Customizing Transparent Thinking Approach (TTA) by Building and Implementing TTA Toolboxes: Paving the Road for TTA Operationalization Phase

Mohammad A. Aliedeh
Mutah University

*Humanity is overburdened by an overwhelming problems that necessitate a change in our "way of thinking". Recently, Transparent Thinking Approach (**TTA**) which is a Conceptual Framework of a new thinking-based higher educational reform approach is published. This paper revisited the **TTA** Conceptualization Phase and presented the results of **TTA** Customization phase by constructing **TTA** Toolboxes. Connected and Analogical Thinking Perspectives and Models are presented using a domain-specific examples that illustrate the practical use of Generic Transparent Thinking (**GTT**) in the Modeling Stage of **TTA** Life Theater. This paper almost accomplished **TTA** Customization Phase and paved the road for **TTA** Operationalization Phase.*

INTRODUCTION

Global Burdens and the Need to Think Anew

As an academician living in a *decade of instability* and in the *heart of swirling Middle East*, I feel obliged to deeply look at the global big picture and to strongly direct my educational reform approach (Aliedeh, M. A., 2015a, b, and c) to alleviate the tragedic, alarming and frightening conflicts and shocking disturbances that are widely spreading the whole region and resonate all over the globe. In these alarming circumstances, the scene is occupied by toppling regimes, igniting ethnic conflicts, killing innocent people, mass flooding of refugees, and conflict management policies. How can an academician propose an educational reform approach without putting in his/her mind the ultimate goal of alleviating the effects of these tragedic events that are widespread all over the globe.

Watching carefully the local and the international TV/Satellite News Channels for just few hours is enough for an observer to realize that the global community is overburdened by a large number of problems and challenges in all domains. These burdens are creating a "*development crisis"* that is growing in spite of all the development efforts of the international community. Academicians, intellectuals, educationists, economists, engineers and scientists are required to *exert an extra effort in digging deeply* for the root causes of these problems while seeking to devise solutions. Most scholars agree that the major root cause of problems lies in our *thinking perspectives* that view the world as devisable, separable and simple system of entities. The current *way of thinking* is hindering our ability to devise an effective solutions for our *complex* and *tangled* global system problems. The ability to reveal the *hidden interconnectedness* and the *deep understanding* of the interaction behavior between these huge number of entities are considered a crucial step in understanding the complex global system behavior and eventually devising an effective solution for the pressing burden of problems. This *thinking crisis* entails

us to develop a *new way of thinking* that will constitute the *core of the needed solution* (Aliedeh, M. A., 2015a).

Responding to Educational Failures by Thinking Anew

> *"Education is the great engine of personal development" Nelson Mandela Long Walk to Freedom*
>
> *"Modern education is competitive, nationalistic and separative. It has trained the child to regard material values as of major importance, to believe that his nation is also of major importance and superior to other nations and peoples. The general level of world information is high but usually biased, influenced by national prejudices, serving to make us citizens of our nation but not of the world." Albert Einstein*

Educational system, in any society, is considered the *engine of development* (Powers, C., 2015, Chung, C., 2005), and the root causes of problems usually emanate from and pour in it. Thinking is at the *core* of this *educational core*. Educational system in *developing countries* suffers a number of *failures*. Aliedeh, M. A., (2015b) summarized some of the developing countries *educational system failures* under the following headings: (1) *Decontextualized* Education (2) *Rote* or *Regurgitated* Education, (3) *Blinded* or *Key-hole* Education, (4) *Fragmented* Education, (5) *Superficial* Education, and (6) *Subtracted Value* or *No-added Value* Education. The absence of *context*, *meaning*, *big picture*, *connections*, *rigor*, *depth*, and *value* strongly indicates that we are suffering a *distortion in thinking* that entails us to pursue a *micro scale thinking renovation*. Therefore, the needed new way of thinking should be *generic, deep, holistic, and meaningful* in order to help our *individual and collective thinkers* to *easily maneuver* between scales, disciplines, domains, theories, and perspectives while searching for solutions. (Aliedeh, M. A., 2015b)

Thinking-Based Educational Reform

> *"The need for new thinking is like the weather. Everyone talks about it, but beyond that, no one does much about it" Mitroff and Linstone, (1993)*
>
> *"If nothing is more practical than a good theory, as Kurt Levin said, there would appear to be nothing less practical than many theories, especially many inconsistent theories." Harpaz, Y. (2014), p. 32.*

People's abilities to think critically, creatively, and effectively are needed in order to deal wisely with today's alarming challenges. Distortion in thinking needs to be corrected by adopting an effective thinking-based educational reform. Many educational theorists and practitioners enthusiastically worked in developing *countless and inconsistent theories* for teaching thinking. This inconsistency in the developed teaching thinking theories makes it helpless for a person who wishes to understand the field and apply it in teaching, due to the "*clutter"* which makes it hard to know which theory to adopt (Harpaz, Y., 2014).

Theorists and practitioners of teaching thinking tried to confront clutter in the field of teaching thinking by combating it using various methods, for example: (1) gathering and organizing the various theories and approaches (e.g., Costa, A. L., 2001), (2) proposing criteria for choosing a good theory (e.g., Sternberg 1984), (3) selecting one or another among the various theories (e.g., Lipman 1991), (4) constructing a framework for teaching and study based on choosing different components from several theories (e.g., Marzano et al. 1988) (5) building an integrated conceptual map of the field of teaching thinking which offers a place for all the theories in the field of teaching thinking and enables them to be practiced in teaching (Harpaz, Y., 2014), (6) digging deep to the micro scale level thinking (core value level) then expanding transparency, as an instrumental core value, to structure an integrated conceptual framework that can be easily expanded and extended in all domain (Aliedeh, M. A., 2015a, b, and c).

TTA Revisiting, TTA Customizing and Paving the Road for TTA Operationalization

Aliedeh, M. A., developed a conceptual framework for a *new thinking approach* (called Transparent Thinking Approach (TTA)). Aliedeh, M. A., fully presented the TTA conceptual framework (core, extended, and expanded) to the *higher educational community* in a series of three papers (Aliedeh, M. A., 2015a, b, and c). TTA is an *innovative, simple and deep* thinking approach that is expected to stir the *reductionist, stagnated and regurgitated modes of thinking* that plagued *Higher Education Realm*.

As will be shown throughout this paper, TTA is considered a *big project* that is planned to be implemented in three phases: (1) TTA Conceptualization, (2) TTA Customization, and (3) TTA Operationalization. TTA Conceptualization phase is almost accomplished by publishing its *Conceptual Framework* (Aliedeh, M. A., 2015a, b, and c). The main objective of this paper is to revisit the *TTA Conceptualization Phase* and to accomplish the TTA Customization Phase that is considered as a road pavement for the practical fruiting in TTA Operationalization Phase. It is important to note that these three phases are not separable and have hazy boundaries. As you will notice while reading the three TTA conceptualization papers (Aliedeh, M. A., 2015a, b, and c), the main focus of the TTA developer was to present these newly developed concepts *as customized as possible* to the higher education audience, in addition to offering a supportive number of practical examples (Preliminary Operationalization Cases). Therefore, this paper will be devoted to: (1) Revisiting, refining, illustrating and connecting the main TTA concepts, (2) Presenting a Friendly Customization of TTA concepts in the form of *TTA Toolboxes*, (3) Presenting practical examples of TTA toolboxes implementation in different domains as preliminary operationalization cases. This paper will show how these three TTA phases are complementary and harmonically overlapping.

TTA REVISITING: BRIEF STORY OF TTA DIVING JOURNEY

TTA Unique and Original Products

TTA Conceptual Development and Implementation can be seen as a story is a *Two-Way Diving Journey* in the deep oceans of life which can be summarized by the following points and graphically illustrated in FIGURE 1 (Aliedeh, M. A., 2015 a, b, and c):

1) **TTA** is a prominent example of a *thinking-based educational reform approach* that is developed in the *womb* of chemical engineering education. **TTA** is highly affected by the engineering way of thinking that is based on engineering analysis, synthesis and visible graphical representation of conceptual constructs. [Conceptualization Phase]
2) **TTA** is developed as *Core Value-Rooted* and Thinking-Based Educational Reform Approach (Micro Scale Approach) that is conceptualized in three parts (**Core TTA**, **Extended TTA**, and **Expanded TTA**). [Conceptualization Phase]
3) **TTA** conceptual development is accomplished by a ***TTA** Maneuvering Journey* in the form of a Two-Way Diving in the deep ocean of life. [Conceptualization and Customization Phase]
4) The ***TTA** Maneuvering Journey* has two parts: (1) ***TTA** Discovery Journey* (Diving in) and (2) ***TTA** Implementation Journey* (Diving out). [Conceptualization and Customization Phase]
5) As a result of the ***TTA** Discovery Journey*, **Transparency** is found to be the *stem* and instrumental core value. [Conceptualization Phase]
6) At the onset ***TTA** Implementation Journey*, **Core TTA** is formulated in the form *Generic Transparent Thinking* (**GTT**) that is based on coining two new and important terms (*Transparization and Opaquaization*) in order to overarch all forms of learning processes in all domains. [Conceptualization Customization Phase]
7) As an initial product of the **Extended TTA**, **Transparency**, as a *stem* and instrumental core value, grows to result in constructing an *Extended Hierarchy of Core Values*. [Conceptualization Phase]
8) The *Extended Hierarchy of Core Values* is diffused into the thinking domain and replicated in the form of a *Transparent Thinking Perspectives Hierarchy*. [Conceptualization Phase]
9) *Transparent Thinking Perspectives Hierarchy* is characterized by combining: *Holistic Thinking* (revealing structure); *Meaningful Thinking* (searching for multiple meanings); *Deep Thinking*

(uncovering rigor); *Simple Thinking* (Gut level insights); *Visible Thinking* (uncovering structure and meaning).

10) The **Extended TTA** is equipped with numerous Perspective, Modeling, Maneuvering, Diagnosis and Technology Thinking Tools that is customized in the form of a **Generic TTA Toolbox**. [Conceptualization and Customization Phases]
11) The implementation of **Generic TTA Toolbox** will be accomplished on *TTA Life Theater* in which spotlights represent thinking perspectives; spotlights movements as maneuverings; and acting on the stage as modeling. [Customization Phases]
12) As a part of **Expanded TTA**, ***TTA*** *Implementation Journey* continues by implementing the Generic TTA Toolbox in education, development and change domains. [Conceptualization Phase]
13) In **Expanded TTA**, the concept of Thinking is "transparized" and expanded to accommodate all processes executed in the Human Mind (The Learning Machine) whether it is *cognitive*, *connative* or *affective*.
14) The formulation of this new Transparent Thinking Concept result in a "transparized" and expanded concept of Intelligence. [Conceptualization Phase]
15) *Transparization* of thinking, learning, knowledge construction, brain neural firing process, knowledge generation, technical understanding, making connections, and meaning making paved the road for the evolution of *Transparent Learning Theory* (**TLT**) which can be called **Transpirism**. [Conceptualization and Operationalization Phase]
16) ***Expanded TTA*** is culminated by TTA diffusion to accommodate all change processes (education and development) under the *big umbrella* of *Transparent Change Process* (**TCP**). [Conceptualization and Operationalization Phase]
17) **Generic TTA Toolbox** is the *seed* that will *fruit,* in knowledge and work domains, building another two important ***TTA*** *toolboxes* which are: (1) **Knowledge TTA Toolbox** and (2) **Work TTA Toolbox**. [Customization and Operationalization Phases]
18) **TTA** is *initially* implemented in *Higher Education Realm* in the form of *Transparent Higher Education* (**THE**) which will keep *diffusing* in all content areas (e.g. Mathematics, Science. Engineering, Medicine, … etc.). [Operationalization Phase]
19) **TTA** is considered a *big stride* in *growing* **Transparency** *seed* to fruit a *robust* and *practical* higher educational reform approach that is expected to be widespread in all walks of life . [Operationalization Phase]

When you read the above *TTA Brief Story* for the first time, you may feel overwhelmed by the large number of newly developed terms and concepts. This feeling will *gradually vanish* as you keep reading on, because each new term is *simply, deeply, clearly and visibly* presented throughout this paper. This paper will *truly overcome* the *hard challenge* of maintaining both *simplicity and depth*.

As a practical implementation of combining simplicity with depth by employing graphical conceptual model, FIGURE 1 illustrate graphically the TTA brief story in the form of road map that spans the three TTA project phases (Conceptualization, Customization and Operationalization). FIGURE 1 will help the reader to visualize and be motivated to read more about these new concepts.

