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A NEW INTEGRATED INFORMATION SEEKING MODEL BASED ON INCONGRUITY AND FOUR HUMOURS

There are various conceptual models or frameworks from different disciplines and domains. These models have ben built to give explanation to the related issues on information seeking and processing especially for the information and the knowledge oriented disciplines and domains. The models in literature dealt with different user groups and information seeking behaviors of these user groups. In this paper, with focusing on, an integrative conceptual model for information processing and seeking will be developed from the perspective of information systems modeling. Accordingly, this paper will first provide background information and suggest a new model based on these information sources. Then, the suggested model will be interlinked with the humoral theory in order to amplify its explanatory and integrative power. To build a suggestion model, this paper will also provide directions for possible new work. The suggested model is creating interlinked connection with the concept of incongruity and the humoral theory.

Key words: Information processing, Information seeking, Incongruity, Four Humours.

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Сәйкессіздік және төрт стихия теорияларына негізделген жаңа интеграцияланған ақпарат іздеу моделі

Түрлі пәндер мен салаларда түрлі концептуалдық модельдер немесе құрылымдар бар. Бұл модельдер ақпаратты іздеу мен өңдеу, әсіресе, ақпарат, пәндер және білімге бағдарланған салалардағы мәселелерді түсіндіру үшін құрылған. Мақалада әртүрлі пайдаланушылар топтары және олардың ақпарат іздеу кезіндегі мінез-құлықтары қарастырылған. Бұл мақалада ақпараттық жүйені модельдеу тұрғысынан ақпаратты өңдеу мен іздеудің кешенді тұжырымдамалық үлгісі ұсынылды. Тиісінше, бұл мақалада алғашқы ақпараттар ұсынылды және осы ақпарат негізінде жаңа модель құрастырылды. Содан кейін ұсынылған модельді түсіндіру және интеграциялық күшейту үшін гуморальдық теориямен байланыстырылды. Мақалада сондай-ақ ұсыныс моделін құрастыруға арналған жаңа мүмкін жұмыстарға байланысты нұсқаулар берілген. Ұсынылған модель сәйкессіздік тұжырымдамасымен және гуморальдық теориямен өзара байланысады.

Түйін сөздер: ақпаратты өңдеу, ақпаратты іздеу, сәйкессіздік, төрт стихия.

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Новая интегрированная модель поиска информации, основанная на теориях несоответствия и четырех стихий

Существуют различные концептуальные модели или структуры из разных дисциплин и областей. Эти модели были построены, для того чтобы дать объяснение смежным вопросам поиска и обработки информации, особенно для информации, дисциплин и областей, ориентированных на знания. Модели в статье рассматривали различные группы пользователей и их поведение при поиске информации. В этой статье разработана интегрированная концептуальная модель для обработки и поиска информации с точки зрения моделирования информационных систем. Соответственно, в этой статье предложена справочная информация, на основе которой предложена новая модель. Затем предложенная модель будет связана с гуморальной теорией, чтобы усилить ее объяснительную и интегративную силу. Также в статье представлены указания для возможной новой работы по построению модели предложения. Предложенная модель создает взаимосвязь с понятием несоответствия и гуморальной теорией.

Ключевые слова: обработка информации, поиск информации, несоответствие, четыре стихии.

Introduction

Information seeking behavior and addressing information needs is a significant topic in information and systems sciences, while the factors influencing how people act and behave have become a key subject in miscellaneous disciplines such as psychology, sociology and social sciences. There are various conceptual models or frameworks from different disciplines to explain related issues on information seeking and processing (Ikoja-Odongo and Mostert, 2006; Wilson, 2006). The models in literature dealt with different user groups and information seeking behaviors of these groups.

For instance, while Voigt (1961), Menzel (1964), Paisley (1968) and Orr (1970) developed a model on information seeking behaviors of scientists, Hermon handled the information seeking behaviors of social scientists in his model. In addition, Marchionini (1995) focused on certain tasks performed during electronic information seeking in various data bases or online library catalogues; whereas, Byström and Jarvelin (1995) modelled the used information resource and channel in information seeking process. Another modelling study by Miller and Jablin (1997) focused on the information seeking behaviors of fresh employees in companies, whereas some studies by Kahlor (2010) and Mckenzie (2003) examined the information seeking behaviors of patients. Baldwin and Rica (1997) developed this modelling, basing upon the information seeking behaviors of financial analysists.

