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DIKIW: Data, Information, Knowledge, Intelligence, Wisdom and their Interrelationships

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Abstract
DIKW hierarchy is the model used for discussion of data, information, knowledge, wisdom and their interrelationships. However, definitions of data, information, and knowledge are entrapped in a logical fallacy known as circular definition. There are some agreements in the definitions without the fallacy. The missing 'Intelligence' in DIKW plays a major role between knowledge and wisdom. This gives rise to a revised DIKW model here named DIKIW.

Key words: Data, Information, Knowledge, Intelligence, Wisdom, DIKW

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INTRODUCTION

There are quite some discussions on the subject of data, information, knowledge, their definitions and interrelationships (DIKW hierarchy) i.e. Ahsan and Shah, 2006; Bernstein, 2009; Brodie and Brodie, 2009; Bierly III, Kessler and Christensen, 2000; Chen et al, 2009; Fricke, 2009; Hoppe, Seising, Nurnberger, and Wenzel, 2011; Klimesova, 2009; Rowley, 2007; Zins, 2007. However, the definition fallacy continues. Liew (2007) presented a common phenomenon in the defining of data, information, and knowledge. They were defined by each other, such circular definitions are logical fallacies. Describing the interrelationships does not constitute a definition. Defining them and describing their interrelationships are two distinct issues.

DATA

Data are recorded (captured and stored) symbols and signal readings.

- *Symbols include words (text and/or verbal), numbers, diagrams, and images (still &/or video), which are the building blocks of communication.*
- *Signals include sensor and/or sensory readings of light, sound, smell, taste, and touch.*

As symbols, 'Data' is the storage of intrinsic meaning, a mere representation. The main purpose of data is to record activities or situations, to attempt to capture the true picture or real event. Liew (2007)

Agreement from others….

Data are defined as symbols that represent properties of objects, events and their environment. (Ackoff, 1989)

Data are representations whose meanings are dependent upon the representation system (i.e. symbols, language) used. (Bierly III, Kessler & Christensen, 2000)

Data is given by simple sequences of signs and symbols…(Hoppe, Seising, Nurnberger, & Wenzel, 2011)

Data is understood as a stream of symbols…(Jankowski & Skowron, 2007)

Data are primitive symbolic entities...(Zins, 2007 citing Belkin & Roberstson, 1976, and Blair, 2002*);*

Data are symbols organized according to established algorithms. (Zins, 2007 citing Debons, 1988*);*

Data are sets of characters, symbols, numbers and audio/visual bits that are represented and/or encountered in raw form. (Zins, 2007 citing Haidar Moukdad*);*

Data are representation of facts or ideas in a formalized manner… (Zins, 2007 citing Holmes, 2001*);*

Data are representations of facts about the world. (Zins, 2007 citing H. M. Gladney*);*

Data is a unique set of symbols representing a perception of raw facts. (Zinz, 2007 citing Nicolae Dragulanescu*);*

Data are a string of symbols (Zins, 2007 citing Thomas J. Froehlich*);*

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Datum is the representation of concepts or other entities. (Zins, 2007 citing Wellisch, 1997*);*

Data is a symbol set that is quantified and/or qualified. (Zins, 2007 citing Wersig & Neveling, 1975)*;*

INFORMATION

Information is a message that contains relevant meaning, implication, or input for decision and/or action. Information comes from both current (communication) and historical (processed data or 'reconstructed picture') sources. In essence, the purpose of information is to aid in making decisions and/or solving problems or realizing an opportunity. Liew (2007)

Agreement from others…

Information…has been given meaning by way of relational connection. (Ahsan & Shah, 2006 citing Achoff, 1989)

(Information is)…meaningful to the recipient and is of real or perceived value in current or prospective actions or decisions. (Bierly III, Kessler & Christensen, 2000 citing Davis & Olson, 1985)

Information…has been given meaning…(Hoppe, Seising, Nurnberger, & Wenzel, 2011)

Information is... given meaning by way of context. (Rowley, 2007 citing Groff & Jones, 2003)

Information is…endowed with meaning, relevance and purpose (Rowley, 2007 citing Awad & Ghaziri, 2004)

…numbers, artificial and natural language, graphic objects that convey significance and meaning. (Zins, 2007 citing Charles Ess)*;*

Information provides meaning…(Zins, 2007 citing Donald Kraft*)*

Information is related to meaning or human intention. (Zins, 2007 citing Hanne Albrechtsen)*;*

Information is related to meaning and humans (Zins, 2007 citing Holmes 2001);

KNOWLEDGE

Knowledge is the (1) cognition or recognition (know-what), (2) capacity to act (know-how), and (3) understanding (know-why) that resides or is contained within the mind or in the brain. The purpose of knowledge is to better our lives. In the context of business, the purpose of knowledge is to create or increase value for the enterprise and all its stakeholders. Liew (2007)

Agreement with others…

Knowledge is the human expertise stored in a person's mind, gained through experience, and interaction with the person's environment (Brodie & Brodie, 2009 citing Sunasee & Sewry, 2002);

