reported that the hierarchical structure's inherent reliance on a 'supreme leader' is greatly mitigated through the emergence of heterarchical elements. In brief, hierarchical structures are vertical, top-down control and reporting structure. Heterarchical structures on the other hand are horizontal. Our findings revealed that at the teachers and also Key Personnel's horizontal levels, spontaneous interactions and collaboration take place within a group and amongst groups of teachers. Through these horizontal professional interactions, individuals exert reciprocal influences on another with the minimal effects of authority power. In this structure, distributed instructional leadership appeared to be deliberately practiced. Key personnel and teachers work in collaborative teams and supported by organizational structures initiated by the principals. This is where various instructional improvement programmes and strategies are initiated and led by staff. This would be highly impossible if the principal practices are heavily based on hierarchical instructional leadership.

What is implied is the study is that decision-making on instructional improvement programmes is rigorously and actively practiced by teachers at the heterarchical level. Decision-making involves getting support for resources and approval from authorities over the teachers. In an organizational hierarchical structure it would be authority immediately above the teachers - the Head of Department, followed by Vice Principal and finally the Principal. Typically such a reporting and resource seeking structure would be inefficient and ineffective in creating instructional improvement programmes. If we were to redo the study and adopt social network analysis measures, how would we present the findings? The figures below are hypothetically generated to provide a possible way to

interpret hierarchical and heterarchical structures:

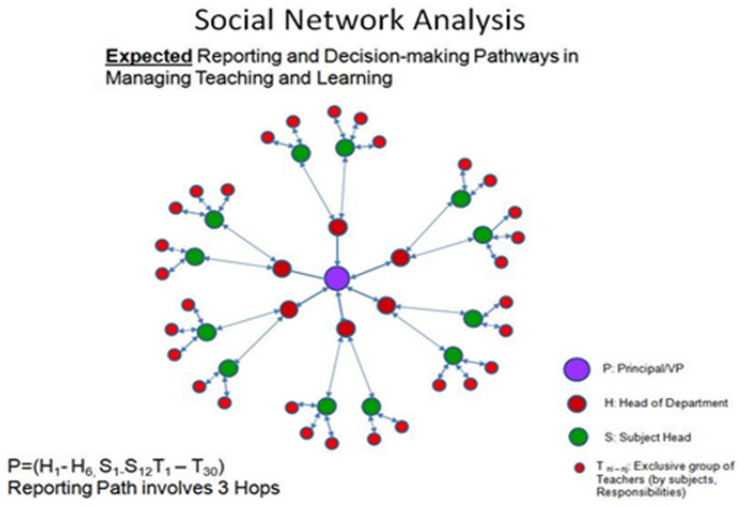

Figure 1: Expected Reporting and Decision-making Pathways in Managing Teaching and Learning

The above figure used social network representation which provides an alternative way to represent hierarchy. The central (purple dot) represents the Principal while the connected red dots to the Principal are the Head of Departments. The Head of Departments then oversee Subject Heads and finally teachers.

Implying from our study where heterarchical elements are exhibited, social network representation could most plausibly provide the means to represent the elements in Figure 2 below:

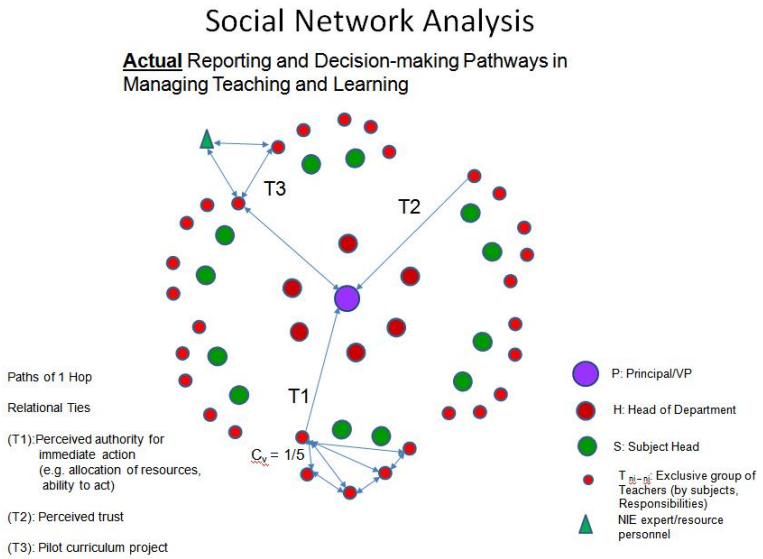

Figure 2: Actual Reporting and Decision-making Pathways in Managing Teaching and Learning

