

Complexity Theory and Macao's School Curriculum Management System

FONG, Peng Long

Macau Inter-University Institute

Abstract: This paper argues for the affinity between complexity theory and Macao's school curriculum management system. Firstly, the paper argues that complexity theory should be a paradigm rather than one unique theory, enriched with reference to the work of the French sociologist Edgar Morin. The paper summarizes key features of complexity theory for understanding better how the complex thinking paradigm informs curriculum management and planning. This is characterized as being multi-level, multi-dimensional, multi-faceted, multi-agent, and multi-perspectival in nature. Secondly, the paper provides a brief historical profile of Macao's schooling, identifying changes in school demography over the last decade. External changes require internal changes to schools and curricula in Macao. The paper suggests that demographic changes in Macao constitute a powerful driving force for current curriculum reform and planning exercises and that the local government needs to conduct further in-depth studies on this. In order to manage curriculum change for sustainable development, issues such as 'who are the new curriculum reforms for?' should be one core theme for debate.

Keywords: complexity theory, Macao, curriculum management system, changing management

A good government is not a luxury, it is a must for development (World Bank, 1997, p.15).

A Complexity Turn

Urry (2005) suggests that social sciences began to go complex from late 1990. He argues that the increasing complexity of products, processes and organizations is linked to the proliferation of computerized networks that 'self-produce' around the globe, forming and reforming themselves in new ways and in which 'everything is connected to everything else'. As technological devices flood daily life (and complexity theory has one of its roots in computation theory) it would be surprising if complexity theory were not to be discussion in relation to school curricula.

Morrison (2005) asserts that schools are complex systems, and that complex phenomena and systems have to learn, adapt and change in order to survive. Fullan (1999) argues change equals learning, and that learning is a central element in school organization, and he expects the education system to become a 'learning organization' that can deal with the

complexity of the change process (Fullan, 1993). Bar-Yam *et al.* (2000) show that rapid changes in, and increased complexity of, today's world present new challenges and put new demands on education systems. The importance of having a right focus of change is a key to improving schools and increasing student achievement (Marzano, 2003, p. 5). What would be the focus for helping Macao's students to achieve more highly? What is the relationship between curriculum management and student achievement? What is the importance of a curriculum system? Is it possible to manage school curricula in terms of a *system* to achieve an even better result from a *school institution* (Tedesco, 1997; Fong, 2000)?

The curriculum is a complex phenomenon. There is a trend in curriculum change, shifting from school level to local/system level, and national and international/global levels; this is combined with an exact reversal of direction in some cases, the movement being for curricula to be determined at the school level. As Fullan (2001) observes, these present complex issues for school curriculum change or renewal, including, for example: (a) the rationales for curriculum change in school education that can be discussed along five dimensions of societal change: economic, technological, environmental, political, and social (Tawil, 2003); (b) the change of curricular paradigms, moving from the paradigm of teaching, inputs, schooling, central control, categorized learning, rote learning, curriculum as documents, and curriculum as subjects towards a focus on learning, outcomes, lifelong learning, shared control, integrated learning, applied learning, curriculum as process, and curriculum as framework (Tawil, 2003). A further complex issue is that of equitable access to basic education for all. Signalled in, amongst others, the World Conference on Education for All in Jomtien in 1990, and the 2000 Dakar Framework of Action, it is seen as a government's responsibility to improve the quality of education and ensure excellence for all.

To achieve these goals, systems have to learn, adapt and change, and this brings with it complex issues of curriculum governance. In order to manage multi-level and multi-dimensional change at the societal level, it can be suggested that the curriculum is one 'hub of educational change' (Braslavsky, 2002 in Tawil, *ibid.*), and the curriculum process is the organization of sequences of learning experiences (Tawil, *ibid.*). The education system, as one of sector in a society, has to respond to the changing needs of economic, technological, environmental, political and social sectors. This is a mezzo level analysis of sub-systems of Macao's society. Within the education system, this includes the relationship between governmental curriculum units and schools, principals, teachers, and students, and it extends to parents. There is a dynamic interaction among all participants in considering what are desirable learning experiences and how to deliver them effectively. And, simultaneously, the macro level analysis of curriculum change needs the education *system* to manage the issue of which desirable learning experiences are significant for individual and societal

development.

This paper suggests that complexity theory can shed light on the practical tasks of a curriculum management system. Complexity theory embraces multi-level and multi-agent empirical analysis (<http://www.pnas.org>) in which education researchers can participate. Complexity theory also suggests that it may be possible to manage a complex system with a few guiding principles (Morrison, 2002). In short, complexity theory seems to offer a possibility for putting together those separate elements and examining their relations; this is the central idea of the complex thinking paradigm proposed by Edgar Morin (Morin, 1990; Ling, 2003).