In addition to these, there are many models related to the information seeking in the field of library and information science and information management. Dervin (1972, 1983), Belkin (1980), Wilson (1981), Krikelas (1983), Ellis (1989), Kuhlthau (1991), Spink and Cole (1997), Ingwersen and Jarvelin (2005) have greatly contributed to the field with their models. In general models focus on the concept of uncertainty that occurs at the beginning of information seeking process. For instance, Wilson focused on the environment, social roles, psychological, emotional and cognitive factors in his models; while, Dervin (1983), handled uncertainty as a gap in person's knowledge and he puts forward that this gap needs to be filled in order for information seeking process to be finalized successfully. Dunn (1997) has put forward Model of Sensory Processing and dealt with "the nervous system's threshold for acting and the person's propensity for responding to those threshold". (Ellis (1989), focused on gradual steps in his information seeking model. He put forward that information seeking is comprised of such processes as starting, chaining, browsing, differentiating, monitoring and extracting. Leckie, Pettigrew and Sylvain (1996), has focused on information seeking behaviors in terms of certain specific professions. They handled the information seeking behaviors of doctors, lawyers, attorneys and engineers. The model is affiliated with the reaction system of humans and focuses on the strategies humans use to determine their behaviors. They stated that duties and roles of individuals in work atmosphere are the determinants

of person's behaviors and they trigger persons to act and start their certain behavior. Saracevic (1996), focused on interaction in information retrieval in his stratified information retrieval model; while Spink (1997), has dealt with the use of feedback systems in information retrieval systems. In literature, models have focused on different components and tried to visualize the conceptualization of information seeking process. Urquhart and Rowley (2007) proposed a model putting forward the information seeking behaviors of students who search for and access electronic resources of information, focuses upon micro (information literacy, search strategy, support and training, pedagogy, discipline and curriculum, academic's information behavior) and macro points (information resource design, policies and funding, availability and constraints to the success, information technology learning infrastructure, organizational knowledge and culture) orienting the information seeking behaviors of students There is a need, however, to update and integrate (if not unify) existing models in order to have a more explanatory power and appeal to recent trends in related disciplines (Wilson, 2006).

Accordingly, this paper will first provide background information and suggest a new model based on these information sources. Then, the suggested model will be interlinked with humoral theory in order to amplify its explanatory and integrative power. The conclusion will also provide directions for new work.

Review of Background Information

According to Rauterberg (1995), "information processing is an interactive concept and observer dependent." and "the stimulus effects of the environment (or context) interact with the real or potential complexity of the receiver". The context can be

(1) the environment beyond the human skin,

(2) the neural stimuli of extremities (e.g., arm and leg movements, motor restlessness), and

(3) mental processes like 'daydreaming', etc.

Accordingly, the complexity of the context (CC) is the sum of the environmental complexity (EC) and of the bodily complexity (BC; e.g., measured by the level of arousal). The complexity of the receiver is limited to the internal complexity of his task related memory or mental model (MC).

Rauterberg (ibid) suggests that "there must be an inverted U-shaped function between subjective 'information' and the information measured by entropy or complexity" (Rauterberg, 1995: 56), interlinking the context of physics with a fundamental psychology law Yerkes-Dodson law (Yerkes and Dodson, 1908) that relates performance to arousal. As a consequence, there a limit to handle complexity, which is the sum of CC (e.g., a given level of task complexity, EC, and/or arousal, BC); and MC (internal, mental complexity).

Following this argument, Reuterberg (ibid.) defines Incongruity as the difference of CC and MC (I=CC-MC):

– If the complexity of the memory or mental model, MC, is less complex than the complexity of the context, CC, then humans try to optimize this positive incongruity.

– Seeking and explorative behavior starts, when the positive incongruity sinks below an individual threshold or changes to negative incongruity (sensory deprivation).

– Behavior of avoidance can be observed, when the positive incongruity exceeds an individual threshold (dissonance, stimulation overflow).

This iterative interlink between CC and MC that results in negative and positive incongruity (and learning) is illustrated in Figure 1.

The inverted U-shaped function between (subjective) information and the information measured by complexity (incongruity) can then be depicted in Figure 2. A human that seeks information would leave a context with too low and too high (positive) incongruity. In between, the medium range enables positive emotions and respective behaviors, which increase novelty on one side, and confirmation (or decrease dissonance) on the other side (Figure 3).

Based on the definition of Incongruity as the difference of CC and MC, in order to increase the incongruity, one can increase CC, which mostly imply exploratory behaviour (novelty tendency) and/or reduce MC, which may imply forgetting or suppression (manipulation of the perception mechanisms). If the sensory stimulation thus incongruity is too low, in order to increase CC one can exhibit locomotor exploration, or manipulatory or investigatory behaviour (for instance game-playing).