TTA as an Engineering-Tasted Thinking-Based Reform Approach

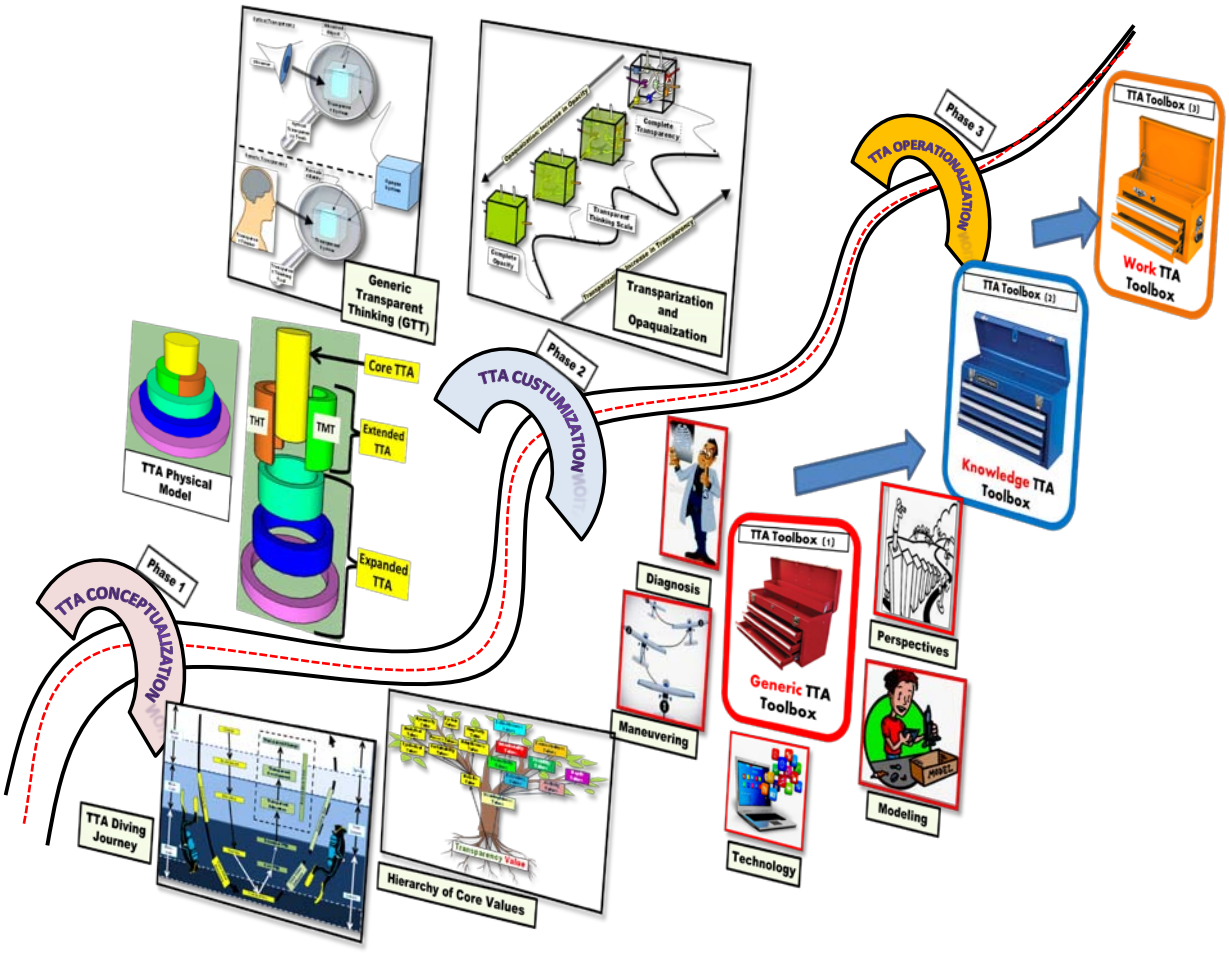
TTA is a *prominent example* of a *thinking-based* educational reform approach that is developed in the *womb* of *chemical engineering education*. **TTA** is highly affected by the engineering way of thinking in the form an engineering way of analysis, synthesis, graphical representation, systematic approach, revealing connectedness, maneuvering between physical and abstract domains, and connection with reality. These engineering features are *dominating the scene* and adding an *engineering taste* to the way of presenting the concepts in this paper.

Haile, J. M. in his article "Balancing text and graphics" points out that technical articles are written either based on: (1) Graphic-Dominant Approach or (2) Text-Dominant Approach. In the first approach,

the massage is primarily carried out via graphics, but in the later the message is mainly conveyed by words. Most researchers in the educational realm lean to use Text-Dominant Writing Approach, but researchers in the physical sciences are inclined to Graphic-Dominant Writing Approach.

As the reader noticed in this paper and the **TTA** Conceptual Framework published ones (Aliedeh, M. A., 2015 a, b, and c), the author leans to adopt Graphic-Dominant Writing Approach by heavily employing graphical conceptual constructs. Transparent Thinker **(TT)** (having **TTA** Mindset) usually *breaks the hard barrier* between concepts development and its practical use by visible communication. This paper is considered a *living example* of the new **TTA** way of thinking (**TTA** Mindset) that is based on *multiple thinking perspectives*, *visible modeling* representations, thinking *maneuvers,* and *diagnostic assessments*.

FIGURE 1
ILLUSTRATING THE BRIEF TTA STORY BY A GRAPHICALLY ENHANCED ROAD MAP

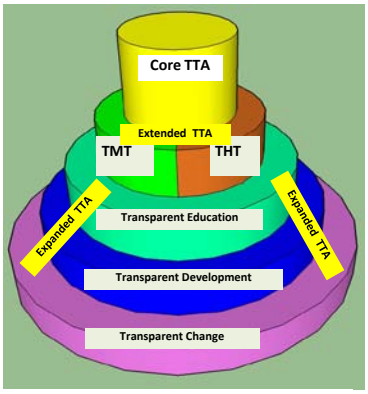


Physical Model of TTA Conceptual Framework

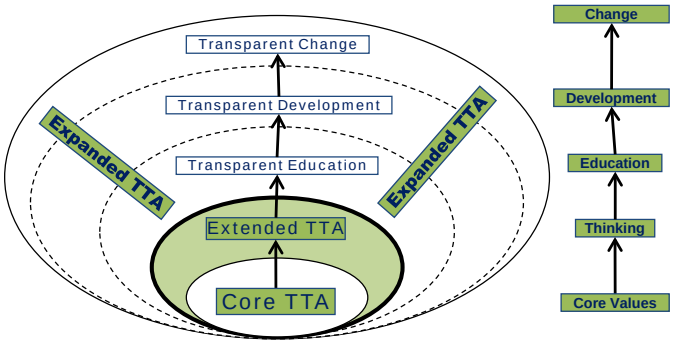
As shown in this paper, maneuvering between physical (practical or empirical) and theoretical (hypothetical) domains is effectively implemented to create meaningful connections, to help in *transferring insights* between the two domains, and to help the reader in acquiring and intuitive feeling of the abstract concepts. As a practical example, a physical model representation of the **TTA** conceptual framework is constructed to help the reader to visualize **TTA** and understand its *conceptual construction*

in *physical model form*, as shown in FIGURE 2. Three dimensional physical model representation is built, in addition to scatter view and step by step assembly as shown in FIGURE 2(b), (c) and (d), respectively. This is considered a practical implementation of the *maneuvering tool between theory and reality* that **TTA** accommodates. Namely, the conceptual construct is supported by physical representation that gives the learner an *intuitive (Gut) feeling* of the main components of the theoretical construct.

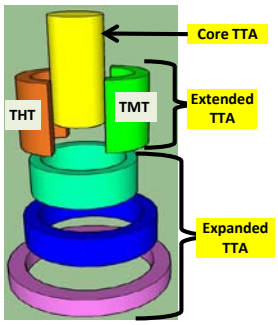
FIGURE 2
TTA PHYSICAL MODEL



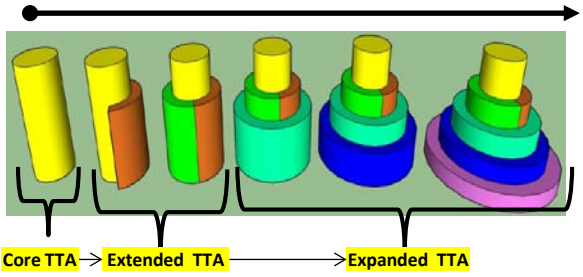
(a) TTA Conceptual Framework Physical Model



(b) TTA Conceptual Framework



(c) TTA Conceptual Framework Physical Model Scatter View



(d) Step by Step Assembly of TTA Conceptual Framework Physical Model

Evolution of TTA Through a Transparent Maneuvering Journey

Two Way Diving Journey Between the Specific and the Generic

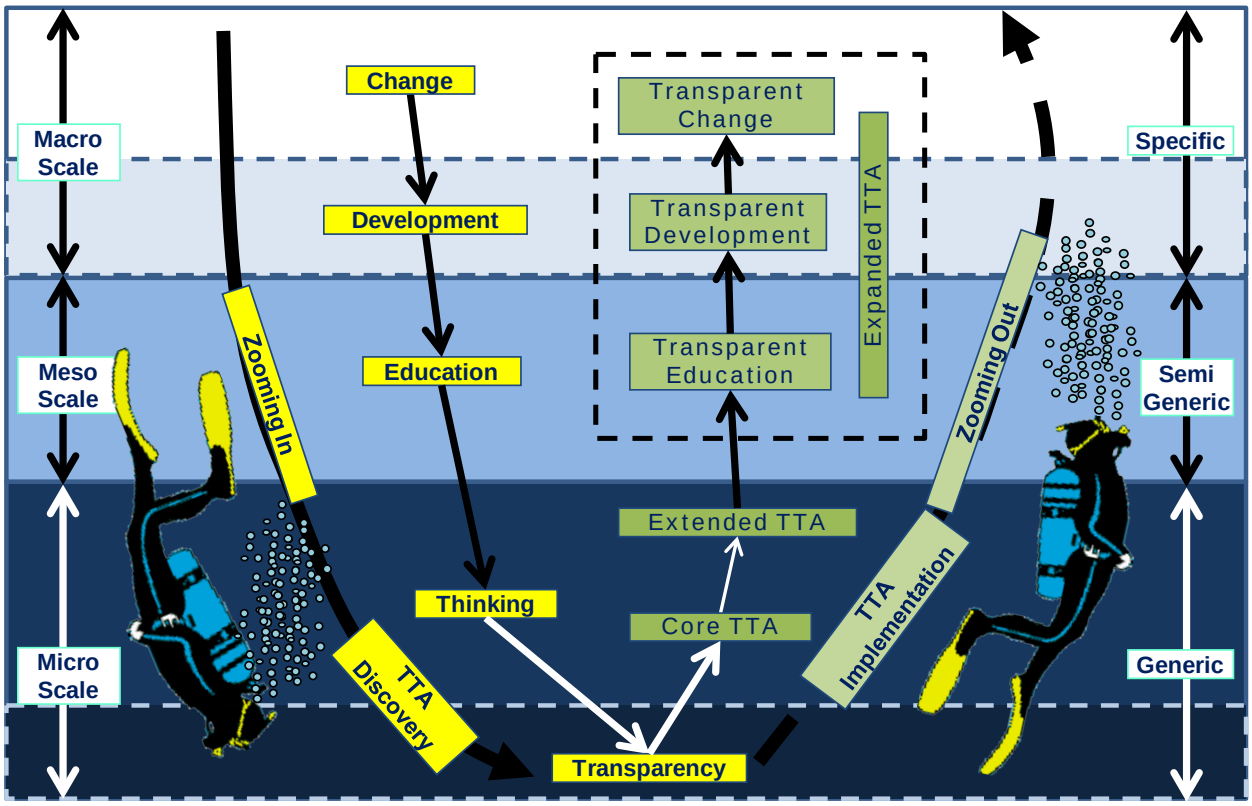
The conceptual framework of **TTA** is constructed in three stages (*core*, *extended* and *expanded*), see FIGURE 2. **TTA** construction is a result of a *maneuvering journey* between all scale levels (*Macro*, *Meso* and then *Micro Scales*) in a form of a *two-way diving journey*: (1) ***TTA*** *Discovery* Journey (Diving in) , and (2) ***TTA*** *Implementation Journey* (Diving out), as shown in FIGURE 3. It is a diving in and out journey in which the first part is considered as journey that aims to get to Transparency as a *stem* and instrumental core value and the other one is a *diving back journey* that aims to *diffuse* the newly developed **TTA** generic tools into the meso and macro scale levels. This *diving adventure* can be also considered an *intellectually maneuvering journey* from the *specific* to the *generic* and back again to the specific, as illustrated by FIGURE 3.

TTA Discovery Journey (From the Specific to the Generic)

While seeking for the root causes of the educational problems, ***TTA*** *Discovery Journey* started by diving in from the *macro scale* that deals with change and development processes into the *meso level*

(Educational Domain Level) which result in discovering that the educational system is not blamed for all these *accumulated problems*, and that the root causes of our global and educational problems reside at the *micro scale* (Thinking Domain Level), as illustrated in FIGURE 3. It is found also that the *thinking processes* at the *micro scale level* of change *accommodates the needed solution*. These thinking processes are *engrained* on a *core values foundation*. Exploring core values at the lowest level result in discovering that *transparency* is the *root core value* that all other core values emanate from. Therefore, **TTA** is considered as an innovative *higher education reform approach* that is *deeply rooted* in the *micro scale core value level* and "Transparency" is a *stem instrumental core value* (Aliedeh, M. A., 2015 a, and b).