For convenience, this paper assumes that school curricula aim for successful and desirable, personal, institutional and societal changes, and that such curricula lie at the core of an education system, can be understood as structural provision of learning experiences, and require adequate intervention by different agents at different levels. School curricula, as means of passing on cultural heritage, may also have as their mission to improve people's lives.

There is a double-level operating here. If the Macao school curriculum management system is well-functioning, it should satisfy all learners' individual needs, and so the decisions on what learning experiences for which group of students should have to be taken at several levels, for example instructional, school, local/school system level, societal level, and international. If the Macao school curriculum management system is well-functioning, it should also satisfy the need for societal change, and so the school and school system levels have to work together for the well-functioning of other sub-systems in the whole society. The possible tension between these two approaches can be conceptualized in two disarmingly simple questions: 'curriculum for what?' and 'who is the curriculum for?' If the end is for individual learners' development, under the changing curricular paradigms at international level, then what does this imply for a local curriculum management system? This paper suggests that in Macao, collective and integrated agenda setting constitute one means of integrating individualistic and communitarian approaches.

The paper commences with an outline of Macao's curriculum management system, showing that Macao's curriculum can be regarded as a complex system, and then analyses it through the lens of complexity theory. What does complexity theory refer to here? What does complexity theory offer in analyzing Macao's curriculum management system? For the first proposition, the author suggests that the complex thinking of Morin is a useful approach within complexity theory. It suggests that Macao's curriculum situation can be

viewed through several different perspectives, some derived from curriculum theory and different understanding of complexity theory.

The first argument of this paper is that complexity theory should be considered to be a paradigm rather than a specific theory. The second proposition of this paper is that if learning experiences lie at the core of school curriculum management, then the complex thinking of Morin can make a contribution to curriculum planning and management. The paper builds on the view that the complex thinking paradigm shows that human beings' nature is multi-dimensional and multi-levelled, and that these embrace individual, society and species reference points simultaneously.

On theory and curriculum theory

Davis, Sumara and Luce-Kapler (2000, p. 52) claim that 'theory' refers to ways of seeing things. A theory is a system of interpretation that both helps to make sense of experiences and focuses our attention on particular events. They argue that humans are irrepressible theorizers. Humans can note similarities among diverse experiences, see relationships between events, and develop theories that explain these relationships (and predict others). They assert that such theories and ways of seeing are necessary but limiting. Humans need them to make sense of a complex world. However, while enabling perception and interpretation, theory also determines what is (and is not) perceptible and comprehensible. Theories, they argue, are often not articulated by observers, and, hence, are unavailable for critical examination. Usually this invisibility is unproblematic. At times, however, it becomes necessary to interrogate popular theories because they might fail to do the work they are intended to do. According to Morrison (2005), complexity theory is one theory for understanding the phenomenon of curriculum; this can also draw on the work of Morin.

Two decades ago Beauchamp (1986) concluded there are many issues and ground rules for curriculum theory building, but he summarizes five statements as warranted generalizations:

- Any curriculum theory should begin by defining its sets of events.
- Any curriculum theory should make clear its accepted values and sources for making decisions.
- Any curriculum theory should specify the characteristics of curriculum of curriculum design.
- Any curriculum theory should describe the essential processes for making curriculum decisions and the interrelationships among those processes.
- Any curriculum theory should provide for continuous regeneration of curriculum.

He acknowledges that these statements are easier to state than to follow in theory-building work in curriculum, but he suggests that these statements can serve as a background for more specific studies and postulations on values, curriculum design, and curriculum engineering. Beauchamp's view of curriculum theory is modernistic and applicable to systems of mass schooling. His way of seeing curriculum phenomena can be reduced to three questions, including:

- Who will be involved in curriculum planning?
- How to implement the curriculum once it is planned?
- How is curriculum evaluation put into practice?

He claims curriculum implementation is more of a problem than an issue. Once the curriculum is planned, its implementation, including leadership in the process, becomes a problem. Similar to the implementation issue, curriculum evaluation is more of a problem than an issue. He believes that if most people agree on the curriculum to be evaluated, then the problem becomes how to achieve this. Beauchamp's comments on curriculum theory imply adopting a multi-levelled view of the curriculum for a more comprehensive understanding of it, arguing that there are several ways of seeing curricula, and amongst them, amongst which is the notion of different levels of curriculum discourse.

If school curricula are to be planned in local schools or school districts, these issues and problems in curriculum design and development are symptoms of a need for a deliberate system within school organization for making and carrying out decisions involved in curriculum planning, implementation, and evaluation. Indeed, the details of such systems cannot be conceptualized unless the arena (the instructional level, the school level, the local/school system level, the societal level, or international) has been identified.