Knowledge is a state of mind. (Fagan III, 2000)

…embedded in human mind through experience... (Rowley, 2007 citing Awad & Ghaziri, 2004);

Knowledge…exists in the mind of the knower…(Zins, 2007 citing Thomas A. Childers)*;*

Knowledge is a set of conceptual structures held in human brains…(Zins, 2007 citing H. M. Gladney*);*

Knowledge is in the head of people (Zins, 2007 citing Jo Link-Pezet)*;*

Knowledge understood within our society originates from scripts. The origin of writing system comes from the need to understand and control agricultural activities in relation to the environment such as seasonality, drought and flooding. (Segundo, 2002) Knowledge is therefore cumulative and transferable with the advent of writing system. Segundo defined knowledge as internalized information, integrated within person's cognitive structures. Conversely, information is a representation of understood knowledge. (Segundo, 2002) In other words, information is embedded meaning in messages and originates from human activities and situational events.

Vizcaya Alnoso (1997) defines knowledge as "process by virtue of which reality is reflected and produced in human thought". Knowledge is a product of human intelligence, intellectual activities, and/or cognitive conscience. Amat (1990) stipulates that if we apply Piaget's theory of knowledge development, there are two perspectives of information, i.e. process of knowledge and pre-codified fact. Process of

knowledge is dependent on the person that knows or the cognitive ability of the subject, as well as on the abilities of the person to assimilate symbolic knowledge (i.e. know-how and know-why). (Segundo, 2002)
"Piaget emphasizes on this point that not only does the figurative aspect play a role, but the medium, material, symbol, or language are also converted into meanings when understanding or an operational interpretation takes place by a subject who knows, and the subject that knows produces symbolic knowledge" (Segundo, 2002). Wertheimer (1945) called human knowledge productive thought. At the same time, McHale (1981) denotes that knowledge involves ordering or associating information within a pre-existing framework within human understanding (Segundo, 2002). The codified fact or figurative aspect of knowledge has a symbiotic relationship with verbal symbols or language. Language and other visual symbols (i.e. images) are the medium of meaning used in communication (information and knowledge transfer) and information processing (interpretation).
Besides memory and information finding, wisdom would also include deeper knowledge that entails prepositional reasoning. There are basically the "truth-based (epistemic) and value based (axiological) assumptions built into reasoning" (Hannabuss, 2001). For example, Confucius asserted that one should have one's deeds match what was spoken of (common saying "a man is as good as his words") in order to establish one's credibility. Another example, Buddhist philosophy stipulates how partially we perceive and understand reality. Consequently, the search for inner knowledge or enlightenment is an on-going process. (Hannabuss, 2001)
However, there is a need to understand the fundamental and related constructs that lead to the understanding of deep knowledge and wisdom. These include data, information, knowledge, and their interrelationships. Knowledge can be defined as a clear and certain perception of a subject or object, and/or the understanding of certain fact. In essence, it is the content that resides in our minds. The process of acquiring knowledge is therefore through our interpretation of information (meaning). Some would consider information and knowledge interchangeable, but this is true only to certain extent. This is true when the same content occupies more than one space. For example, information content of a communication email also becomes knowledge of the reader once it is read. However, information is by no means equal to knowledge particularly deep knowledge. The process of information-knowledge transformation is through learning and human interpretation; and the process of knowledge-information transformation is achieved by communication of what is known amongst people.
"A knowledgeable person is one who holds justified true belief, or belief supported by fact. However, being knowledgeable is but one component to wisdom, the other being a demonstration of sound and serene judgment regarding the conduct of life." (Bierly III et al., 2000) As such, wisdom is a construct of multiplicity, and thus arcane to many.

INTELLIGENCE

Intelligence requires ability to sense the environment, to make decisions, and to control action. Higher levels of intelligence may include the ability to recognize objects and events, to present knowledge in a world model, and to reason about the plan for the future. In advanced forms, intelligence provides the capacity to perceive and understand, to choose wisely, and to act successfully under a large variety of circumstances as to survive, prosper, and reproduce in a complex and often hostile environment. (Albus 1991);
Albus (1991) four system elements of intelligence:

1. *Sensory processing; monitoring state of external world and internal state.*
2. *World modeling; best estimate of the state of the world…knowledge of the world…also contains simulation capability that generates expectations and predictions…(to) make plans and behavioral choices.*
3. *Value judgment; determines what is good and bad, rewarding and punishing, important and trivial, certain and improbable… provides basis for making decisions.*
4. *Behavior generation; selects goals, plans, and executes tasks.*

Intelligence as (mental) processing. (Fagan III, 2000; Sternberg, 1985 in Gottfredson, 2003)
Gardner (1987)'s theory of multiple intelligences:

1. *verbal/linguistic*
2. *logical/mathematical*
3. *visual/spatial*

4. *bodily/kinesthetic*
5. *musical*
6. *interpersonal*
7. *intrapersonal*
8. *naturalist*
9. *spiritual*
10. *existential* (8-10 in Sternberg, 1999b)