FIGURE 3
TWO-WAY TTA MANEUVERING JOURNEY: (1) DISCOVERY MANEUVERING BY ZOOMING IN (DIVING IN) TO GET TO TRANSPARENCY AS A STEM CORE VALUE (2) IMPLEMENTATION MANEUVERING JOURNEY TO DIFFUSE THE FORMULATED CORE IDEA TO EDUCATION, DEVELOPMENT AND CHANGE DOMAINS



TTA Implementation Journey (Generic to Specific)

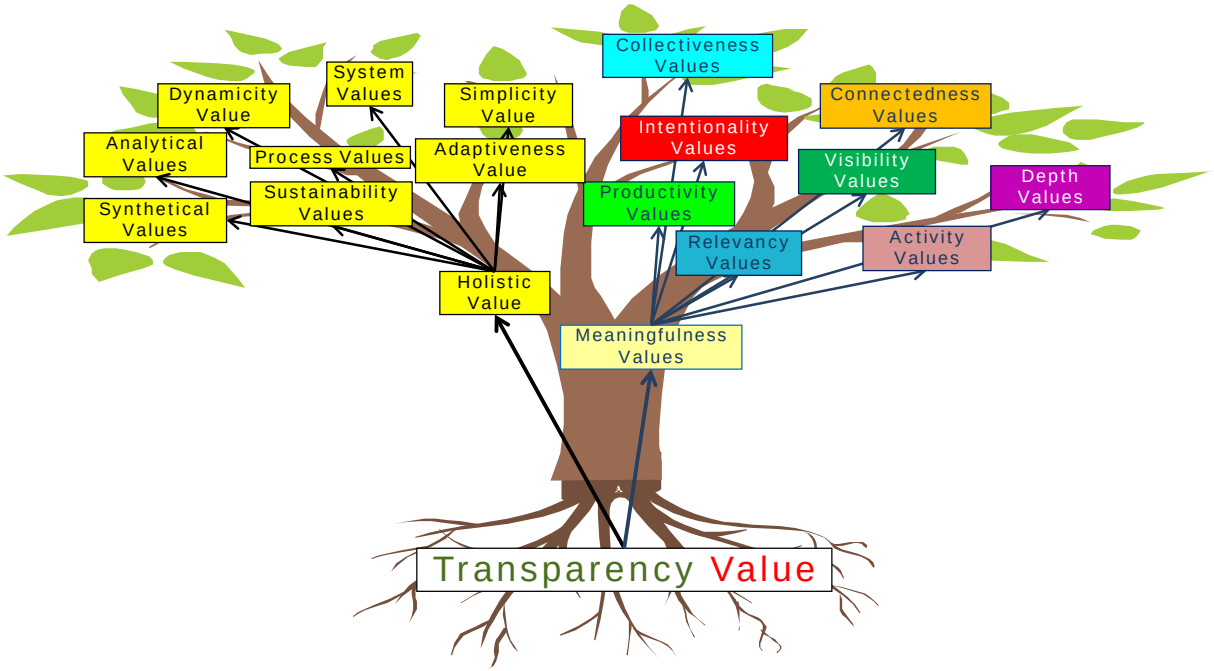
The diving back journey "***TTA** Implementation*" is started after discovering that Transparency is the "fountainhead" of almost all core values. ***TTA** Implementation* is a journey from the *generic* back to the *specific* or from the *micro* back the *macro*. The first important job to accomplish in this diving back journey is to formulate two core and opposing process concepts (*Transparization* and *Opaquization)*. These two new terms will constitute the *backbone* of Generic Transparent Thinking (GTT). GTT have a generic structure made of four components: (1) Transparent Thinker (**TT**) , (2) Transparent Thinking Tool, (3) Transparent System, and (4) Transparized Entities. **TT** uses this generic structure to maneuver between domains. For example, In medicine, GTT can be reflected to result in having a medical analyst as

TT; a blood sample as a transparent system; a microscope as a transparent thinking tool; and a bacteria as the transparized entity (for more examples in other domains see Aliedeh, M. A., 2015a). GTT is the *seed* of Core **TTA** that grows to *fruit* in all scale levels and domains.

After GTT formulation, the diving back journey "***TTA** Implementation*" reaches Extended **TTA** Conceptual Framework stage which is marked by clustering (breeding) a conceptual structure of an appropriate group of core values that emanate from transparency such as *connectedness*, *simplicity*, *holism*, *meaningfulness*, *depth*, *visibility*, *relevancy*, *intentionality*, …etc., as illustrated in FIGURE 4. This *crystallization* process results in forming an *Extended Hierarchy of Core Values*.

As the journey reaches the thinking domain, *the Extended Hierarchy of Core Values* is then replicated to result a similar *Extended Hierarchy of Thinking Perspectives*. By going from the purely generic to the purely specific, **TTA** Implementation Journey continues to be extended and expanded to encompass education, development and eventually change processes, as illustrated in FIGURE 3 (Aliedeh, M. A., 2015 a, and b).

FIGURE 4
THE EXTENDED HIERARCHY OF CORE VALUES (TREE OF TRANSPARENT VALUES), BREEDING OF TRANSPARENT VALUES



The Value-Engrained and Thinking-Based TTA Knowledge Production

As explained above, Transparency as a core instrumental value breed to form an extended structure shown in FIGURE 4. This core value structure is then reflected on the thinking domain to from a similar thinking perspectives hierarchy (will be explained later in this paper). These transparent perspective tools will work in harmony with other thinking tools in the **TTA** Generic Toolbox to generate knowledge and create work skills. To illustrate the process of **TTA** knowledge generation a ***TTA** Thinking Tree* is used as analogy, see FIGURE 5. This thinking tree has roots made of core values that supply nutrients to help in fruiting new knowledge. Namely, the ***TTA** Thinking Tree* has a structure of thinking tools that is supported by roots of core values. The fruits of this tree are widespread to cover many knowledge domains and fields. We can zoom in one fruit that represent Industry (for example), and then zoom more to get to its core that represent Chemical Process Industry, and then zoom more to a single seed to

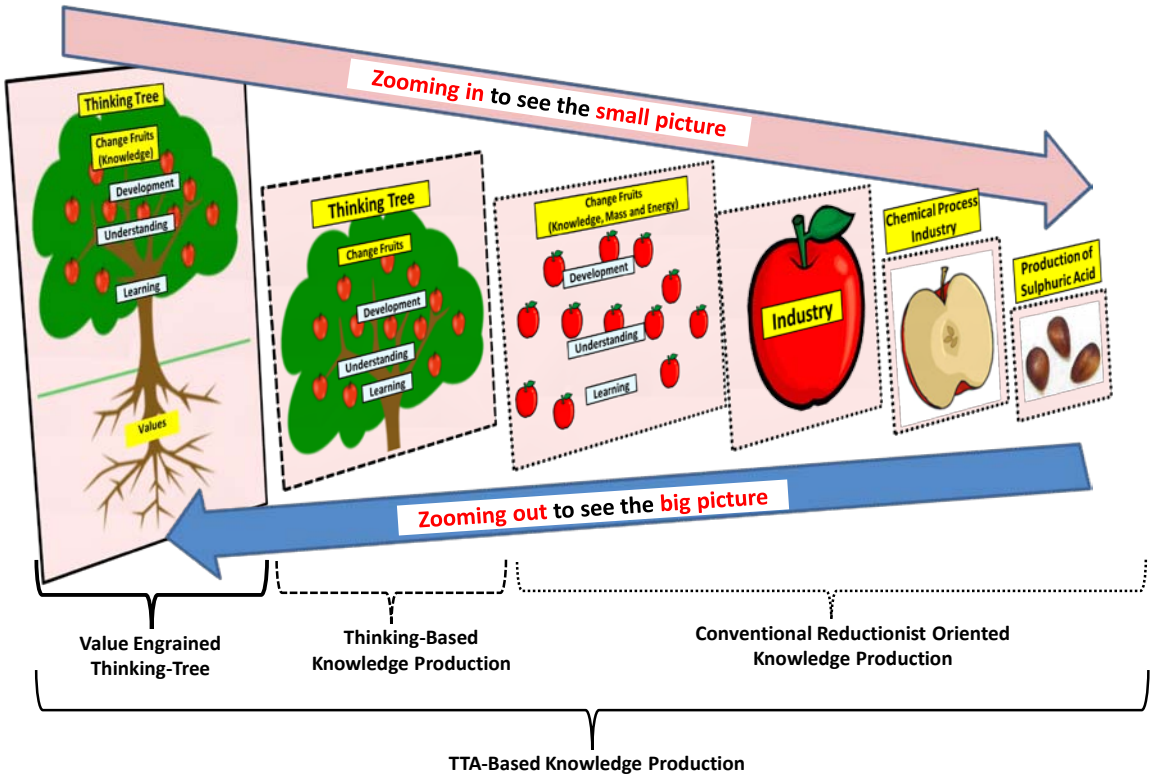
represent Sulphuric Acid Production Technology, as illustrated in FIGURE 5. In building **TTA** knowledge generation model, the whole process is spanned from the value roots of the thinking tree, till we gets to the production of any specific knowledge piece in any specific domain. It an integrated journey from roots to fruits or from values to knowledge.

Most educational Systems focus on fruits without paying attention to the tree and roots, and some of them (e.g. Thinking-Based Learning Programs) focus on thinking, but none except **TTA** which is able to maneuver from roots (values) to the tiny pieces of knowledge in micro subdomains, as illustrated in FIGURE 5.

TTA Project Planning: Maneuvering from Roots to Fruits

As part of the **TTA** Implementation (Diving out) journey, **TTA** project is planned to be accomplished in three phases: (1) **TTA** Conceptualization, (2) **TTA** Customization, and (3) **TTA** Operationalization, as illustrated in FIGURE 6. As briefly introduced above, Aliedeh, M. A., in his three series of papers, accomplished the **TTA** conceptualization phase by constructing its conceptual framework (Aliedeh, M. A., 2015 a, b, and c). **TTA** is considered as a *thinking-based educational reform approach* that can be extended and expanded in all domains and fields. Therefore, **TTA** Conceptual framework need to be customized before being operationalized in all these diverse fields. ***TTA*** *customization phase* is mainly based on building the needed *thinking toolboxes* in a way that will make **TTA** easily operationalized. As stated above, one of the *main objective* of this paper is to accomplish the ***TTA*** *project Customization phase*.

FIGURE 5
VALUE-ENGRAINED THINKING-BASED TTA KNOWLEDGE PRODUCTION (TTA KNOWLEDGE PRODUCTION TREE)



TTA CUSTOMIZATION PHASE

As illustrated before, **TTA** area of *reform attack* is extending to include almost all change domains. Maneuvering between all these domains *necessitates* the *customization* of **TTA** thinking tools into an *organized toolboxes*. As illustrated in FIGURE 6 and FIGURE 7, three main types of **TTA** toolboxes are developed: (1) *Generic* **TTA** Toolbox, (2) *Knowledge* **TTA** Toolbox, and (3) *Work* **TTA** Toolbox. The Generic **TTA** Toolbox is *the most important one* because it enables the **TT** to maneuver between domains and it is also considered as the *base* for building the other two toolboxes (Knowledge and Work Toolboxes), as illustrated in FIGURE 7. **TTA** is not only a group of generic thinking tools, but it also includes knowledge generation tools and work skills development tools. In this paper, the detailed structure of the Generic **TTA** toolbox is presented with practical examples from different fields to illustrate its proper use. Generic **TTA** Toolbox is fully developed and presented, but *Knowledge and Work **TTA** Toolboxes* will be *gradually developed* as a part of **TTA** Operationalization Phase in which **TTA** keeps diffusing in different knowledge and work domains.

FIGURE 6
THE PRODUCTS OF TTA IMPLEMENTATION JOURNEY (FROM ROOTS TO FRUITS):
(1) THE MAIN TTA DEVELOPMENT PHASES AND
(2) DEVELOPED TTA TOOLBOXES