What is Complexity Theory in curriculum discourse?

What is complexity, and how can complexity theory inform curriculum analysis? In discussing curriculum and complexity theory, Morrison (2005) claims that complexity theory is an amoral, descriptive, and sometimes explanatory theory. It reports evolution and analyses curriculum phenomena from a systems view, but it does not speak to morals.

Heylighen (1996) suggests that the term 'complexity' is difficult to define, stating that definitions that have been offered all fall short in one respect or another, classifying something as complex which one intuitively would see as simple, or denying an obviously complex phenomenon the label of complexity. Moreover, these definitions are either only

applicable to a very restricted domain, such as computer algorithms or genomes, or so vague as to be unhelpful. Heylighen believes there is a common, ‘objective’ core in different concepts of complexity, and he goes back to the original Latin word *complexus*, means ‘entwined’ or ‘twisted together’. Heylighen adds that distinction and connection are two dimensions of complexity, and that complexity can only exist if both aspects are present: neither perfect *disorder* (which can be described statistically through laws of large numbers), nor perfect *order* (which can be described by traditional deterministic methods).

Morrison (2002, p. 24) addresses *why* and *how* an understanding of complexity theory is important for leadership in education. He suggests that schools need to ‘find order without control and to lead without coercion.’ This paper confines itself limits to Morrison’s concerns for curricula. He (*ibid.*) remarks that complexity is a question, not an answer. Complexity is a challenge with the thought and not the receipt of thought. He writes that ‘complexity theory is a new way of thinking; it requires new constructs rather than seeking to explain phenomena using existing constructs. . . . We may not yet have the appropriate tools to understand the phenomena in front of our eyes’. He raises several questions that require an answer with regard to *curricula*:

- What does it mean to ‘know’ in a climate of uncertainty?
- How do logical relations (e.g. inclusion, exclusion) apply in an uncertain, web-based, boundlessly interconnected world?
- Who are the learners?
- How can, and should, diversity, autonomy, creativity and unpredictability thrive in prescribed circumstances (e.g. nationally mandated curricula)?
- How can freedom, diversity, autonomy and choice be exercised within centrally-prescribed curricula?
- What are the risks and benefits in moving from imposed control to emergent order in education?
- How can, and how should, risk-taking be promoted in education?
- What constitutes a web of learning rather than a programmed sequence of learning?
- How can and should assessment, which is overwhelmingly of an individual’s performance, catch interactivity, connectedness and collective knowledge?
- What kind of feedback promotes emergence, self-organization and connectedness in education?
- What should we do as a result of feedback?
- What constitutes openness in education?
- What are the necessary and sufficient conditions for the state of being complex, for emergence and self-organization?

- What are the differences between ideas, ideology and theory in deciding ‘what works’ in education if unpredictability, change and diversity reign?
- On what criteria are some methods, curricula, pedagogies, assessments to be judged preferable to others if their outcomes are, in principle, uncertain?
- Why try to measure performance when, by definition in complexity, even if it were measurable, the measures may add little of significance to our understanding?

He (*ibid.*) questions how far complexity theory can help to plan for the moral activity of education, commenting that complexity theory can suggest what to do if one wishes to promote development, but that complexity theory does not tell us if those actions are desirable. However, it seems that complexity theory can offer insights for curriculum phenomena, and that complexity theory may meet some challenges in education.

This paper takes some constructs from Edgar Morin in relation to complexity theory. Morin, as one of the founders of a complex thinking paradigm, offers one response to the philosophical dilemma of an amoral (complexity) theory being applied to the moral activity of education. Morin suggests seven complex lessons that may be considered for implementation in schools (ideas that were promoted by UNESCO from 1999). These could address Morrison’s concern about what desirable actions in school education systems may flow from complexity thinking. The paper advocates the adoption of Morin’s views for rethinking the Macao curriculum management system.

Complexity theory offers a relatively new paradigmatic approach to understanding curricula and their management in schools; paradigms concern:

- *What* is to be observed and scrutinized,
- The kind of *questions* that are supposed to be asked and probed for answers in relation to this subject,
- *How* these questions are to be structured,
- *How* the results of scientific investigations should be interpreted,
- *How* is an experiment to be conducted, and *what* equipment is available to conduct the experiment. (<http://en.wikipedia.org/wiki/Paradigm>)

The word *paradigm* stems from the Greek and has two denotations: one means ‘patterns’, ‘example’ or ‘modèle’ in French; another means ‘demonstrate’. With complexity theory’s focus on emergence of curriculum phenomena, it pursues and expects patterns as a result, it also expects examples to demonstrate how the complex thinking paradigm fits comfortably into a curriculum management system. Complexity theory can be both a way of seeing

things and an explanation, not only a description, of phenomenon. To take the argument further, one can use the example of curriculum reform in Hong Kong.