Neisser et al. (1996) concepts of intelligence:

1. *understand complex ideas*
2. *adapt effectively to environment*
3. *learn from experience*
4. *engage in various forms of reasoning*
5. *overcome obstacles by taking thought*

Intelligence is mental processing given environmental context (Sternberg, 1999a)

Theory of successful intelligence proposed by Sternberg (1999a):

1. *Intelligence is the ability to achieve success in life in terms of one's personal standards within one's socio-cultural context.*
2. *Ability to achieve success depends on one's capitalizing on one's strengths and correcting or compensating for one's weaknesses.*
3. *Balance of analytical, creative and practical abilities.*
4. *Balancing of abilities is achieved to adapt to, shape, and select environments.*

Mental processes (Sternberg, 1999c)

1. *Meta-cognitive skills: problem recognition. problem definition, problem representation. Strategy formulation, resource allocation, monitoring of problem solving, and evaluation.*
2. *Learning: implicit (incidental) vs. explicit (selective)*
3. *Thinking: critical thinking (analyzing, critiquing, judging, evaluating, comparing & contrasting, assessing); creative thinking (creating, discovering, inventing, imaging, supposing, hypothesizing); practical thinking (applying, using, utilizing, practicing).*
4. *Knowledge: declarative vs. procedural*
5. *Motivation: achievement seeking, belief in own competence (self-efficacy)*

Weinberg (1989) three facets of implicit theory of intelligence:

1) *practical problem solving ability (reasoning logically, seeing all sides of the problem, keeping an open mind)*
2) *verbal ability (being a good conversationalist, reading often and well)*
3) *social intelligence (being sensitive to social cues, admitting mistakes, and displaying interest to the world at large)*

In essence, intelligence is thought or mental processing capacities:

1. learning – pattern recognition, memorizing, recalling, correcting mistakes, sense-making
2. conceptualizing – modeling, prioritizing, categorizing
3. analytical thinking – analyzing, interpretation, understanding, scenario playing, evaluating
4. critical thinking – logic, reasoning
5. creative thinking – imaging, imagining, supposing, hypothesizing, simulating
6. quick thinking
7. performing – reading, speaking, music, physical activities etc
8. problem solving, decision making, judging,
9. affective thinking – emotion handling

WISDOM

There are many theories in the literature on intelligence such as psychometric theories, cognitive theories, genetic-epistemological theories, and social-psychological theories. On the other hand, literature on wisdom is quite limited to a handful of researchers such that of Sternberg, Staudinger, and Baltes. There are many attempts to measure intelligence, and far less with creativity tests despite many disagreements in those tests. As for wisdom, there are no tests thus far to warrant any disagreement.

As such, implicit theories can be useful in developing conceptual framework for defining wisdom. "Implicit theories are constructions by people that reside in the minds of these individuals. Such theories need to be discovered rather than invented because they already exist in some form, in people's head" (Sternberg, 1985). The simplest and most direct way of finding such implicit theories is to ask people what they are. Sternberg (1985) citing research findings from editors of Journal of Educational Psychology revealed several intelligence components:

1. Ability to carry abstract thinking
2. Ability to adapt oneself adequately to relatively new situations in life
3. Practical problem-solving ability (e.g. logical thinking, identifies connections among ideas, see all aspects of problem)
4. Verbal ability (e.g. articulate)
5. Social competence (e.g. accepts others for what they are, admits mistakes, display interest in the world as a whole)

Barron's (1968) research (cited by Sternberg, 1985) on creative writers obtained five major distinctive attributes:

1. Appear to have a high degree of intellectual capacity
2. Genuinely values intellectual and cognitive matters
3. Values own independence and autonomy
4. Verbally fluent – can express ideas well
5. Enjoys aesthetic impressions – aesthetically reactive

Clayton's (1975) study revealed descriptive terms for wisdom; experienced, intuitive, introspective, pragmatic, understanding, gentle, empathetic, intelligent, peaceful, knowledgeable, sense of humor, and observant. Clayton discovered that the descriptive terms could be clustered into two dimensions of wisdom, i.e. "affective" and "reflective". (Sternberg, 1985)

Virtues

The philosophy of Confucius influenced morality and politics in the history of the Chinese. The five main virtues central to Confucius teachings include *Jen* (仁 Benevolence), *Yi* (義 Justice and Obligation), *Li* (禮 Etiquette), *Zhi* (智 Perspicacity), and *Xin* (信 Credibility and Trust). Confucian ideal of *Yi* denotes an obligation or duty towards the state, and commitment towards justice or just cause. The precept of *Li* pertains to treating others sensitively, with respect, and with consideration for another's feelings. *Xin* is a directive that includes honesty, sincerity, consistency in words and behaviors, and trust, or in one word 'credibility'. Confucian philosophy also emphasized temperance advocating modesty and self control i.e. refraining from extravagance and self-aggrandizing boasts. (Dahlsgaard et al., 2005)