These suggestions with respect to incongruity and behaviour resonates with Csíkszentmihályi's Flow Theory (1975, 1990). Accordingly, "boredom is experienced when the skills are greater than the current challenge and anxiety appears in the opposite case, when the challenge is too difficult for the current action capabilities of an individual". A third optimal state, flow, "can then be experienced when there is a balance between both challenge and skills" (Gaya, 2017: 40-41) (Figure 4).

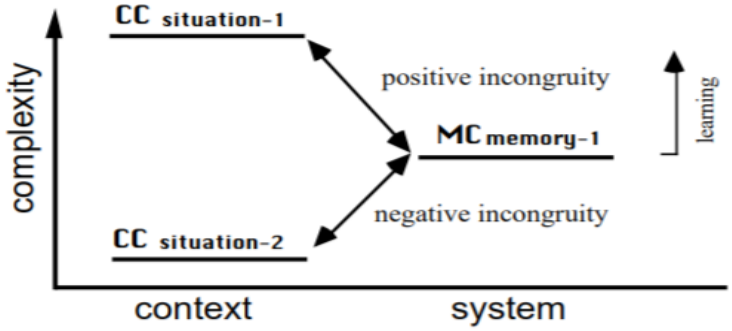

Figure 1 – Positive and Negative Incongruity
Source: Rauterberg, 1995

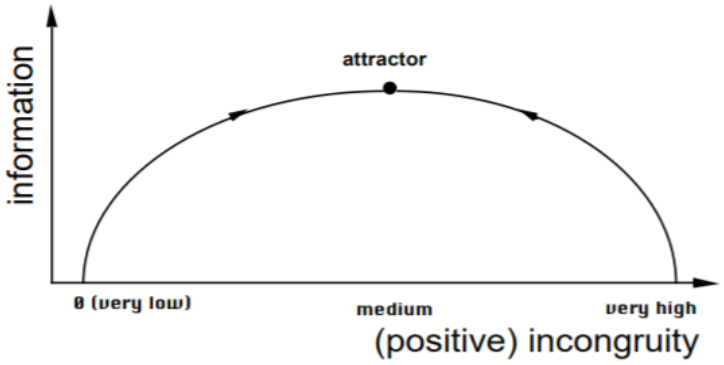

Figure 2 – The Relation between (Positive) Incongruity and Information
Source: Rauterberg, 1995

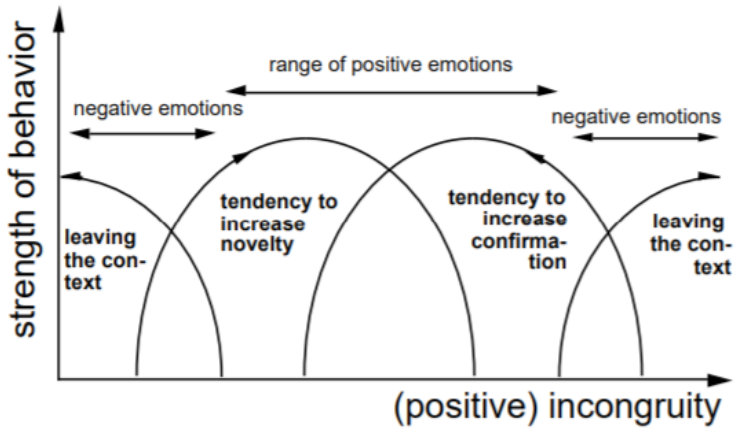

Figure 3 – The Relation between Positive Incongruity and Behaviour
Source: Rauterberg, 1995

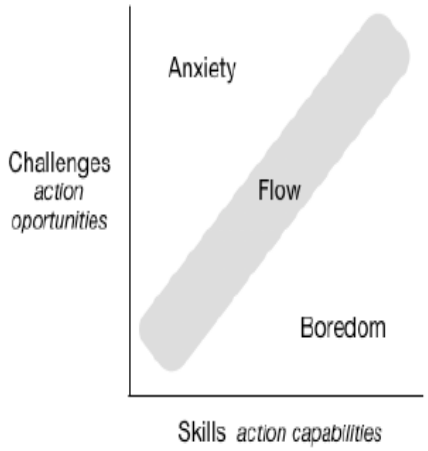

Figure 4 – Flow Theory
Source: Gaya, 2017: 40

Model Suggestion

Benefiting from and interlinking ideas of Rauterberg (1995), Csíkszentmihályi (1975) and Gaya (2017), a new model will be suggested in this section. This new model combines and expands Rauterberg's ideas by interlinking incongruity with the flow model (Figure 5).