Koo (2002), in discussing the Hong Kong curriculum reform, shows how both modernistic and post-modernistic paradigms of curricula can be rooted in Dewey's philosophy of education, and he points out that there are many conceptions of school curriculum, 'what is should be for' and 'what it should contain'. Using Dewey's conceptions of education, he develops views on post-modern curricula, which could be drivers of quality education in Hong Kong's education. Koo views theories of chaos and complexity as a division of postmodernism. He regards the present world as characterized by change and uncertainty, unpredictability and instability, that it needs ever-increasing self-organization and adaptability in order to survive, and that it is important to move from a view of a stable world-order to an ever-changing, unfixed scenario. He quotes Morrison's (1998: 3-4) work thus:

Laplacian and Newtonian theories of a deterministic modernistically viewed universe are characterized by predictability, patterning, linearity, causality, stability and objectivity. They contributed to the view of the universe as an ordered mechanism, a closed and deterministic system susceptible to scientific laws. Their link with modernity is evident, for both are premised on the same principles of progress.

Since the 1960s, such theories have been increasingly challenged with the rise of theories of chaos and complexity imbued with the spirit of change, uncertainty, openness and unpredictability and some thought-provoking principles. More recently, theories of chaos have been extended to complexity theory. Morrison . . . argues that order is not totally predetermined and fixed but that the universe is creative, emergent (through iteration, learning and recursion), evolutionary and changing, transformative and turbulent. Order emerges in complex systems that are founded on simple rules for interacting organisms. *Systems*, however defined, are complex, unstable, emergent, adaptive, dynamical and changing. It is the emphasis on non-equilibrium that brings order out of chaos. Change, uncertainty, openness are the order of the day and that a premium is placed on organizations (and self-organizations) that can respond to, live with, cope with and lead change. It is apparent that postmodernism, chaos theory and complexity theory are inseparable from one another.

Cilliers (1998) calls attention to differences between 'complexity' and 'postmodernism'. He does not agree with the *relativism* of postmodernism, and he believes it is hard to find examples of the restricted sense of 'real chaos' in nature. Therefore, instead of classifying

certain types of chaos theory into a paradigm of complex system studies, he puts ‘deterministic chaos’ into a modernistic paradigm. Fullan (1999, p.4) summarizes this new science of complexity in claiming that; (a) the link between cause and effect is difficult to trace; (b) change (planned and otherwise) unfolds in non-linear ways; (c) paradoxes and contradictions abound; (d) creative solutions arise out of interaction under conditions of uncertainty, diversity and instability. On the one hand, the totality of complexity theory is enriched by different focus points from different theorists; on the other hand, it is hard to find a single set of characteristics of complexity theory. As complex science does not exclude empirical study, and welcomes rational probing of concepts, the future of applied studies of complexity theory in curriculum management may be optimistic.

Morin (1994) is optimistic that, in a scattered way, there emerges a cognitive paradigm which can establish bridges between sciences and other disciplines. He draws on examples of von Neumann, von Föster, Prigogine and Ruelle, and from several fields, to suggest that order, disorder and organization must be thought of as being together, that is, that there are connections between order (analyzed), disorder (not-revealed), organization (emergence) and their interactions and inter-relations (the terms originally used by Morin are ‘*la boucle tétralogue*’ and ‘*la reliance*’). In short, this is *the hologrammatic principle*, in which not only the parts are present in the totality, but also the totality in the parts. We can see that the organization is present in individual members of the organization, throughout its culture and norms.

Morin rejects the Cartesian simplifications of disjunction and reduction, arguing for the principle of complexity in which distinguishing parts are connected. Morin concludes that the analysis of inter-disciplines suggests a common ambition for knowledge movements that go from the parts to the whole and from the whole to the parts. He suggests (2006) that the project of a communicating organization should break into the greater number of actors possible for self-organizational efficacy. With reference to curricula in Macao, within the complexity research paradigm, this argues that Morin’s work offers a useful tool for thinking about curricula within the complexity paradigm.

Morin’s characteristics of complexity

Morin (1990, p. 21) points out that *complexity* is a fabric of heterogeneous components that are inseparably associated:

Anything being helped and helping, caused and causing, I hold impossible to know the whole without knowing the parts and to know the parts without knowing the whole.