Taoist Philosophy cited important virtues such as humanity, justice, propriety, knowledge, and temperance. In Buddhist philosophy the fundamental five precepts are virtues of abstentions from 1) harming living things, 2) theft or fraud, 3) misconduct in pleasures, 4) lies or boasting, 5) substance abuse (e.g. alcohol, drugs). Hindu Philosophy advocates virtue of penance, forbearance, rectitude, knowledge, experience, faith, valor, fortitude, and charity. Athenian cited virtues include wisdom, courage, temperance, and justice. Jewish promotes virtues include justice, temperance, prudence, integrity, leadership, trustworthiness, diligence, understanding, knowledge, respect, and transcendence. Islamic philosophy includes virtues like justice, contemplation, intellect, understanding, moderation, courage, and generosity. (Dahlsgaard et al., 2005)

Justice, humanity, temperance, and transcendence (some implied) are the common virtues advocated in majority of religion, which incidentally, also cite wisdom as the goal of being. Virtue and moral reasoning can be argued as the supporting ingredients for handling human affairs appropriately, as well as being part of human nature. Unfortunately, virtue is not the whole of human nature; as such human also requires mindfulness and knowledge to pursue wisdom and transcendence.

Spirituality

Spirituality is virtuous and emotional in nature that involves understanding and appreciation of one's position in the universe, one's soul, and the divine. Majority of religions, if not all, follow one common and fundamental ideal: 'treat others as you would wish to be treated'. Bierly III et al (2000) argue that spirituality can enhance wisdom in two ways.

First, "wisdom is gained through self-reflection of experiences and formulation of deeper goals" (Bierly III et al., 2000). Spirituality helps to clarify one's goals and align one's core virtuous values and beliefs with purpose in life. Wisdom is not merely the result of rational analysis, but also includes a strong spirituality of pursuing integrity, truth, and rectitude through reflection and diligence. In other words, spirituality supports wisdom development in the understanding of the difference in what is right and wrong. In addition, it also supports the notion that the interest of the community and greater good outweighs individual self-interest. However, this is not to say that greater good should be achieved at the expense of self-interest. On the contrary, if practical wisdom was to have it, it would be a win-win situation where all interests are served.

Second, "spirituality provides faith, courage and hope that facilitate wise decision-making and actions". (Bierly III et al., 2000) In other words, spirituality provides the guidance and reassurance in the belief that one is making the right decision and doing the right thing. Moreover, one must also have the strength of belief to overcome personal barriers and external obstacles for doing the right thing. Spirituality also promotes passion and dedication to one's mission whereby the undertaking is believed to be meaningful and worthy.

For example, James E. Burke's, former CEO of Johnson and Johnson, decision in the Tylenol tragedy illustrates action oriented wisdom reflecting the knowledge of what is right and the courage to do it. In the aftermath, the company's reputation strengthened, and the overall corporate value increased instead.

Wisdom as Philosophy

Confucius, in the Analects, posits that wisdom involves righteousness, and that wise people is knowledgeable about the Way (Tao). Wisdom in Buddhism is a form of enlightenment (nirvana) whereby one would understand and lead life accordance to what is 'Right'. Aristotle maintains that practical wisdom is the ability to deliberate well with regard to conduct of life. *The Survival of the Wisest*, cited by Bierly III et al (2000), spoke of wisdom as practical value of human survival, and the enhancement of quality of life. Bierly III et al (2000) citing Beck (1999) describe wisdom as both "knowledge (understanding the truth) and action (doing what is good)", Rothberg's (1993) notion of wisdom as "socially engaged spirituality" meaning integration of practical lives with spirituality development, where wisdom is not only the result of inquiry and reflecting relationships between self and society, but also action taken to transform self and society for a better whole, and Maxwell's (1984) idea of wisdom as "including knowledge (rational inquiry) and judgment of value for better ways of living, better institutions, customs, and social relations."

Knowledge is necessary but not sufficient for wisdom. In other words, to be wise one must be knowledgeable, but being knowledgeable does not make one wise. Knowledge may inhibit the pursuit of wisdom if it obscures perspectives and consequently to positive changes. Hence, it highlights the importance of critical reflection and sound judgment.

Wisdom as an Expert System

Bloom (1985), and Ericsson and Lehman (1996) treat wisdom as an expert system in association with the fundamental pragmatics of life where four conditions support the development of wisdom. One, acquisition of wisdom involves extended and intense process of learning, practice, and the pursuit of excellence. Two, multiple and cross-related processes are expected in the generation of wisdom. Three, due to wisdom's integrative aspects of knowledge and virtue, the preconditions of wisdom development include cognitive, motivational, social, interpersonal, and spiritual elements. Four, mastery of critical life experience, guidance of mentors, experience, and social influences are also crucial factors in wisdom development. In short, "wisdom is intended for the well-being of oneself and others. It also involves an effective coordination of mind and virtue" that requires interplay of intelligence, cognitive style, and personality. Moreover, wisdom coordinates knowledge and judgment about fundamental pragmatics of life with several properties such as

1. Strategies and goals with regard to conduct and meaning of life
2. Limitation of human and knowledge acquisition
3. Uncertainty of reality
4. Superior level of judgment and advice
5. Knowledge with extraordinary scope, depth, and balance

6. Balance between mind and virtue
7. Pursuit of well-being of oneself and others

(Baltes and Staudinger, 2000)

Wisdom as Learning

Learning is the input side of wisdom, and it can be defined as acquisition of knowledge, experience, and skills. There are several types of learning conducive to developing wisdom i.e. experiential learning, practical theorizing, and meta-learning.