What is immediately evident is that the representation provides us a more realistic way to look at social interactions involving decision-making. The connected dots among teachers could reveal who they interact most with. In addition, what would be most revealing is the emergence of how teachers in a hybrid hierarchical and heterachical structures make decisions. Specifically the emergence of by-passing the constraints of a typical top-down hierarchical structure by directly getting support from centrality - the principal who controls and provide resources and also who approves final decisions.

In summary, the discussion on one of the complexity science methodologies - social network present opportunities for us to reframe educational leadership research. It is now possible for us to ask research questions that are not bound by the constraints of current social science methodologies. Here are a number of questions using Social Network Analysis alone:

- What is the local (indigenous) knowledge base of instructional leadership and how does it emerge?
- How do different level leaders (Ministry of Education, Superintendents, Principals, etc.) shape the perception of curriculum policies in schools? (And for specific local

understanding – Who are the influential personnel impacting curriculum policy implementation?)

- Examination of ties among Departments in the school that affect school improvement: What are the implications for long-term strategy process for school improvement in light of the complex and adaptive nature of departments?
- What does engagement in decision-making look like?
- How do aspects of relations within the network: structural (pattern of interaction, face-to-face interaction), affective (benevolence and trust), and cognitive (mutual knowledge about each other's skills and knowledge and shared systems of meaning) affect professional development/learning?
- Will an intended school vision/policy have the desired positive reception among staff?

Conclusion

In this paper we have reviewed that social science methodologies and analytical tools have been consistently and almost universally adopted in educational leadership research for the past three decades. We have also highlighted a number of limitations of current social science methodologies. The alternative complexity science research methodologies proposed are not merely alternative or novel ways of examining the problems or issues encountered. What is more valuable is that these alternative methodologies bring with them their contrasting disciplinary roots where the types of research questions that can be raised are now made possible by the different disciplines. Our interest in the effects of educational leadership on school improvement can now be investigated by asking different research questions. We could indeed go deeper, wide-angle or zoom-in and even predict by revisiting the basic question of 'What do we wish to know about school improvement that we do not yet know enough? Being opened to alternative methodologies through a disciplined approach has nothing to lose but everything to gain in our scholastic pursuit of knowledge in the field of educational leadership and management. We must avoid being educational leadership researchers who sees our world from the perspectives that we have live in and accept these perspectives as the only perspectives without question.

The choice of research method or combination of methods affect the type of research questions asked (although in practice the questions are also often shaped by the researcher's training and area of expertise). Ideally, we should not be constrained by methods before asking research questions. Research questions are the primary drivers for our quest for knowledge. It should be from this basis that we find the most relevant methodologies that can answer our research questions and provide us the findings that can contribute to theory formation, knowledge building and translation to practice.

The authors propose the following implications for practice and for research:

- Introduce complexity science (and also other disciplinary) as additional graduate research courses. We can still tap on the transmission-form of knowledge transfer and supervisor-supervisee platform.
- Partner with established experts in the discipline of complexity science to leverage and speed up transfer of learning and research skills among educational leadership professors
- Engage in epistemological and ontological discussions (including generalizability of findings) on complexity theory – to deepen our understanding of the advantages and limitations of complexity science disciplined inquiries.
- Expand educational leadership journals to accept findings and research that do not necessarily conform to social science methodologies alone.

Finally, reframing educational leadership research is an imperative in the light of diminishing researchable aspects due to the limitations of current methodologies. Again, we want to reiterate that we do not advocate replacing social science methodologies. We acknowledge that social methodologies are still essential and vital. We will need the full spectrum of social science research methodologies to continue to contribute to theory development in educational leadership and management. But we also need alternatives and complementary approaches to social science such as complexity science methodologies for both theory development and theory building. The important thing to remember is that the questions come first and the methods follow.

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