Complexity theory involves the intersection of several theories: of information, systemic approaches, auto-organization and chaos. There is complexity in interactions, interrelationships between distinguishable elements whose total system forms a relatively coherent dynamic totality. According to Moigne (2006), there are some misconceived ideas circulating on complexity, for example:

- complexity does not affirm that ‘all with one’ is complex (synonymous cannot include/understand), nor does it affirm inaccuracy or uncertainty;
- complexity is not a ‘holistic’ thought which privileges the total over the analysis of its components. Rather, it seeks to articulate the whole and its parts, the total one and the private individual in one outward journey and ceaseless return;
- complexity is not the same as being complicated.

Moigne explains that a computer is complicated, ‘but a very dismountable machine’ in a unit with finished parts. On the other hand, a living organism is ‘complex’ in that it cannot be broken up and rebuilt, starting from simple independent elements, and that it metamorphoses. For Morin, complexity does not give up the principles of traditional science, but integrates them in a broader and richer tapestry. Complexity is presented in the form of a building at several stages. The base is formed from three theories (information, cybernetics and system) and is comprised of the tools necessary for a theory of the organization. The second stage involves the ideas of Von Neuman, Von Foerster and Prigogine on auto-organization. To these conceptions Morin brings additional elements, in particular, three principles: the dialogical principle, the principle of recursion and the hologrammatic principle.

- *the dialogical principle*: this links two antagonistic principles or concepts (e.g. atomism and holism), which apparently should push against each other, but which are indissociable and essential for understanding the same reality. The physicist Niels Bohr has, by example, recognized the need for thinking about physical particles as corpuscles and waves simultaneously.
- *the principle of recursion*: the organization goes beyond the principle of feedback (feedback) and exceeds the concept of regulation as in a machine. It is a generating loop in which products and the effects are themselves creators of what produces them. Thus individuals are both the products and producers of a system. Individuals produce the company in, and by, their interactions, and the emergent company produces humanity out of these individuals.
- *the hologrammatic principle*: this highlights the apparent paradox of some systems, where not only is the part in the whole, but the whole is in the part. Thus, each cell is a part of a whole – the total organization – but the whole is itself in the part. In

the same way, the individual is a part of society, but the society is present in each individual.

Morin (1999) raises a paradox in that the purpose of education is to transmit knowledge, and yet education is blind to the realities of human knowledge, its systems, infirmities, difficulties, and its propensity to error and illusion. He suggests that education does not often bother to teach what knowledge actually is. He argues that knowledge cannot be handled like a ready-made tool that can be used without studying its nature, and that knowing about knowledge should figure as a primary requirement to prepare the mind to confront the constant threat of error and illusion that parasitize the human mind. Therefore, the first lesson for education is to detect error and illusion. He suggests that humans have to introduce and develop the study of the cultural, intellectual, and cerebral properties of human knowledge, its process and modalities, and the psychological and cultural dispositions which make them vulnerable to error and illusion (*ibid.*, p.1). In other words, he is suggesting that humans involuntarily, or sometimes consciously, commit error, for example when one perceives the outside world, then transforms it into a paradigm inside one's mind, and makes an analysis of parts from whole and *vice versa*. This could be synthesized into a foundational lesson for teaching learners in Macao's schooling system to detect error and illusion, and refers to meta-cognitive strategies.

Morin (*ibid.*) argues that humans are, by nature, Homo Complexus, with *multi-dimensionality* or *multi-referentiality*, and, at the same time, are physical, biological, psychological, cultural, social, historical beings (Morin, 1999, p.1). In fact, the concept of the human trinity (individual-society-species) places a person in a situation which allows at the same time vast diversity and yet specificity. Human identity is carried in the form of plural and polymorphic human conditions, not in a disjoined or successive way, but at the same time '*faber, sapiens, economicus, ludens, delirians, contradict*' (Morin, 1994). A person builds himself/herself in a dialogue with others, but also in a dialogue with himself/herself. Part of him/her thinks and sees an emotional and imaginary work which has a horizon death in a dialogical circulation (e.g. rationality-affectivity-imaginary-reality-insanity-neurosis-creativity). This could be a lesson for teaching the human condition. This lesson could be synthesized by a focus on three loops: *the brain-mind-culture loop*, *the reason-emotion-impulse loop*, and *individual-society-species loop*. Humans are complex and being together both unity and diversity.

Morin argues for the importance of subjectivity of individuals taking part in action. Perhaps the greatest progress in contemporary sciences is re-integrate the observer and the observation. This is logically necessary: any concept returns not only to the known object, but

also the people who own the concepts' (Rochet). From this standpoint, it follows that knowledge may not be possible to separate from the knower. If Morrison (2005) captured the nature of complexity theory as a way of thinking, Morin puts his focus on the way of knowing and the condition of how humans produce knowledge and false knowledge. This could be a lesson that refers to constructivist views on active learning. It could also refer to scaffolding theory in helping learners to create knowledge rather than rote learning, with understanding of the meaning of that which they have learned.