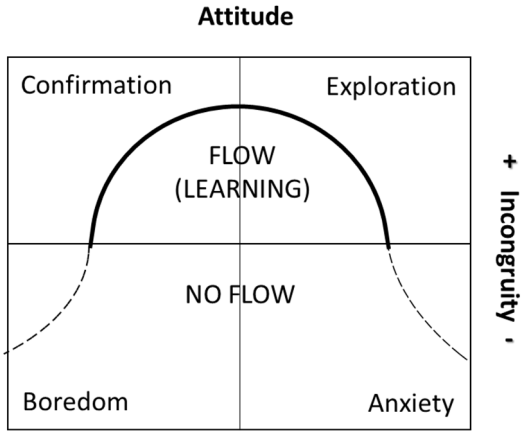

Figure 5 – The Relation between Positive and Negative Incongruency and Attitude
Note: Part of the suggested Model by the Authors

The top half of this model reflects the illustrations and discussions on positive incongruity provided above, at higher levels of positive congruity there is tendency to explore novel aspects and at lower levels of positive congruity there is tendency to confirm existing aspects, both of which provides a processing flow of seeking and learning (existing) information. However, when the congruity levels are too high or too low, it turns into negative incongruity, as the bottom half of the illustration. And, when it is negative incongruity, there is anxiety on one side and boredom on the other side, leading towards out-of-context. While positive incongruity side facilitates flow that results in learning as part of an inverted-U type of function, there is no such flow on the negative congruity side. The overall bigger picture provides a useful illustration of the interaction between the level of information in the form of complexity and human (system) attitude and behaviour, as the basic model that incorporates negative incongruity to complement positive incongruity.

In the model attitude is used as a bridging concept between emotions and behaviours. Furthermore positive or negative aspects in emotions or attitudes are considered to have relative meaning, thus bringing an absolute value function (I CC-MC I) to incongruity could normalize their meaning, resulting in a sustainable continuous flow that incorporates Anxiety and Boredom parts to complement Exploration and Confirmation parts of incongruity.

The model can then be expanded with the inclusion of conditions that increase not only positive but also negative incongruity. What leads towards Anxiety (due to overflow of stimulation or skills being too lower than task challenges, or first-contact/beginner stress) could be explained by I MaxCC-MC I or I CC-MinMC I, and what leads to Boredom (due to sensory deprivation or skills being too greater than task challenges) could be explained by I MinCC-MC I or I CC-MaxMC I .

Incongruity and Four Humours

With the incorporation of the absolute value function, the suggested model for information seeking and learning can also be adapted to humoural theory, the Grand Unified Theory of its time for living and non-living systems (, whose existence could be based on and explained by information or material exchange,) effectively adapted by Hippocrates, Galen, and Ibn Sina, and even Shakespeare among others (Bhikha and Glynn, 2017, National Library of Medicine, n.d.). The relationship between different humours and their respective characteristics are provided in Table 1.

Table 1 – Four Humours and their Related Characteristics

	Fire	Air	Water	Earth
Qualities	Hot & dry	Hot & moist	Cold & moist	Cold & dry
Season	Summer	Spring	Winter	Autumn
Humour	Yellow bile	Blood	Phlegm	Black bile
Temperament	Bilious	Sanguine	Phlegmatic	Melancholic
Body tissues	Nerve tissue	Muscles, blood	Lymph, fluid, fat	Ligaments, skeleton
Body function	Metabolism	Respiration	Nutrition	Formation
Faculty	Attractive	Digestive	Propulsive	Retentive
Sense	Smell	Taste	Sight	Hearing
Mental state	Anger	Humour	Submission	Stubbornness
Emotion	Excitement	Cheerfulness	Apathy	Depression
Flavour	Bitter	Sweet	Salt	Sour
Age	Youth	Childhood	Maturity	Adulthood
Time	Afternoon	Morning	Night	Evening

Source: Bhikha and Glynn, 2017: 15030

In other words, as Osborn (n.d.) explains:

– "The essence of blood is exchange and contact, as it is the basic nutritional and metabolic currency of the organism. Blood has an Attractive virtue, or force, since all cells, organs and tissues have an absolute need for it, and are therefore attracted to it";

– Yellow "Bile has a hot, caustic nature and a Digestive virtue, or force, which ... metabolize and transform";

– "Black Bile has a Retentive virtue or force, and enables the digestive organs to hold on to their contents long enough to process them properly";

– "The Plegmatic humor has an Expulsive virtue, or force, which flushes out impurities, transports vital nutrients, and helps eliminate wastes. ... The Phlegmatic humor nourishes the body on a deep and fundamental level".