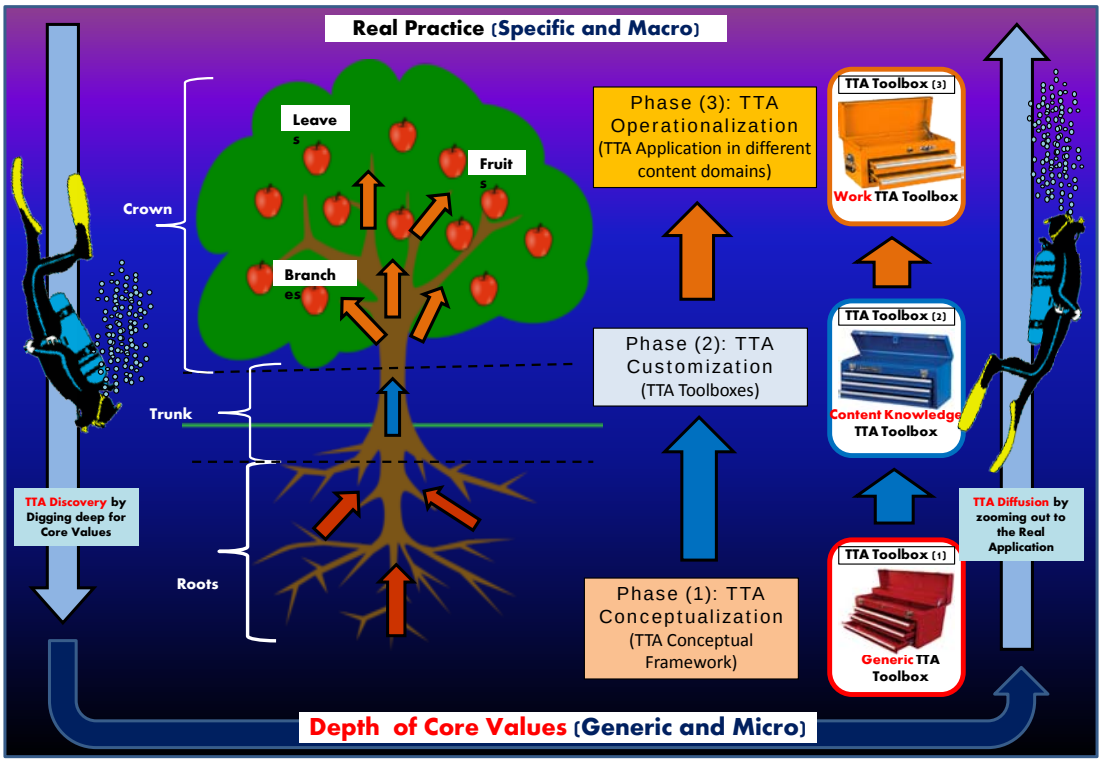
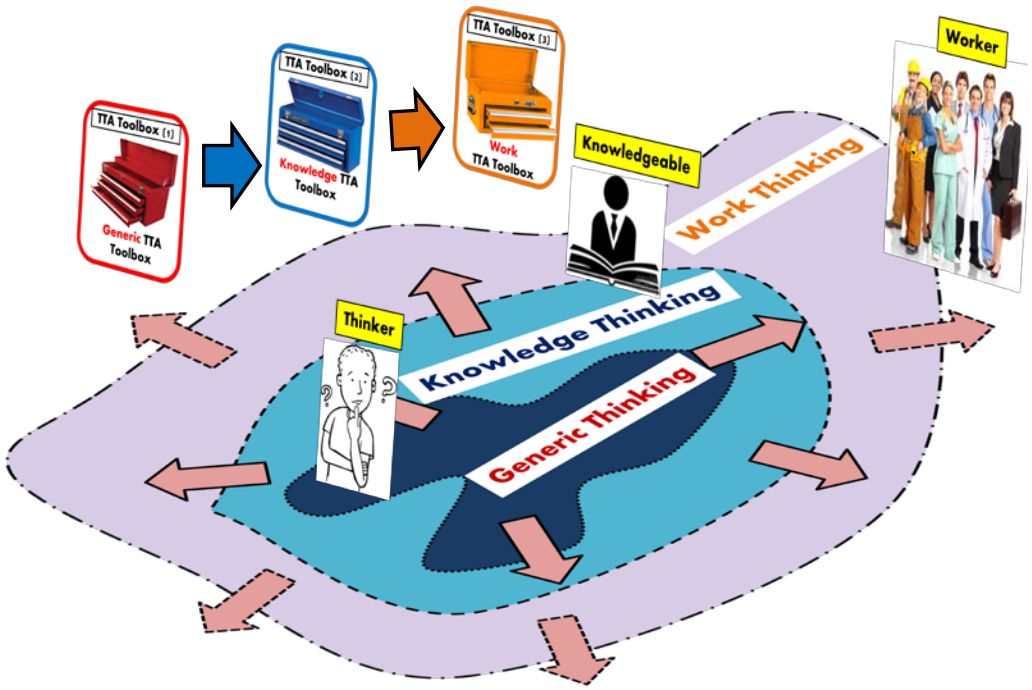


FIGURE 7
THE THREE MAIN TTA THINKING TOOLBOXES (DIFFUSION OF TTA)



GENERIC THINKING SKILLS

Accommodating Generic Thinking Skills in Reformed Curriculum

In the 1990s, the term *generic skills* (or sometimes called key, core, common, or transferable skills) was the *buzzword* in the research literature, political speeches and public commentary. This was part of an argument that as we approach the new millennium, employers are facing an *increasing global competitors* and normally are looking to employ graduates that are *confident communicators*, able to *work effectively in teams*, have *critical thinking* abilities, *problem solvers*, and able to *initiate and respond to change* (Babcock et al., 2010). Also, it is getting evident that groups of employers *value such skills more than content knowledge skills* (Babcock et al., 2010). Higher Education Academic programs responded to these employers' requirements by reforming their curriculum based on an *outcome-based approach* that groups learning outcomes into two broad categories: (1) Content Knowledge Outcomes, and (2) Generic and Transferable Skills Outcomes (Dodrige, M., 1999). K-12 Education moved in the same direction by considering generic skills as one of *three main pillars* of their Curriculum Framework topics that worth learning: (1) Key Learning Areas, (2) Generic Skills, and (3) Values and Attitudes (Curriculum Development Council, Hong Kong, 2000).

Generic skills are considered of a fundamental value in helping students to: (1) learn to acquire knowledge, (2) construct knowledge, and (3) apply knowledge to solve new problems. These generic skills are too broad and different programs classify them in different structures. Generic skills can be clustered in nine groups: (1) Collaborative Skills, (2) Communication Skills, (3) Creativity, (4) Critical Thinking Skills, (5) Information Technology Skills, (6) Numeracy Skills, (7) Problem Solving, (8) Self Management and (9) Study skills (Curriculum Development Council, Hong Kong, 2000).

Complexities of Teaching Generic Thinking Skills

Babcock et al., (2010) reported a number of complexities that face teaching students generic thinking skills which are: (1) generic skills have a numerous definitions, classification structures and stated significance based on the academic and governmental bodies that issued them, (2) the separation between *generic* and *domain specific skills* is *still under debate* while there is an *inclination towards fusing* the generic with the content knowledge skills in teaching and assessment, (3) Many Higher Education and K-12 Institutions believe in including of generic skills in their curriculum structure but the *balance and harmony* between them and the *content knowledge skills* still under investigation, (4) There are still a widespread claims that universities and schools are *not adequately preparing* their graduates for joining the workforce which indicated that *generic skills inclusion programs* need improvements, (5) Large number of universities incorporated generic skills in their curriculum framework, but the next important step is to include an authentic generic skills assessment with them (Babcock et al., 2010).

The teaching approaches of critical thinking (as an important group of generic skills) clusters in two main groups: (1) The generic critical thinking skills approach, (2) The specific disciplinary discourse approach (Moore, T. J., 2011). The *generic approach* is based on the presumption that a *common core* of any generic skill makes it applied to many fields (Ennis, 1987). The *specific approach* is based on translating the generic skill into *specific imprint* that is going to be used in a specific domain (McPeck, J. 1992). These two thinking skills approaches (generic and specific) suffer a number of problems. In generic approach, learners acquire the common features of the skill so they can maneuver between domains (*generic thinking pedagogy*), but at the same time the learners will lack the ability to translate these commons into a specific domain practices. On the contrary, the *specific thinking pedagogy* will help the learners to master the specific practices, but they will lack the ability to recognize the common features of the skill and consequently will not be able to maneuver between domains (Moore, T. J., 2011). Smith, G. F., reviewed thoroughly the thinking skill generality question to find that generic and domain specific teaching of thinking skills should be integrated to help the learners *move between domains by common tools* and also apply these tools to a specific domain thinking practices (Smith, G. F., 2002). The question that arises at this point is how can we overcome these serious complexities that confront the effective inclusion of generic thinking skills in curriculum frameworks and teaching these generic skills in different educational settings? An innovative solution for generic thinking skill teaching complexities is *embedded* in **TTA** Conceptual Framework and TTA Generic Toolboxes as will be explained in the next section.

GENERIC TTA TOOLBOX

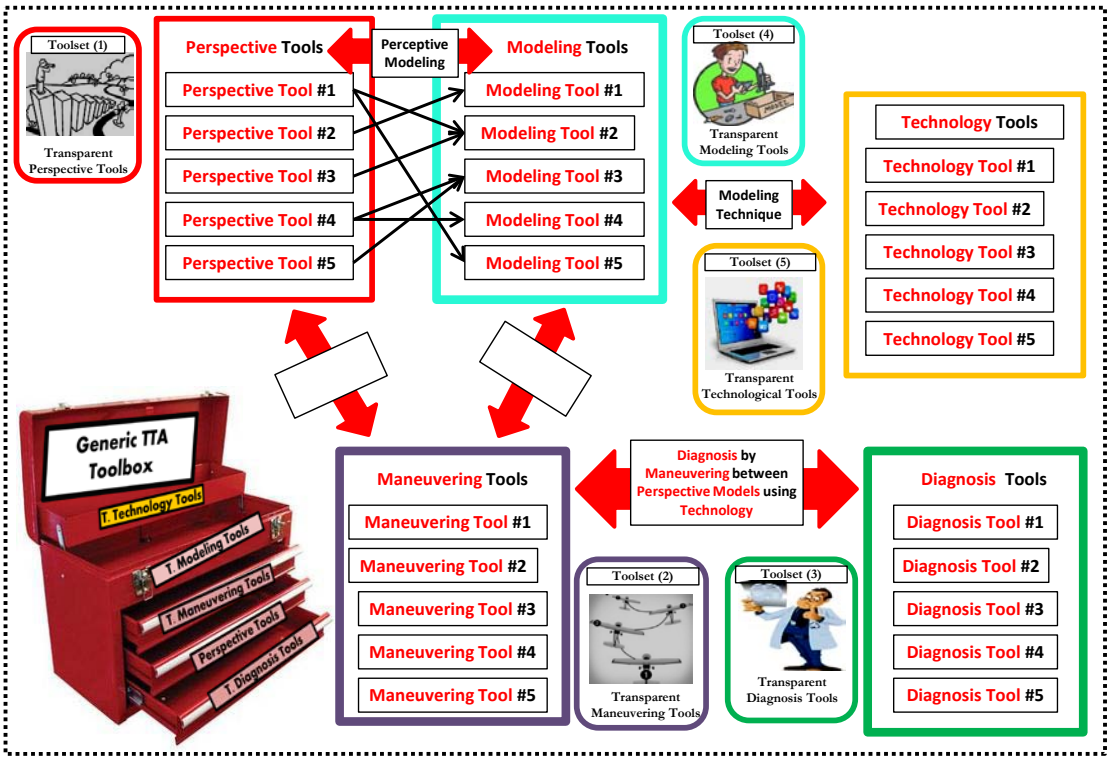
Conceptual Structure of Generic TTA Toolbox

The Generic Transparent Thinking (GTT) can be defined as

> "GTT is the *diagnostic* thinking abilities of the TT that result from *maneuverings* between *perspectives* which are represented by *models* using *technological* tools".

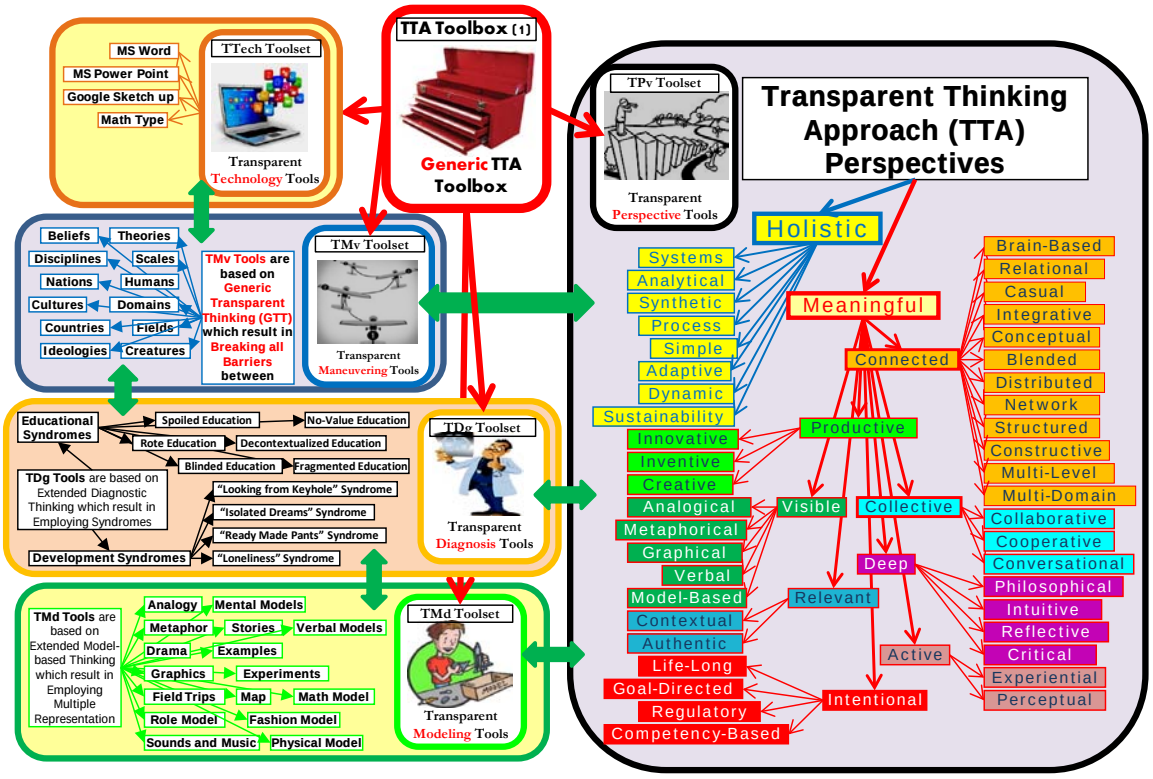
Based on this *very concise* definition, it is evident that the generic **TTA** Toolbox has five thinking toolsets: (1) *Transparent Perspectives* (TPv) Toolset, (2) *Transparent Modeling* (TMd) Toolset, (3) *Transparent Maneuvering* (TMv) Toolset, (4) *Transparent Diagnosis* (TDg) Toolset, and (5) *Transparent Technology* (TTechT) Toolset, as illustrated in FIGURE 8. These toolsets are *generic in nature* and can be easily implemented in all domains. The detailed lists of thinking tools in each toolset in the Generic **TTA** toolbox is shown in FIGURE 9.