Since 1977, Morin established the 'Paradigm of Complexity' which permits the development of exercises in modeling phenomena that we perceive as complex (Morin, 1986; 1990). The basic point of view of Morin (1986) in *La Methode: Tome I - La Nature de la Nature* is that 'complexity is organized and, recursively, organizing.' Morin explains the 'thought of complexity' in an example of building an edifice (discussed above), the base of which is formed by a theory of information, a theory of cybernetics and system theory. These three theories help in conceptual development of the idea of auto-organisation (self-organization). Since the organization is a living being, it extracts energy and information from its environment, and integrates the organization into the environment.

The emergence of Macao's curriculum management system since the early 1990s

Macao's education system can be considered as a 'disorganized' system or 'unorganized' system in the 1980s. Following the understanding of a more modernistic view of curriculum phenomena (e.g. Glatthorn, 1994, 1999, 2000; CERI/OECD, 1998), it is possible to describe Macao's curriculum phenomena at three levels: local or school system level, school level and classroom level. In the early 1990s, following the Portuguese education system, curriculum reform efforts adopted a top-down system approach, and yet in a highly diversified Macao context in which almost 90 per cent of schools were private. The school curriculum system was established by education law and its regulations (Fernandes *et al.*, 1992; Da Silva, 1994; Fong, 1997; 2000; Koo, 2002). The substantive law on school curriculum matters are mainly Education Law 11/91/M, Decree-Law 38/94/M, Decree-Law 39/94/M, and Decree-Law 46/97/M. Other Decree-Laws, such as those for special education, art education, technical and vocational education, were set up separately. With regulations and circulations on assessment, teaching materials, school functioning and teachers status, all elements of the curriculum were interwoven with each other to form a *multi-levelled* and *multi-faceted*, complex curriculum system.

The recent evolution of Macao's school curriculum management system

For the local or school system level, the local education authority coordinates the work for curriculum document renewal; at the school level, the school has to provide ability

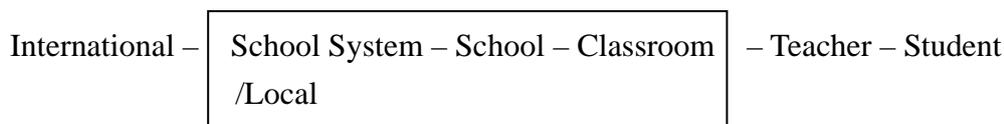
grouping of students and teaching task allocations according to teachers' specialisms and attributes; at the classroom level, the concern is for pedagogy and resources. From an administrative system perspective, there should be policy congruency – alignment – between different levels. Hence criteria such as coherence, efficacy, efficiency, and adequacy are the common language for policy discussion and implementation (Fong, 1998).

At the school level the curriculum management system can be understood at two levels. The first one is a micro-perspective of classroom instruction, the teacher-media-student forms the core of the reform effort. Issues like textbook selection, quality of didactic materials, effective use of learning materials, effective teaching practice and effective learning activities organization, and developmentally appropriated experiences. The second one is a micro-perspective of school curriculum practice, the principal-curricula-subject leaders/teachers forms another complex network. In this second loop, the principal or the representative of the school board should lead the changing management process, that is, form diverse learning-teams, such as subject panels, student learning and guidance groups, and functional heads of diverse school affairs, then delegate powers or empower adequate leading performers to deal with coordinating issue under the auspices of being a learning community. As with a living organism in an ecological environment, if an organization is not developing, it is dying, and someone else will take over. The same could be true in educational and curricular terms.

The local education authority in Macao (DSEJ) acts as a permanent governance body to coordinate the complex school curriculum affairs (Fong, 1997). The required competencies for this include systemic and dynamic curriculum reform planning, launching studies/commissioning-studies and sub-projects on viable curriculum innovation, promotion of innovative curriculum design and field experiences, dissemination of best practice, cooperative efforts on the development of teaching materials adequate to the local context, support for schools and teachers to adopt new practices, evaluation of the consequences of curriculum innovation and change, and setting new policy reform directions and priorities (Fong, 2006). In short, the local curriculum administrative unit has to assume the functions of planning, research, development, dissemination, experimental trials, resource allocation, policy document renewal, teaching and assessment supportive initiatives, and systematic evaluation on curriculum system.