Experiential Learning

The emphasis on experience is the main concept of Andragogy. Many educators affirm the importance of experiential methods such that of games, simulations, case studies, psychodrama, role-play and internships. However, experiences and perspectives "change according to language and categories of analysis we use, and according to the cultural, morale, and ideological vantage points from which they are viewed" (Brookfield, 1995a). David Kolb's (1984) experiential learning theory describes how learning is maximized through cycle of concrete experience to observations and reflection, to formulation of abstraction and generalization, to application in new situation. Experience should be rich and meaningful in order for us to gain critical insights. People's histories, stories, and experiences must be affirmed critically if they are to be affirmed to avoid blind acceptance or being malleable from obscurantism. (Bierly III et al., 2000)

Education, training, learning, and 'seasoning' of a person can assists in achieving wisdom. Experience aids people in understanding new knowledge and its integration in existing knowledge, as well as assigning value to different types of knowledge. (Bierly III et al., 2000)

Aeschylus, one of the three great ancient Greek tragedians, believed "wisdom comes along through suffering". Learning from own mistakes is one of the important ways to gain wisdom. However, it should not be taken out of context by assuming that wisdom is gained only from making mistakes. Nevertheless, learning from mistakes is useful including vicarious learning. Learning from other people's mistakes is a substitute of learning from own mistakes. Vicarious learning may not have the same impact as learning from own mistakes, but there are much more case examples of other people's mistakes. One lacks in impact makes up in volume in vicarious learning. Vicarious learning is conducive in avoidance of serious mistakes by observing others and hence removes unwarranted foolishness. Other ways of increasing learning from mistakes with limited risk include simulation or role play, and experimentation. (Brookfield, 1995a)

Practical Learning

Practical theorizing originates from the attempts to make educational practitioners critically aware of the informally developed theories and/or implicit theories that guide their practices. Practical theorizing makes comparison of emerging informal theories amongst practitioners through individual conversations and structured reflection group participation. In these reflection groups, participants serve as "reflective mirrors" to reactions and experiences dealing with the given practice. Participants can "re-frame, broaden, and refine" their own implicit theories of practice. In addition, participants can also use formal or explicit theories to make comparison to their implicit or emerging theories. Through this process, experiences and formal theories interplay dialectically to develop emerging and practical theories, hence the term practical theorizing. (Brookfield, 1995a)

Meta-learning

Meta-learning also known as 'meta-cognition' or in layman's terms 'leaning how to learn' lacks a commonly agreed definition. However, Brookfield (1995a) tentatively defines meta-learning as "attempts to develop insights into own habitual ways of learning". Basically, it means people "possesses a self-conscious awareness of how it is they come to know what they know; and awareness of the reasoning assumptions, evidence and justifications" that underlie their beliefs in the truth. Although far from having a plethora of meta-learning research, research suggests that meta-learning process manifests itself in the diverse contexts of life pragmatism, development of practical intelligence, emotional learning, and emotional intelligence, which incidentally are also important ingredients in wisdom development. (Brookfield, 1995a)

Wisdom as Interactive Minds

Staudinger and Baltes (1998) considered wisdom "to be inherently tied to collective systems of knowledge". They also stipulated that the likelihood of wisdom is influenced by interactions of multiple minds. Hence they coined the term "interactive minds" to suggest "collective and social-interactions facet of human life".

Staudinger (1996) (in Staudinger and Baltes, 1998) proposed that knowledge and judgment related to wisdom is collective and social-interactive in several ways. First, wisdom is social interactive with "cultural evolution and ontogenesis" within human communities. Baltes and Smith (1990) ontogenetic model of wisdom posits that "mentorship and experiences in various social contexts, such as families, peer groups, or professional socialization, are critical factors in the acquisition of wisdom related knowledge and judgment". For example, people tend to seek advice from people valued highly for difficult life problems. Sometimes, this consultation may take place in our heads where we simulate what others might advise or do in particular difficult situation in life.

Second, activating and applying wisdom requires interactive minds; applying wisdom related knowledge and judgment to difficult and uncertain life situation most likely involves more than one individual. This is because the body of knowledge and skills can be considered too large and complex to be retained by a single mind. Third, evaluating and validating wisdom also requires interactive minds. Since there is no absolute criterion of wisdom definition, wisdom can only be recognized and attributed by consensus, as such, an agreement in subjective majority in essence becomes relatively objective.