FIGURE 8
THE GENERAL STRUCTURE OF THE GENERIC TTA TOOLBOX



The following is a *generic example* that is used to clarify the process of applying GTT using *Generic **TTA** Toolbox* in studying a *generic case.* Suppose that a **TT** is planning to apply GTT to study a certain case using the *Generic **TTA** Toolbox*. As illustrated in FIGURE 8, the *process* of GTT started by choosing an appropriate *Transparent Perspectives* (TPv) to view the studied case from this chosen *angle*. The chosen *Transparent Perspectives* (TPv) Tool will guide the **TT** to use an appropriate *Transparent Modeling* (TMd) Tool in order to formulate the *best model of understanding* of the studied case. The **TT** keeps *maneuvering* (changing thinking position) in thinking between different TPv tools and different TMd Tools till he/she feels satisfied that the produced models of understanding may lead to an appropriate *Transparent Diagnosis* (TDg) of the studied case. During this GTT process, *Transparent Technology* (TTech) Tools will be implemented to enhance the whole process. Throughout this paper, a number of domain-specific examples will be used to illustrate more clearly the process of implementing GTT by using different group of tools in *Generic **TTA** Toolbox.*

FIGURE 9
DETAILED THINKING TOOLS IN GENERIC TTA TOOLBOX



A GTT Performance on TTA Life Theater Stage

Our universe is a *huge life theater*, and all of us are *actors* or actresses in this *continuously running play*. *Thinking* using our *thinking machines* (Minds) is the *hidden main player* in controlling events in our life play scenes. Since the first existence of our human species on this earth, *Human Thinking* has continuously evolved till it got to its *current status* and will continue to evolve.

This paper is introducing GTT as the *heart* of **TTA**. A ***TTA*** *life theater* is analogically modeled to simplify and illustrate the application of GTT. ***TTA*** *life theater* is visualized to have a *modeling stage* to implement TMd tools, and also equipped with numerous *spotlights* that are used as TPv tools, as shown in FIGURE 10. Each *spotlight* will be able to *illuminate* any knowledge or work area from its particular perspective or position (*Meaningful*, *holistic*, *deep*, *intentional*, *relevant*, *visible*, *analogical*, *analytical*, …etc.). Each perspective (Spotlight) illumination will enable the **TT** to perform on the *modeling stage* by formulating the respective model of understanding using an appropriate TMd tool. The *modeling stage* will be a place where the **TT** can master the use of Transparent Diagnosis (TDg) tools to study a certain case by implementing *Transparent maneuvering* between multi-perspective tools and multi-modeling tools. Multi-perspectives are created by switching between spotlights and by dynamically moving the spotlight to *attack different knowledge domains*, as illustrated in FIGURE 10 and FIGURE 11. For each perspective, the **TT** will have a variety of modeling tools to choose from. These large number of choices will equip the **TT** with the transparent ability to diagnose (TDg Tools) by maneuvering (TMv Tools) between TPv Tools and TMd Tools. The Transparent Technology (TTech) Tools will be the *gadgets* that will enhance the smooth implementation of the whole GTT process. **TTA** Life Theater visualization is used as a way to create *an intuitive feeling* of how the process of implementing GTT works. Throughout this paper, a number of *domain-specific examples* will be used to *shed light on* the process of implementing GTT by using different sets of tools in *Generic* ***TTA*** *Toolbox.* This shows how *deep*,

simple, *crucial* and *important* is the ***TTA*** *Customization Phase* in preparing *appropriate*, *practical* and *useful* tools for ***TTA*** *Operationalization Phase* in different knowledge fields.

FIGURE 10
TTA LIFE THEATER

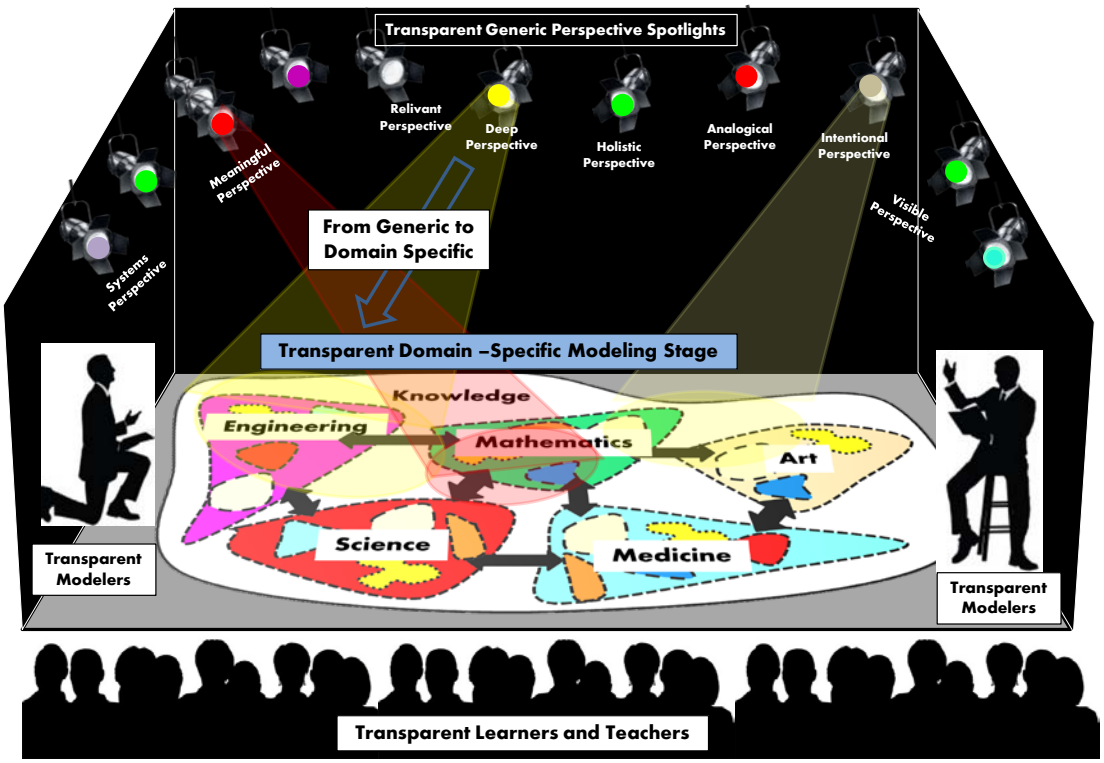
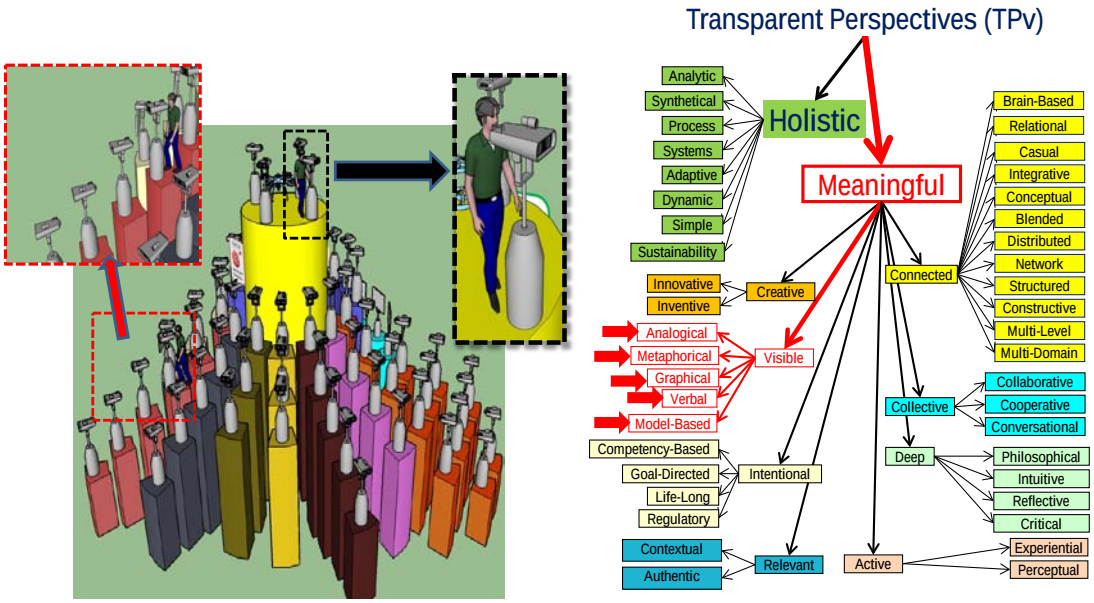


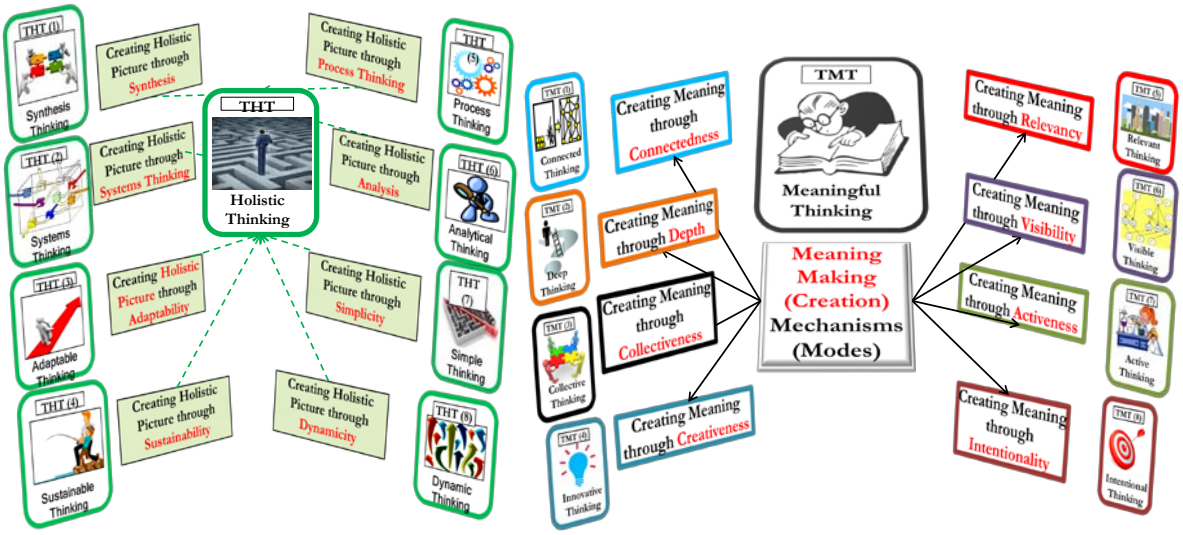
FIGURE 11
TRANSPARENT THINKING PERSPECTIVE TOOLS



Transparent Perspective (TPv) Tools

TPv Tools are a result of the *instrumental transparency core value extension* to encompass a conceptual structure of core values (see FIGURE 4) which is then extended into thinking domain in the form of thinking tools. *Meaningfulness* and *Holism* perspectives are the two main branches of *Transparent* Perspective Tools, as illustrated in FIGURE 11.

FIGURE 12
TRANSPARENT PERSPECTIVES: (1) TRANSPARENT HOLISTIC PERSPECTIVES: SEEING THE HOLISTIC PICTURE FROM EIGHT PERSPECTIVES, (2) TRANSPARENT MEANINGFUL PERSPECTIVES: CREATING MEANING THROUGH CONNECTEDNESS USING ANOTHER EIGHT PERSPECTIVES



Holism expands to eight more thinking perspectives: *analysis*, *synthesis*, *process*, *complexity*, *adaptiveness*, *dynamicity*, *simplicity*, and *sustainability*. Each of the eight perspectives aims to show the *holistic picture*, as shown in FIGURE 12. The concept of *holistic picture* is not the *big picture* only, but it is the ability of the **TT** to maneuver between a range of picture scales starting from big picture and getting to small scale ones by zooming in or zooming out in the opposite direction.

In a similar fashion, *Meaningfulness*, as a core value, expands to include eight more values: *connectedness*, *collectiveness*, *depth*, *activeness*, *relevance*, *intentionality*, *visibility*, and *creativity*, as illustrated by FIGURE 11. These Expanded Meaningful thinking perspectives aims to create a numerous variety of meanings, as illustrated in FIGURE 12. *Connectedness* is expanded more to include more perspectives: *brain-based*, *relational*, *causal*, *integrative*, *conceptual*, *blended*, *distributive*, *network*, *structured*, *constructive*, *multi-level*, and *multi-domain*. The *breeding of perspectives* and traits continues to move in all other branches. For example, *Analogical thinking perspective* is a part of the meaningfulness/visibility route of extension as highlighted in FIGURE 11.