Accordingly, yellow bile has an attractive nature, while blood is more related with digestive characteristics. Phlegm is associated with propulsive i.e. expulsive behaviour, and black bile has a Retentive type of behavioural impact. These characteristics can be interlinked with different parts of the incongruity (Figure 6).

In this model, the initial over-flow associated with the first contact with the context and abundancy of stimulation is linked with the attractive nature of blood. The learning that follows exploration is connected with digestive mechanisms of yellow bile, and confirmation with the retentive mechanisms of black bile. The expulsive nature of phlegm then associates with the boredom and redundancy at the final. The interactions within and among these four humoural stages result in a continuous, undisrupted flow of information and material exchange. Here it is important to recall that there are no positive or negative meanings or values associated with each humoural stages in our modeling. (Surely, to achieve an effective flow of information seeking and learning, a good balance needs to be available among these humoral stages).

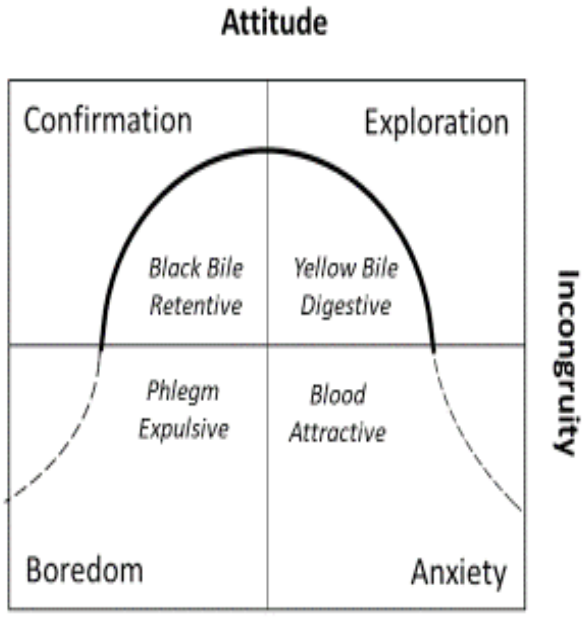

Figure 6 – The Interlink between Incongruity and Four Humours
Note: Suggested Model by the Authors

Conclusions and Future Work

In this paper, by integrating and expanding existing perspectives, a new, updated model that could explain and combine the learning behaviors in human is suggested. The modeling is based

on information processing as exemplified by incongruity framework, and material exchange, as exemplified by the incorporation of four humoural theory.

While this outcome does not claim to provide a unified theory of learning, knowledge and systems science, it could have certain useful implications for learning and training activities with respect to human and non-human systems and their interactions, also following again the suggestions of Rauterberg (1995). The humoural stages of incongruity and learning can be also linked with humour and incongruity, since "the difference between incongruity and incongruence is that incongruity is the state of being incongruous, or lacking congruence while incongruence is a want of congruence; incongruity". (Wikidiff, n.d.), and incongruence is suggested as a significant concept for humour and its impact on learning. This could provide especially interesting implications and inferences for gamification and gamified learning, as a topic that is increasingly gaining momentum in information science and education practice (Seaborn and Fels, 2015).

For instance, games for learning can be designed and delivered that could enable and test users' attitudes with respect to anxiety, exploration, confirmation and boredom. The characteristics of four humours (four instance their association with four elements (Osborn, n.d.) or temperaments (Bhikha and Glynn, 2017)) can also be incorporated into game design to reinforce the learning.