Staudinger (1996) differentiated two basic forms of interactive minds, i.e. external and internal dialogue. External dialogue happens between two or more persons where advice is given to individual seeking assistance. Internal or virtual dialogue, on the other hand, refers to "mental representation of he or she has of another person's opinion or knowledge system". In other words, internal dialogue means thinking what others might do or say about the problem at hand. In short, it is a mental simulation. Nevertheless, both mechanisms are conducive to improving judgment and hence developing wisdom. (Staudinger and Baltes, 1998)

Wisdom as Critical Reflection

Knowledge and judgment are essential ingredients of wisdom development. Critical reflection can be found in developmental psychology where an abundance of constructs such as embedded logic, working intelligence, post-formal reasoning, dialectic thinking, reflective judgment, and epistemic cognition illustrate how one come to thinking critically, acquire deep knowledge, and make sound judgment. Critical reflection involves three interrelated processes:

1. Process of questioning and replacing assumptions that were once accepted tacitly as commonsense.
2. Process of accepting alternative perspective on previously taken for granted ideas, concepts and reasoning.
3. Process of recognizing and understanding the hegemonic aspect of values in dominant culture, alienated values of minority ideology, and the 'natural' state of the world.

(Brookfield, 1995a)

Critical reflection of assumptions comes in three broad categories – paradigmatic, prescriptive, and causal. (Brookfield, 1995b)

Paradigmatic assumptions are deeply embedded assumptions about reality. These assumptions are not recognized as assumptions even when they are pointed out. They are regarded as "objectively valid renderings of reality" or as facts. It would take a tremendous amount of counterintuitive evidence and disconfirming evidences to change these beliefs on assumptions once held true. However, once they are challenged and changed, the impact on people's lives is profound and pervasive. (Brookfield, 1995b)

Prescriptive assumptions are assumptions about what one thing ought to be in a given situation, i.e. how one should act, what certain process should look like, what responsibility is expected in given position or relationship. Essentially, prescriptive assumptions are derivatives of paradigmatic assumptions. For example, if we believe adult independence, we assume they would choose their own learning interest. (Brookfield, 1995b)

Causal assumptions are assumptions of cause-and-effect relationship of all eventual happenings. They are usually stated in predictive terms i.e. if-then statements. An example of causal assumption would be if we practice what we preach then others will follow. (Brookfield, 1995b)

Brookfield (1995b) believes that there are six reasons why critical reflection is important to learning and development of wisdom:

1. Critical reflection helps us take informed actions where actions are critically based, as well as assumptions investigated, explained, and justified. An informed and well-justified action has a very good change of achieving the intended effects. Critical reflection in learning and action thus increases the chance of being productive.
2. Critical reflection helps us develop a rationale for practice. It solidifies the rationale behind the profession or practice, and thus the commitment and confidence to the practice.
3. Critical reflection helps us avoid self-laceration or self-blame when things do not quite go our way. It galvanizes our focus on effort and not on factors that may be beyond our control that leads to guilt or self-blame.
4. Critical reflection grounds us emotionally with proper recognition and management of uncertainty and difficulties of life situations.
5. Critical reflection enlivens or energizes our professional practice by providing a model of "passionate skepticism". It allows us to create an "emotional climate in which accepting change and risking failure are valued" as well as a "challenging, interesting, and stimulating" work environment.
6. Critical reflection also increases democratic trust since it promotes independent thinking, and creates condition under which each individual is "respected, valued, and heard". Also "anchored in values of justice, fairness, and compassion", critical reflection becomes and important element in the democratic process.

(Brookfield, 1995b)

In Sternberg's (1985) study, findings suggest "intelligence and wisdom are perceived more similar to each other than either is perceived as similar to creativity". This may imply strong interrelationship between intelligence and wisdom. The implicit theory study also reveals various components of intelligence, creativity, and wisdom:

INTELLIGENCE DIMENSIONS

1. Practical problem-solving (tends to see attainable goals and accomplish them; has ability to change directions and use another procedure; is able to apply knowledge to particular problems)
2. Verbal ability (can converse on almost any topic; has demonstrated a good vocabulary; has a good command of language)
3. Intellectual balance and integration (has ability to recognize similarities and differences; listens to all sides of an issue; is able to grasp abstract ideas and focus his or her attention to those ideas)
4. Goal orientation and attainment (tends to obtain and use information for specific purposes; possesses ability for high achievement is motivated by goals)
5. Contextual intelligence (learns and remembers, and gains information from past mistakes or successes; has the ability to understand and interpret his or her environment; knows what's going on in the world)
6. Fluid thought (has a thorough grasp of mathematics, good spatial ability, or both, has a high IQ level; thinks quickly)

CREATIVITY DIMENSIONS

1. Non-entrenchment (makes up rules as he or she goes along; has a free spirit; is unorthodox)
2. Integration and intellectuality (makes connections and distinctions between ideas and things; has the ability to recognize similarities and differences; is able to put old information, theories, and so forth together in a new way)
3. Aesthetic taste and imagination (has an appreciation of art, music, and so forth; can write, draw, compose music; has good taste)