The Collective Performance of TPv Tools

The numerous TPv Tools (spotlights in **TTA** Life Theater) that are implemented in GTT interact in more than one patterns on the ***TTA*** *Modeling Stage*. As illustrated in FIGURE 13, these patterns can be of three types: (1) Multiple perspectives projected on single domain-specific knowledge, (2) Single perspective projected multiple domain-specific knowledge, and (3) Single perspective projected on a single domain-specific knowledge. As listed in TABLE 1, an analysis for all the perspective patterns that

are implemented in this paper's figures is conducted to find that the mostly dominant patterns are of type (1) and (2).

Transparent Modeling (TMd) Tools

In **TTA**, *Modeling* is considered as a *representation process* of what the **TT** perceive from maneuvering between perspectives (See FIGURE 11). Maneuvering between perspectives crucially needs modeling tools to *record these shots of understanding* and construct them together in a form of *visible model*. **TTA** looks at modeling from the *widest perspective*. Transparent modeling gathers a wide spectrum of tools such as pictures, physical models, conceptual frameworks, drama, video, storytelling, journey, mathematics, verbal language, fashion model, role model ….. etc., as illustrated in FIGURE 14. All these are some in a long list of tools that **TT**'s uses to record their understanding.

FIGURE 13
PERSPECTIVES PROJECTION PATTERNS ON TTA LIFE THEATER

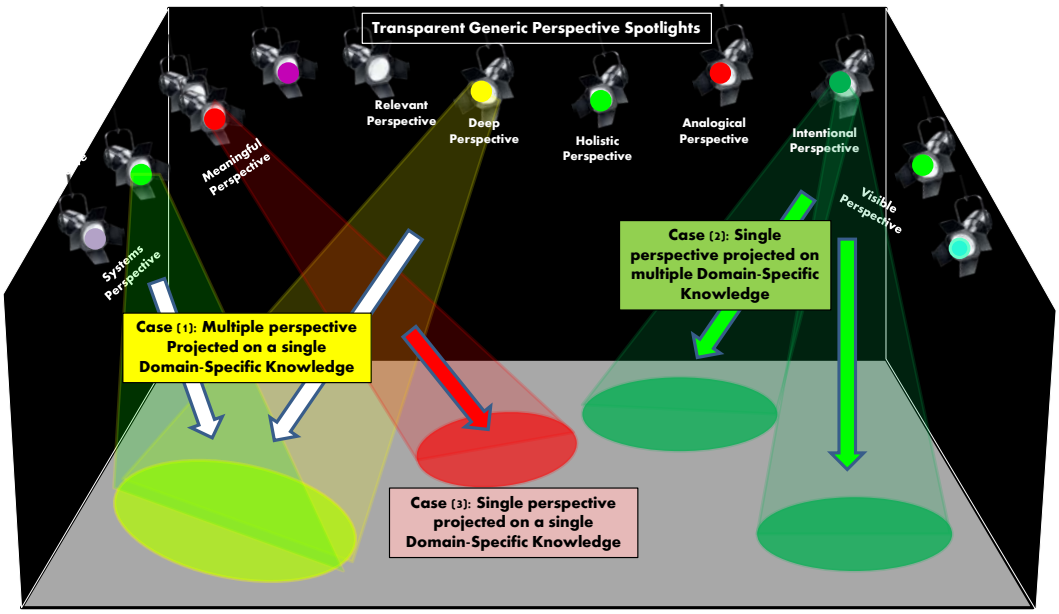


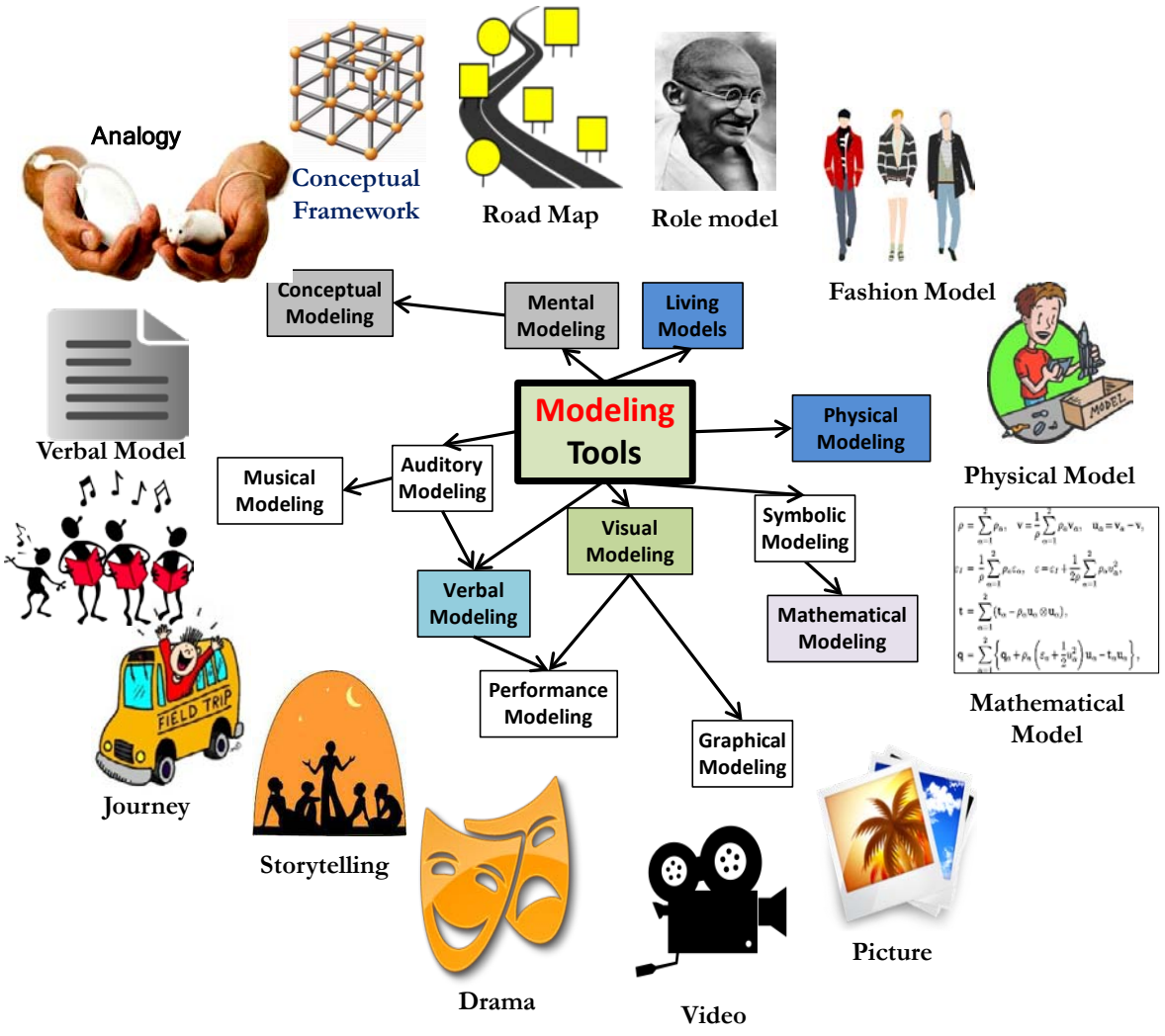
TABLE 1
THIS PAPER'S FIGURES ANALYSIS OF THE ADOPTED THINKING PERSPECTIVES

Figure No.	Meaningful Perspectives								Holistic Perspectives								Figure No.	Meaningful Perspectives								Holistic Perspectives							
	Deep	Connected	Collective	Intentional	Relevant	Productive	Active	Visible	Analysis	Synthesis	Systems	Dynamic	Process	Simple	Adaptable	Sustainable		Deep	Connected	Collective	Intentional	Relevant	Productive	Active	Visible	Analysis	Synthesis	Systems	Dynamic	Process	Simple	Adaptable	Sustainable
1	√	√		√				√	√	√			√	√			12	√	√		√		√		√	√	√				√		
2	√	√		√		√		√	√	√	√		√	√			13	√	√		√				√	√	√			√	√		
3	√	√		√		√		√	√	√	√		√	√			14	√	√		√				√	√	√				√		
4	√	√		√		√		√	√	√	√		√	√			15	√	√		√		√		√	√	√			√	√		
5	√	√		√		√		√	√	√	√		√	√			16	√	√		√		√		√	√	√			√	√		
6	√	√		√		√		√	√	√	√		√	√			17	√	√		√		√		√	√	√			√	√		
7	√	√		√		√		√	√	√	√		√	√			18	√	√		√		√		√	√	√				√		
8	√	√		√		√		√	√	√			√	√			19	√	√		√				√	√	√				√		
9	√	√		√	√	√		√	√	√	√			√			20	√	√		√				√	√	√			√	√		
10	√	√		√	√	√		√	√	√	√		√	√			21	√	√		√				√	√	√			√	√		
11	√	√		√	√	√		√	√	√			√	√			22	√	√		√				√	√	√				√		

Transparent Maneuvering (TMv) Tools

While reading the above sections you may be *surprised* why the author is showing the *big picture* by *zooming out* to see the *widest angle one* and then *zooming in* to see the small one. This act of *maneuvering between scales* is one of the *fruits* of implementing **TTA**. Maneuvering can be defined as the *skillful and careful movement*. It is commonly used to describe a jet fighter movement while trying to attack a target, or an army troops movement while attacking an enemy. To *intuitively* understand the maneuvering act, four different maneuvering examples are illustrated in FIGURE 15(a). The four examples are: *helicopter* maneuvers to *explore a terrain*, a *bee* maneuvers in the garden looking for *nectar*, an *eagle* maneuvers while looking for *prey*, or a *diver* maneuvers in the sea searching for a *shipwreck*.

FIGURE 14
TRANSPARENT MODELING TOOLS



TT is also able to maneuver between thinking tools till he/she gets to the proper diagnosis. **TT** implements multi perspective and multi modeling tools, as illustrated before in FIGURE 11 and FIGURE 14. Switching between perspectives and models entails **TT** to acquire the ability to *maneuver between perspectives and modeling tools*. Transparent Maneuvering (TMv) enables **TT** to *break all barriers* that hinder him/her from movement (*physically and hypothetically*). As a generic term, TMv describes the skillful action or movement in any terrain whether it is physical or hypothetical. In our current highly interrelated, connected and complex life, humans are required to skillfully act, change their positions and perspectives (*physically or abstractly*), and manipulate parameters to achieve their goals. The fast pace of change in our life, in this new millennium, entails us to *dynamically maneuver* between plans, actions, perspectives, and positions according to circumstances. TMv is devised as a toolset to help **TT** to use one or more of the following maneuvers; maneuvering between Holism and Reductionism to show the big and small pictures; maneuvering between analysis and synthesis to show connectedness; maneuvering between simplicity and complexity to achieve depth; maneuvering between scales to see the big and the small pictures; maneuvering between domains to show the road map; maneuvering between meanings to experience different perspectives; maneuvering between contextualization and decontextualization;

maneuvering between theories, paradigms, perspectives, and values, ….. etc., as illustrated in FIGURE 15(b) (Aliedeh, M. A., 2015b).