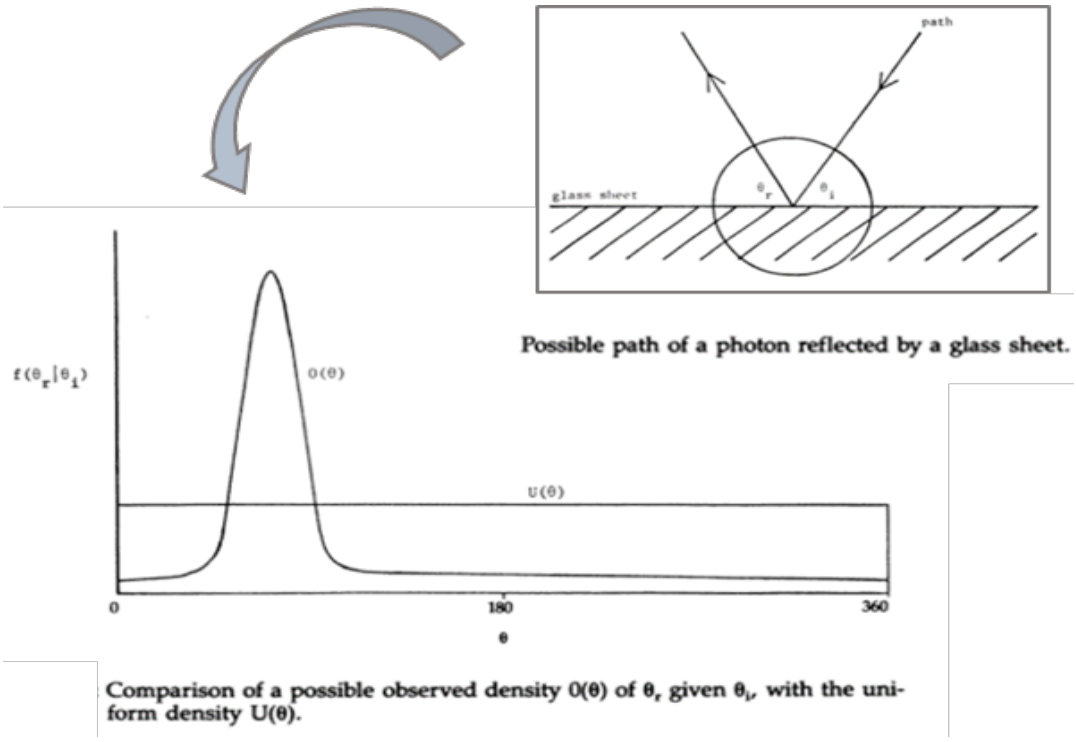

Figure 7 – Measuring Information Content based upon Comparison of Possible Observed Density with Uniform Density
Note: Adapted from Ward, 1989

Furthermore, based on evolutionary epistemology, according to which living systems' capacities for information and knowledge are the products of biological and social evolution, Ward (1989) suggests that an end-seeking property can be associated with evaluation, selection or information. In order to develop a model for end-directedness, Ward then proposes a general methodology for measuring information content for a material phenomenon as a "comparison of reality with what it would be like if chaos reigned", with respect to observed density angles of reflection and refraction at a glass surface (as an example case). The density explains the possibility of a photon hitting the glass at a specific angle "will leave the surface at any given angle" around the

circle. The glass surface contains information on how the possible paths of reflection (or refraction) are determined in contrast to a chaotic state that contains no information and bears no relation (uniform density). The suggested formula and the resulting illustration resembles with the Inverted-U shape of information incongruity (and also is compatible with Shannon's definition of average information content) and combines selection and information perspectives both of which can be based upon reduction of possible alternative states, and is also strengthened by complementary information and adapted response (Figure 7). Accordingly, the discussion on information processing and absolute incongruity can be expanded with reflective and refractive functions, making it possible to measure the information content of any material phenomenon. Inferences could be made for the levels of possible density that are above or below the uniform density (chaotic stages or an absolute/ obsolete level of incongruity?). Similar to the above discussions on inverted U-shape function, the observed information density is high at the middle ranges and becomes lower and lower, getting close to certain minimum and maximum end points, and even passes certain thresholds, going beyond these minimum and maximum points.

Accordingly, these suggestions provide possible directions for further research with respect to designing and delivering learning (and information processing) events, as well as measuring the parameters of the conceptual framework that could guide these designs and deliveries. These suggestions for future work could then be useful to interlink this conceptual paper with (current) practice and reality.

The paper has also followed the assumptions that come from the main sources it has utilized. For instance Rauterberg (1995: 63) assumes that "the mental model of an expert is more comprehensive than that of a beginner" to conceptualize the MC and its relation with CC. These assumptions could impose certain limitations on the explanatory value of the suggested modeling.

It is also interesting to recall the origins of Turkish word for knowing, 'bil' can be used in different forms including 'bile' and 'bilge' with their own respective meanings in English. Nevertheless, it is hoped this work gives new ideas for researchers all around the world that work on learning, knowing and intelligence of human and non-human systems.

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