4. Decisional skill and flexibility (follows his or her gut feelings in making decisions after weighing the pros and cons; has ability to change directions and use another procedure)
5. Perspicacity (questions societal norms, truisms, assumptions; is willing to take a stand)
6. Drive for accomplishment and recognition (motivated by goals, likes to be complimented on his or her work; is energetic)
7. Inquisitiveness and intuition

WISDOM DIMENSIONS

1. Reasoning ability (has the unique ability to look at a problem or situation and solve it; has good problem solving ability; has a logical mind)
2. Sagacity (considers advices; understands people through dealing with a variety of people; feels he or she can always learn from other people; is fair)
3. Learning from ideas and environment (attaches importance to ideas; looks at different perspectives; learns from other people's mistakes)
4. Judgment (acts within own physical and intellectual limitations; is sensible; has good judgment at all times; thinks before acting or making decisions)
5. Expeditious use of information (is experienced; seek out information, especially details; learns and remembers and gains information from past mistakes or successes)
6. Perspicacity (can offer solutions that are on the side of right and truth; is able to see through things - read between the lines; has the ability to understand and interpret his or her environment)

(Sternberg, 1985)

Implicit theories can provide a useful way of understanding constructs of intelligence, creativity, and wisdom. The test of an account of implicit theories is whether it accurately and fully reflects the notions of people have in their heads, and the way in which these people are systemized. People have implicit theories of intelligence, creativity, and wisdom, and they use these theories in judging themselves as well as others. (Sternberg, 1985)

Sternberg, (2001) also believes that "wise people recognize the need to balance intelligence and creativity to achieve both stability and change within societal context". This balance may come in the form of dialectic process in which "intelligence represents a thesis, creativity an antithesis, and wisdom a synthesis". The convergent view on intelligence is the "ability to adapt to the environment" or acquisition of skills that lead one to fit into existing environments. Creativity, on the other hand, refers to "the potential to produce novel ideas" (Kuhn, 1970; cited by Sternberg 2001), basically a breakthrough that defies contemporary views, paradigm-rejecting notion, or redirecting/reinitiating a given field. This gives creativity its "antithetical and crowd defying nature" (Sternberg, 2001).

In all likelihood, intelligence is a prerequisite of creativity since creative people usually generate lots of ideas, analyze them, and choose the better ones. They may also redefine problems, seek seemingly bizarre connections between ideas that others cannot, and recognize existing body of knowledge that can be conducive as well as hindrance to generating creative ideas. Wise people exhibit both intelligence and creativity in one form or another, and an emerging wisdom derived in part from intelligence and creativity. This entails balance between change (creativity) and stability (intelligence) in societal activities and human behaviors when wisdom progresses i.e. making head ways in a given field in its quest for new knowledge and understanding. (Sternberg, 2001)

Sternberg (1990) citing other researchers such as Csilszentmihalyi and Rathunde described components of wisdom as 1) cognitive process or way of thinking; 2) virtue in which wisdom become best guide for supreme good and action; 3) personal good that implies intrinsic rewarding experience with highest enjoyment and happiness available. Kekes' (1995) four components of wisdom include 1) conception of a good life; 2) knowledge of good and evil; 3) evaluation using knowledge to actual situation; 4) judgment (reasonable decision) in complex situation; or in other words, wisdom is a "form of understanding with reflective attitude and practical concern, and with good judgment about the evaluation of complex situations". Small's (2004) description include intellect acuteness, intelligence, knowledge, speculative depth, intellectual grasp, sound judgment in choice of means and ends, prudence (avoidance of foolish act, loss of integrity, credibility etc), virtues; complex interplay of contemplation, truth and reality, and

understanding with ability to make good judgments; an ability to make right use of knowledge, insight and/or capacity to judge rightly in matters relating to life and conduct. Meadiam (in Sternberg 1990) sees wisdom as attitude towards beliefs, values, knowledge, information, abilities and skills. Birren and Fisher (in Sternberg 1990) see wisdom as bringing together experience, cognitive abilities, and affect, and allowed good decisions to be made at an individual and societal level. Staudinger and Pasupathi (2003) describe wisdom as expert level knowledge and judgment in fundamental pragmatics of life. Baltes and Kubzmann (2003) describe wisdom as integration of knowledge and character of mind and virtue; as expert knowledge and judgment about important, difficult and uncertain questions with regard to meaning and conduct of life; importance of emotion and values, performance for welfare of others.
With the given contributions from various researchers, we can then re-categorize the elements of wisdom:

1. Mindful (Theory-of-mind)

- Intelligence
- Creativity cognitive styles
- Reflective thinking
- Judgment
- Emotional reasoning
- Mental-real distinction

2. Knowledgeable (Knowledge and Skill)

- Factual and procedural knowledge of life
- Life-span contextualism
- Experience, and openness to experience
- Problem solving, planning, and decision-making skills