FIGURE 15
FOUR DIFFERENT MANEUVERING EXAMPLES AND TMV TOOLS

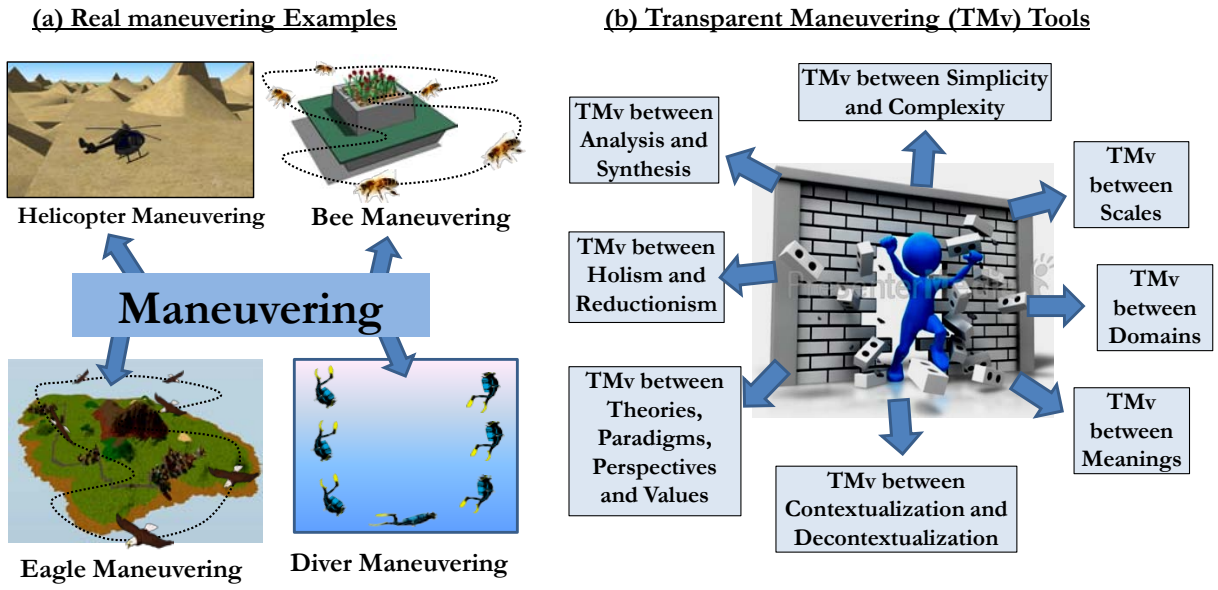


FIGURE 16
MANEUVERING BETWEEN GENERIC AND SPECIFIC

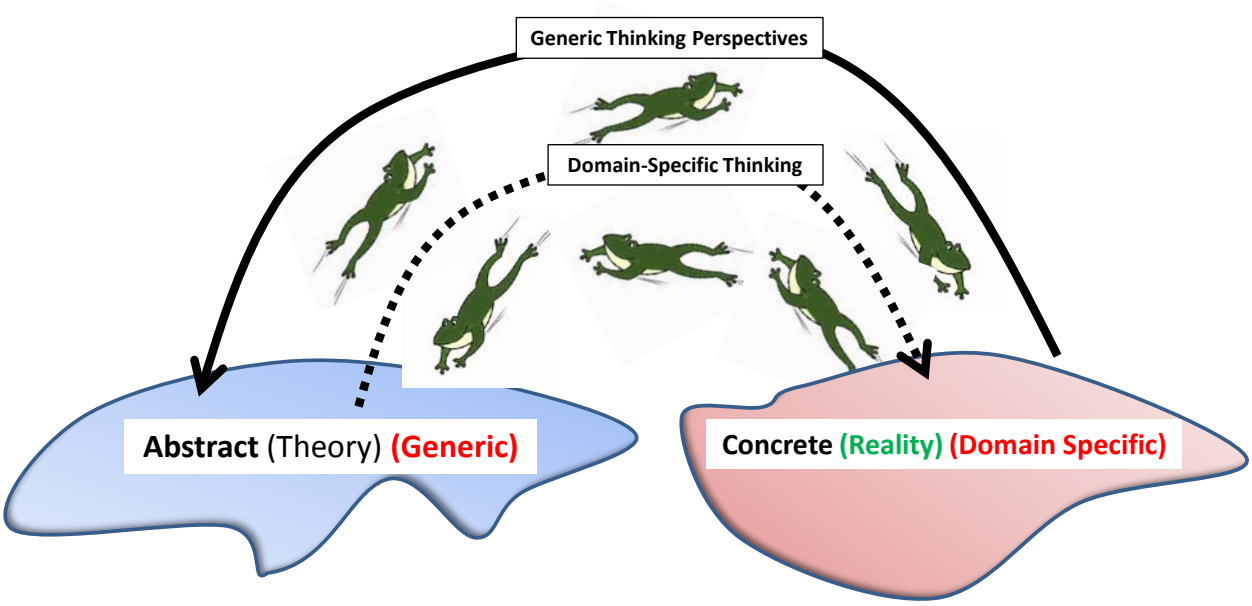
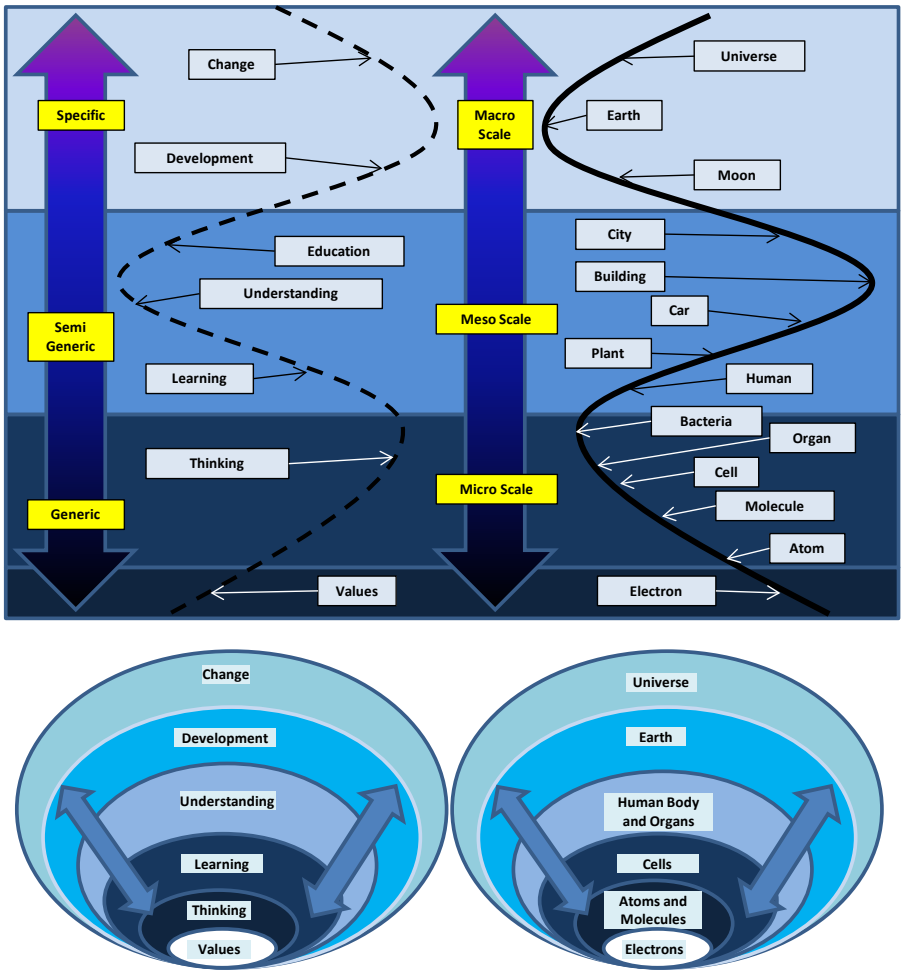


FIGURE 17
GENERIC THINKING AS MULTI-SCALE OR MULTI-DOMAIN THINKING



Generic thinking as a TTA Multi Scale and Multi Domain Maneuvering

TMv tools is the most important toolset that enable **TT** to choose between multiple perspectives and multiple modeling tools, as illustrated in FIGURE 8. Generic thinking is practically based on the ability of the thinker to maneuver between domains. TMv between the generic and the specific (or between theory and practice) result in either a generic thinking perspective or a specific-domain one, as illustrated in FIGURE 16. GTT is not including only the ability to see the big picture, but it is the ability to maneuver between the big and the small picture, as illustrated by FIGURE 17. GTT is the ability to maneuver between the generic and the specific, as illustrated in FIGURE 3 and confirmed in FIGURE 17.

How TTA Solved Generic Skills Teaching Complexities?

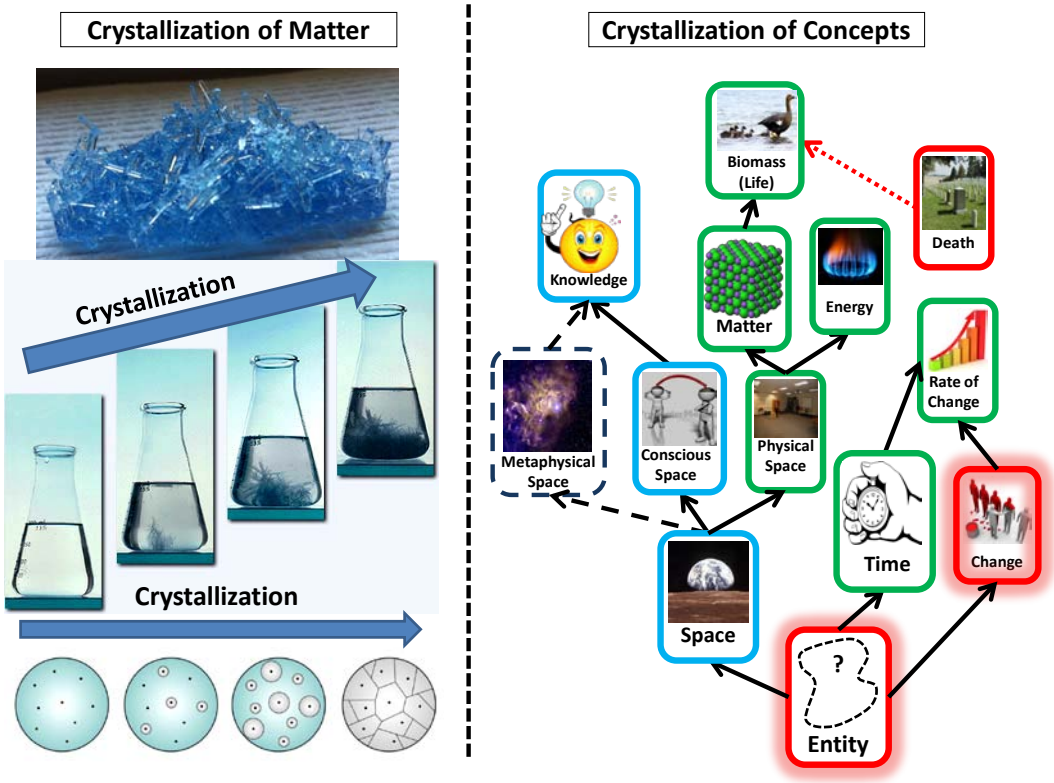
GTT created a *revolutionary change* in *connecting the generic with the specific*. This changes in the conceptual construct of generic thinking from the ability to apply a conceptual construct in more than one domain to a notion that describes the process of giving the thinker the ability to maneuver between scales, domains, theories, applications, perspectives, models, etc. This *extension* of generic thinking definition will be the *answer for most of the complexities* that Generic skills teaching approaches suffer. With this new definition, generic and specific are *mutually serving each other* (mutually synergetic). Generic conception is projected on reality to create domain-specific understanding, and domain-specific

understanding is re-projected again to the generic side to get more insights, as analogically illustrated by FIGURE 16 in the form of frogs leaping. Therefore, generic skills should have a *generic common core* to maneuver with while being able to be imprinted on a domain-specific knowledge. These two roles are *complementary and integrative*. **TT** diagnostic job starts in the generic domain, but never ends till he/she get a product in the specific domain. GTT breaks the boundaries between all entities.

Domain-Specific Examples

To illustrate clearly the use of GTT by implementing **TTA** Generic Toolbox a two specific examples are used. These two specific examples are chosen based on the analysis of this paper's figures implemented perspectives and listed in TABLE 1. *Meaningful/Connected Thinking* and *Meaningful/ Visible/Analogical* Perspectives are found to be among the most frequently used TPv's. To clarify the practical use of *Meaningful/Connected Thinking* and *Meaningful/Visible/Analogical* Perspectives, the following sections will cover a more *domain-specific examples*.

FIGURE 18
THE SEED CRYSTAL OF UNIVERSE CORE ENTITIES



MEANINGFUL/CONNECTED THINKING PERSPECTIVES AND MODELS

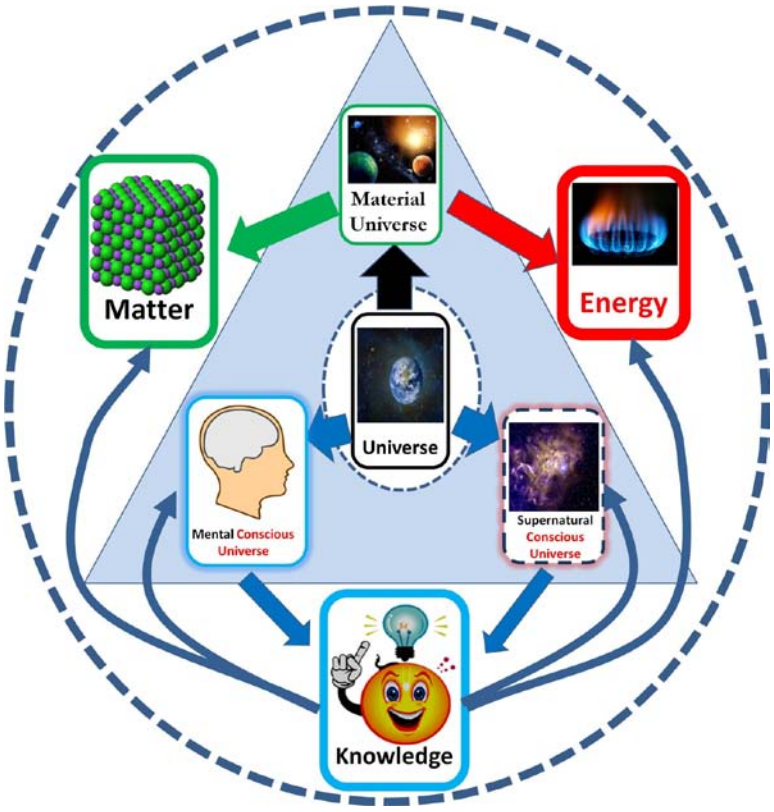
Transparizing the Crystallization of Universe Core Entities

Faclav Havel, the politician, artist and poet, offered a definition of education as

"Education is the ability to perceive the hidden connections between phenomena"
Vaclav Havel

When we explore our *surrounding universe*, we encounter many things, concepts and processes that vary in structure, behavior and nature, which are preferably called *entities* (a term borrowed from philosophy), as shown in FIGURE 18. To be able to structure a new concept, a *foundation structure* for these concepts should be built first. This foundation structure is needed as the place where the new level of concepts is to be built. By analogy, crystals grow similarly by starting from *seed crystals* and then grows to get bigger in size, as illustrated in FIGURE 18. *Entities* in this universe varied from a purely abstract to a completely materialistic, from a fictitious to a realistic, from a conscious to an unconscious. While *maneuvering in this universe*, three basic entities are encountered which are *space*, *time* and *change*. *Space* can be either *physical or Conscious*, and conscious space can be either mental or metaphysical. The main product of consciousness is knowledge. The basic entities that a physical space contains are matter and energy. Matter can be either a living (Biomass) or nonliving entities. As there are living entities, there are also a nonliving (dead) entities, as shown in FIGURE 18. Based on the built *core structure*, universe can be analyzed into a basic entities such as space, time, change, matter, energy, life and knowledge. Change is a very important entity that humans deal with in life. This foundation entity structure is crystallized to help in *further building more conceptual structures* of our understanding of the surrounding universe.