With regard to the issue of launching curriculum studies sub-projects, planners focus on different levels when systemic planning reform policy, from policy formation to policy practice. Since there are different agents at societal, school system, school and classroom levels, each with their own core issues, problems and agenda, it is more fitting to show these

levels as horizontal rather than hierarchical. The initial three levels of the Macao school curriculum management system could be extended to six levels:



In light of Morin's complex thought, a dialogical principle may call for distributed leadership functioning at different levels yet working together, with widening team commitment to the Macao school curriculum management system. How each agent perceives their understanding of his/her environments, what relationship the agent defines for himself/herself in their roles, to the intra and inter level agent in the network, and to the ever-changing environment, will affect their behavior and decisions on the curriculum. All the agents and institutions at all levels interrelate and interact with each other. With this level concept, new challenges for the Macao school curriculum management system emerge.

The local education authority (DSEJ) is small, and the curriculum administrative unit, with various functions and competencies, is expected to cover issues as set out by the Chief Executive's Dispatch no.102/2006 (Governo de Macao, 2006), not only for the school system level only, but at other levels as well. This is not easy as Macao lacks the experts to work at the different level. In particular, it is important for Macao's educational levels to address several fields, for example, for the issue of systemic studies on curriculum it could include:

- International Comparative Studies (methods, practices, trends)
- National / Local Contexts (demographics, politics, economics, culture)
- National / Local Content (subject areas, theory, method)
- Curriculum Innovation and School Development (mechanisms, leadership, change management)
- Curriculum and Instruction Resources Development (practical tools, subject matter)
- Teacher and Classroom Teaching (effective teaching, teaching strategy, subject knowledge)
- Student and Class Learning (attained experiences, learning activity, effective learning)
- Curriculum Evaluation and Learning Assessment (evidence/corroboration, improvement, development)

Strategies for school curriculum implementation could include:

- Identity and Heritage
- Reading and Understanding
- Thinking and Communication
- Inquiry and Technologies
- Development and Care
- Aesthetics and Creativities
- Sports and Leisure

Some thematic research for policy implementation purposes might include:

- Macao's Curriculum Management Mechanism (School System Level)
- Context Analysis of Macao's School Curriculum Development
- Macao's School Curriculum Framework
- Macao's School Curriculum Standard (areas/disciplines)
- Knowledge bases for Macao's Curriculum
- Theory on Dynamic Curriculum Research
- Learner-Centered Effective Teaching and Learning
- Resources Bank for Curriculum, Instruction, Learning and Assessment

This agrees with Koo's analysis that the study of the school curriculum should adopt multidisciplinary, interdisciplinary and trans-disciplinary approaches.

It is necessary to change the school learning system in Macao, and to invest in institutionalizing a local curriculum administrative unit in order to improve the education of students. In addition to making Macao self-sustainable, the next generation should be well equipped to respond continually to changing and demanding, open environments. The school curriculum can be seen as an effective means for individual change management. This implies an investment in curriculum and investment in children.

Facing the emerging challenges, this paper provides examples to support the claims for understanding Macao's school curriculum management system using the concept of it being *multi-level, multi-dimensional, multi-agent* and *multi-perspectival*. Using Cilliers' (1998) views of complexity theory, in Macao this suggests that demographic factors impact on curriculum planning (though Cilliers perhaps would classify demographic as 'deterministic chaos' or modernistic paradigm). This paper argues curriculum developers in Macao should take the demographic factor into account and as an important embedded background. In the last decade, Macao's school population declined from almost 9,000 babies per year to 3,162

babies per year), though it has risen slightly to 3,671 in 2005.

Table 1: *Numbers of students in Macao schools*

	K1	K2	K3	P1	P2	P3	P4	P5	P6	S1	S2	S3	S4	S5	S6	Total
2004	3,02	3,74	4,19	4,69	5,24	5,96	6,48	7,15	7,35	8,83	8,96	8,85	7,88	6,73	5,24	94,3
-5	0	6	6	4	9	8	3	2	0	7	0	9	5	0	3	72
2002	3,65	4,17	4,80	5,53	6,00	6,57	7,14	7,96	8,14	9,70	9,31	8,22	6,96	5,82	4,04	98,0
-3	8	4	7	5	8	3	6	3	2	5	6	4	5	0	1	77
1996	5,81	6,41	6,72	7,24	7,65	8,15	8,35	8,16	7,62	6,81	5,34	4,28	3,87	2,97	1,88	91,3
-7	1	4	0	8	4	7	5	3	2	7	7	3	2	4	4	21

Source: DSEC, Macao government.

The birth rate may determine the population of schooling each year, and, thereby, the total subsidy that a school receives from the Macao government, together with the numbers of student enrolments which, in turn, determine the total number of teachers needed. In the Macao subsidy system, with more than 85% private schools, the parents have an absolute right on school choice, and some private schools choose students in this competitive education market system. In Macao there exists a diversified curriculum system. Indeed Macao's system has been termed both 'disorganized' and 'unorganized' (there was no organization in the first place!)