3. Human Affairs Handling (Issues Handling)

- Understanding human nature
- Recognition and response to human limitations
- Recognition and management of uncertainty
- False belief understanding
- Social understanding and interaction (social intelligence)
- Understanding and managing pragmatics of life

4. Virtue (Value System that builds personality through moral reasoning)

- Integrity
- Credibility (honesty, truthfulness, sincerity, consistency, trust)
- Valor (courage)
- Fairness (equity)
- Temperance (fortitude, forbearance, restraint, self control)
- Benevolence (humanity)
- Justice (rectitude, righteousness)
- Penance
- Modesty
- Prudence (diligence)
- Respect
- Understanding
- Transcendence

In summary, wisdom is 1) understanding of universal truth [知真理], 2) sound judgment [正判斷], and 3) appropriate execution [成所作].
In conjunction with the DIKW model, the revised model is DIKIW shown in diagram below:

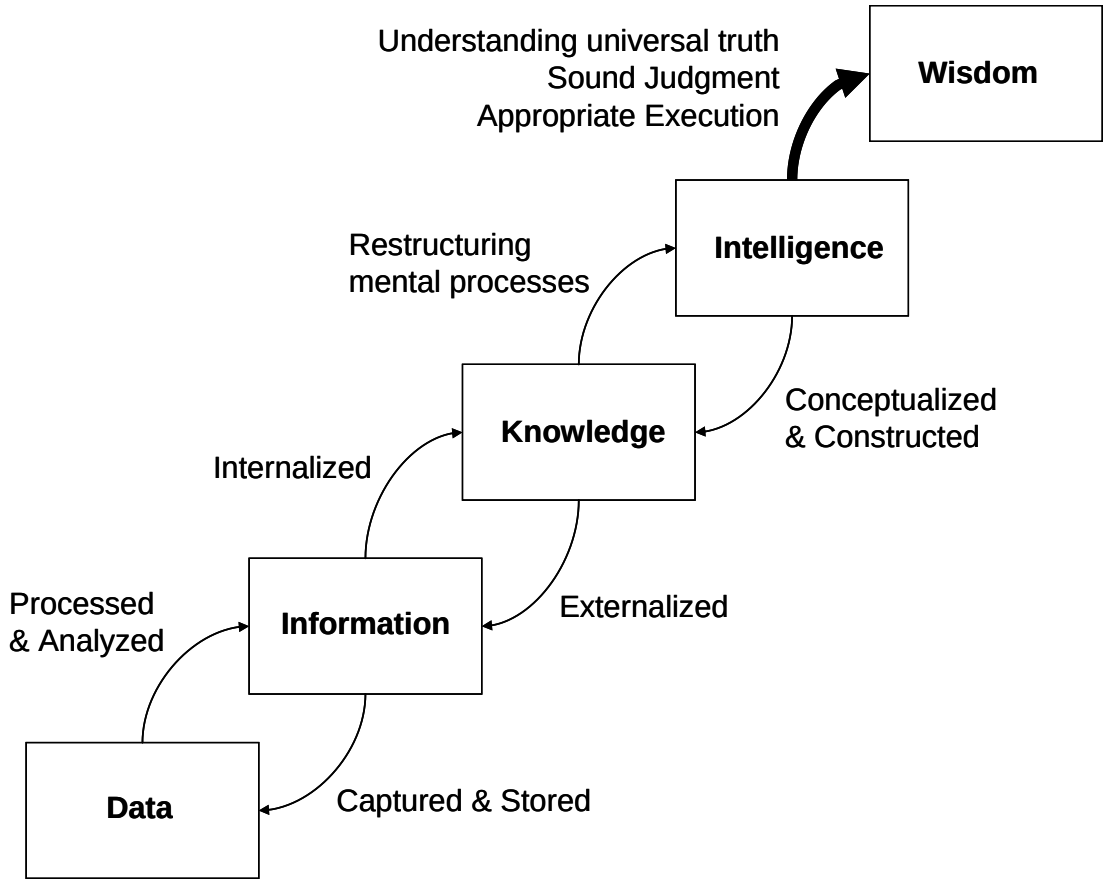

Figure 1 DIKIW

CONCLUSION

The fallacy of circular definition can be avoided in defining terms such as data, information and knowledge with interrelationships given mindfulness. It makes sense to include intelligence as the unit of analysis in the DIKW hierarchy since intelligence has inseparable relationships with knowledge and wisdom. Therefore, it is also fitting to rename the DIKW acronym to DIKIW.

Wisdom, arguably, is sought after by many if not all throughout time. Yet wisdom in its practicality is still an illusive and profound construct even if we exclude theoretical and transcending wisdom from examination. Nevertheless, practical wisdom with its multi-facet elements provides a plausible goal for all individuals and organizations alike that seek a brighter future and the greater good. Practical wisdom embraced practical problem solving of business, human, and social issues. Presuming that practical wisdom can be cultivated in individuals systematically and developed in organizations collectively, practical wisdom would offer nontrivial contributions to society as a whole. Therefore wisdom may well be the greatest goal as well as journey of human development.