There is limited intervention by the government in education, no common schooling system, nor unified curriculum, nor common exam system. Therefore, issues for education reform may focus on working within this schooling system and curriculum, and providing public examinations to secure the quality of school education. On the other hand one could argue that Macao's system is functioning without these and under some guiding *principles* of complex thinking paradigm proposed by Morin.

In Macao, different schools have different curricula orientation (GCE, Macao, Hong Kong, Taiwan, and China), teaching medium (Chinese, English, Portuguese, Sino-Portuguese), nature of school board (Church, Protestant, Association, Charity), purposes and goals (oscillates from 'formation of elite for the better functioning of society' to 'prevent the young adolescents from staying on the street'), sources of teacher and teacher training (Macao, China, Taiwan, others), the values of parental choice in school, the private school autonomy on administration, curriculum, teaching, and decision on acceptance of new students, and textbook adoption policy in line with the entrance examinations to university. This suggests that the curriculum is a 'multi-dependency curriculum system'.

In the long run the *demographic factor* may pose problems for the sustainable development of Macao. The local education authority should plan for a more effective and productive curriculum, in order to deal with the emerging ageing society and the opportunities and challenges brought by unlimited expansion of the gaming industry.

A core issue for debate is ‘for whom is the curriculum reform?’ In the formal education system, the curriculum is a means for the development of children and teachers, or in broader term, a system for life-long learning opportunities for each citizen; these are the responsibility of government under the spirit of humanization. *Education for all and of all life long* become a new social contract. This education reconstruction project should come into action in the coming decades, to realize the top priority of civic formation of citizen and equal opportunity to all (Bindé, 2002), and the affinity between school curricula and demographic change.

Conclusion

This paper has reviewed the changing paradigm on the school curriculum offered by complexity theory and the move from modernistic to post-modernistic and complexity theory-informed curricula. It has reviewed some basic characteristic of complexity theories, then set out some ideas of complex thinking from Edgar Morin, and has used these to explain the curriculum management system in Macao. It would be possible to adapt a multi-discipline approach within complexity theory. Morin shows how his complex thinking paradigm builds on theories of biology, physics, and mathematics. A few guiding principles for the Macao school curriculum management system are hard to be defined, but, as a post-modernistic view suggests, they are in a state of being defined.

The paper has also suggested, using Morin’s views, that the complexity paradigm is not necessarily an amoral theory. In fact, Morin addresses totally seven lessons for learners. This could be a complement to Morrison’s conception on complexity theory. While Morrison’s complexity theory may be suitable for school institution improvement, Morin adopts a broader embrace, taking in human nature. His three principles: dialogical, recursive, and hologrammatic, can synthetically further an understanding of a curriculum management system emerging and changing through order (analysed), disorder (non-revealed), organization (emergence) and their interactions and inter-relations. Using Morin’s thought on complex thinking, describing the local curriculum management system, the paper has summarized key issues for better understanding of local curriculum reform practice.

This paper has juxtaposed the evolution of the local curriculum management system with

the evolution of school demographic change. The paper has argued that demographic change in Macao is a powerful driving force for current curriculum reform and planning exercises.

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APPENDIX A**EXCERPT TRANSLATION OF CHIEF EXECUTIVE DESPATCH N.º 102/2006 (23 APRIL 2006)**

Using of the college conferred for article 50.º of the Basic Law of Special the Administrative Region of Macau, the Chief of the Executive orders:

1. The Commission for the Curriculum Reform and Development is created, ahead assigned for CRDC.
2. The CRDC has as objectives to conceive, to plan, to execute and to evaluate the new general picture of the curricular organization and respective criteria, and correspondent to all the levels of not superior education, as the defined general objectives for the area of the Education.
3. The CRDC competencies as:
 - 1) Promote the accomplishment of studies guided for the definition of the new general picture of the correspondent curricular organization to all the levels of not superior education;
 - 2) Define and to consider the orienting lines the one that must obey to the conception and definition of the general picture of the curricular organization, in compliance with the directives of the Government;
 - 3) Elaborate project of development of the general picture of the curricular organization;
 - 4) Define the strategies of execution and implementation of the new general picture of the curricular organization, and the respective criteria;
 - 5) Collaborate with the educative institutions of Special the Administrative Region of Macau in the process of implementation of the new general picture of the curricular organization;
 - 6) Coordinate the process of characterization and global and continued evaluation of the results gotten with the implementation of the new general picture of the curricular organization;
 - 7) Elaborate to seem and to consider criteria and relative norms of renewal to the improvement and development of the new general picture of the curricular organization;
 - 8) Orient the preparation of project of statutes that, in consequence of the effectual evaluation, if becomes necessary to carry through.

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20 April, 2006.

The Chief Executive, Ho Hau Wah.