FIGURE 19
THE CONDENSED REPRESENTATION OF UNIVERSE CORE ENTITIES



Based on core entities structure shown in FIGURE 18, It is appropriate to focus more on universe core entities to get a *more condensed representation*, as shown in FIGURE 19. This condensation of core entities stressed that the universe is made of three basic spaces: mental, metaphysical and physical, and that the three basic products of these three basic spaces are *matter*, *energy* and *knowledge*. The interaction between these three spaces is creating the *essence of life* and the interaction between these three products

are creating the essence of our production in our universe. Knowledge is the most important product that *conscious spaces* (Mental and Metaphysical) acquire while *unconscious or material spaces* are producing matter and energy.

No Singularity of Perspectives or Models

The above *Universe Core Entities* Crystallization example is mainly based on Meaningfulness/ Connectedness (creating meaning by making connections) Perspective and conceptual graphical models, but we cannot ignore the fact that a number of other TPv's shared in creating the above shown meanings and models. Meaningfulness/Visibility/Analogy, Meaningfulness/Deep/Philosophical, Meaningful/ Intentional/Goal-Directed, Meaningful/Creative, Holistic/Analysis, Holistic/Synthetic, Holistic/Simple are some of the TPv's that share in creating meanings and creating holistic pictures in the above *Universe Core Entities* Crystallization example. This proves that TPv's, TMv's, TMd's work collectively and in complete harmony.

MEANINGFUL/VISIBLE/ANALOGICAL THINKING PERSPECTIVES AND MODELS

Based on data listed in TABLE 1, It is found that Meaningful/Visible/Analogical Thinking Perspective is one of the most frequently used TPv's. Another domain-specific examples based on this Analogical Thinking Perspective is presented to clarify its practical implementation in real contexts.

Accommodation of Transparent Analogy

Analogical thinking tool is one of the most important TPv tools (see FIGURE 11). **TT** employs analogy as an important and effective thinking tool. *Analogical thinking tool* is part of *visible thinking perspective tools* and these visible thinking tools are part of a *meaningful thinking tools*, which are part of the widest umbrella of *transparent thinking tools*. This *hierarchy* of values shows that transparency leads to meaningfulness, and meaningfulness leads to visibility, then visibility leads to analogy (see FIGURE 11).

In Generic **TTA** toolbox, analogy is considered also as one of the modeling tools that **TT** uses (see FIGURE 14). The **TT** maneuvering ability will enable him/her to use all these resources *wisely and as the situation entails* (see FIGURE 15). **TT**s are unique in their ability to maneuver between a variety of different thinking perspective tools that are available in the *generic **TTA** toolbox*.

Analogy as an Important Cognitive Tool

Einstein and Infeld in their book "the evolution of physics" *described deeply* the important role of scientists' analogy between phenomena that seams distant and how these phenomena looks after being *deeply and analogically analyzed*.

> *"It has often happened in physics that an essential advance was achieved by carrying out a consistent analogy between apparently unrelated phenomena….The association of solved problems with those unsolved may throw new light on our difficulties by suggesting new ideas. It is easy to find a superficial analogy which really expresses nothing. But to discover some essential common features, hidden beneath a surface of external differences, to form, on this basis, a new successful theory, is important creative work." Einstein and Infeld*

This quotes indicates the important role that analogy plays in *transparizing* our understanding of the surrounding phenomena and ending in discovering useful connections. In other words, we "transparize" things or phenomena to understand them by trying to see clearly the *hidden connections* inside them. Analogy is one of the most important cognitive tools that helps in creating this *deep and meaningful learning*.

Implementing Analogy in Deep and Meaningful Learning

Analogy (and similarly metaphor and simile) is considered a cognitive device that create a relationship between things, processes, or concepts in *analog domain* with similar ones in a *target domain*. Learners are *intuitively drifted* to employ what they already fully understand in a certain analog domain to structure a similar *deep understanding* in another target domain. A *highway of transfer of knowledge* between the two domains is established which result in more *elaborated connections*, namely deeper understanding. The product of deeper understanding is a transferable knowledge between the two domains (Jonane, L., 2015).

Meaningful learning occurs when the learners create connections between newly studied material and what they already know. Analogy mapping between analog domain and target domain to create connections and insights is a form of *meaningful learning*. As the learner *dig deeper* in creating the connections between domains, a deeper meaning is created. Analogy created links promote conceptual understanding and create coherence between prior knowledge and newly structured one (Harrison, A. G., 2006).

Avoiding Being Drifted into Misunderstanding Zone

Analogy is connecting two entities that are *similar* in certain aspects, but they are also *different* in others. Learners and instructors have to be careful in using this cognitive devise in order not to be *drifted to the misunderstanding zone*. Glynn, 2008, wrote about this:

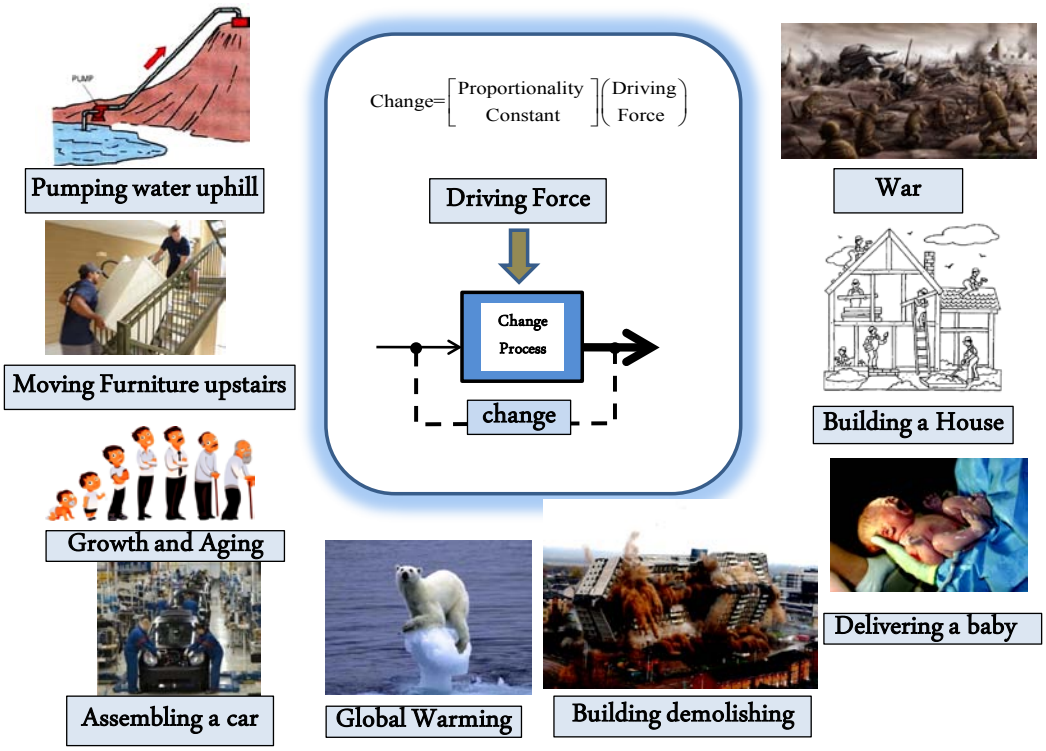
> *" analogies are double-edged swords: They can foster understanding, but they can also lead to misconceptions".*

In the same direction, Duit, Roth, Komorek, and Wilbers (2001) warned that we should be cautious in using analogy:

> *"A growing body of research shows that analogies may be powerful tools for guiding students from their pre-instructional conceptions towards science concepts. But it has also become apparent that analogies may deeply mislead students' learning processes. Conceptual change, to put it into other words, may be both supported and hampered by the same analogy"*

Learners and teachers should keep in their minds that analogy usually leads to meaningful and deep learning if it is *used carefully*. But, if analogy is *misused*, it may result in forming misconceptions.

FIGURE 20
THE GENERIC CONCEPT OF CHANGE



Transparizing Forms of Change by Analogical Maneuvering

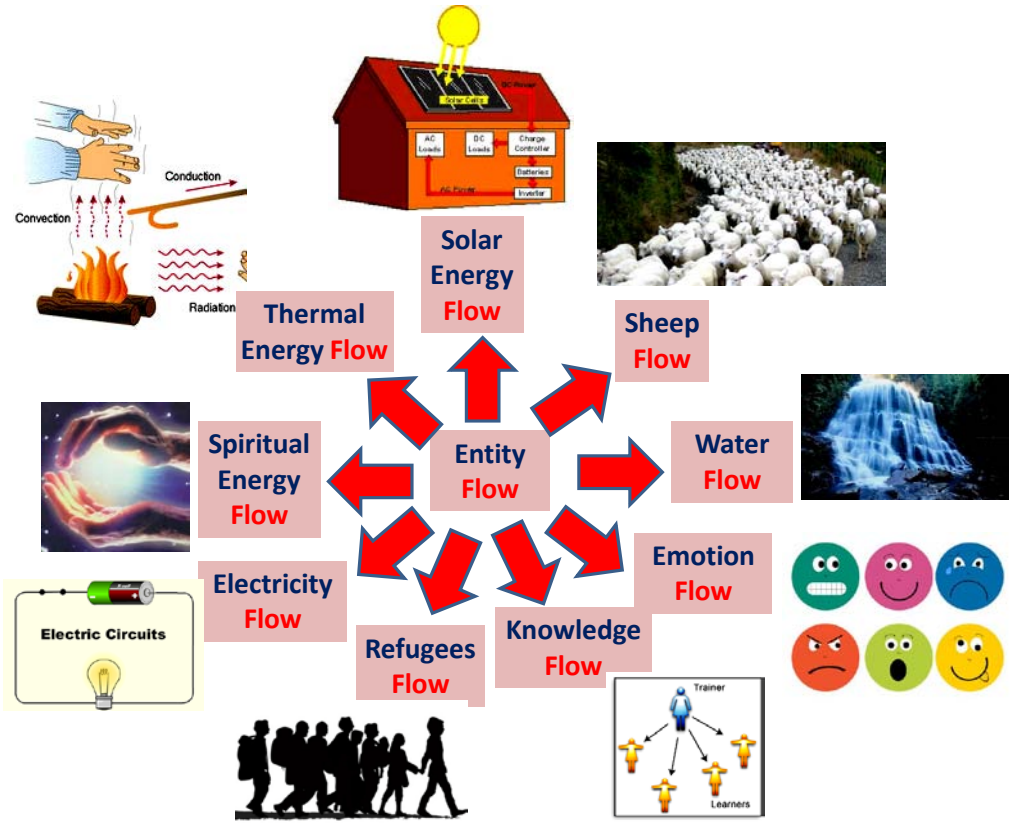
As mentioned before, *Change* is one of the most important entities in this universe. Humans can be called "Managers of change". In general, all the processes that the universe undergoes are inherently *change processes*. As illustrated in FIGURE 20, change can be in the form of pumping water uphill, moving furniture upstairs, growth, aging, global warming, wars and conflicts, building a house, ….etc. Change needs a *driving force* to make it happened. *Generic Change* can be modeled to be proportional to the driving force and governed by proportionality change constant, as shown in FIGURE 20. The analogical maneuvering between change forms in these different domains is crucial in stressing the importance of this phenomena in our life. It is evident that as there are similarities between these change forms, there are also differences. Drawing analogy between different forms of change will help the learner to intuitively grasp the *basic concept of change*. But, if learners need to elaborate in *revealing analogical structures*, they should be *cautious* because the nature of each form of change is unique.

Transparizing a Flow Concept Using Analogical Maneuvering

Flow is a form of movement of an entity. Flow is one of the important forms of change in position that an entity undergoes. As illustrated in FIGURE 21, flow occurs when an entity moves from a place to another. Flow is also called *transfer*, *transport*, and *diffusion*, which are forms of movement similar to flow. Analogically, solar radiation flows from the sun to the earth; thermal energy flows from the heater to your body; water flows in rivers, refugees flow from a place to the other seeking safety and food; electricity flows in wires to light up a lamp in a circuit; sheep herd flows in pastures. All these are forms of flow that are usually encountered in life. These different forms of flow in these different domains are similar in certain aspects, but they are totally different in others. Maneuvering between domains to collect analogous flow examples in different domains will create an *intuitive feeling* of the concept of flow.

Analogical maneuvering between domains will help in affecting a transfer of deep understanding from one domain to the other one. Analogical maneuvering is considered a very important form of *transparization*.

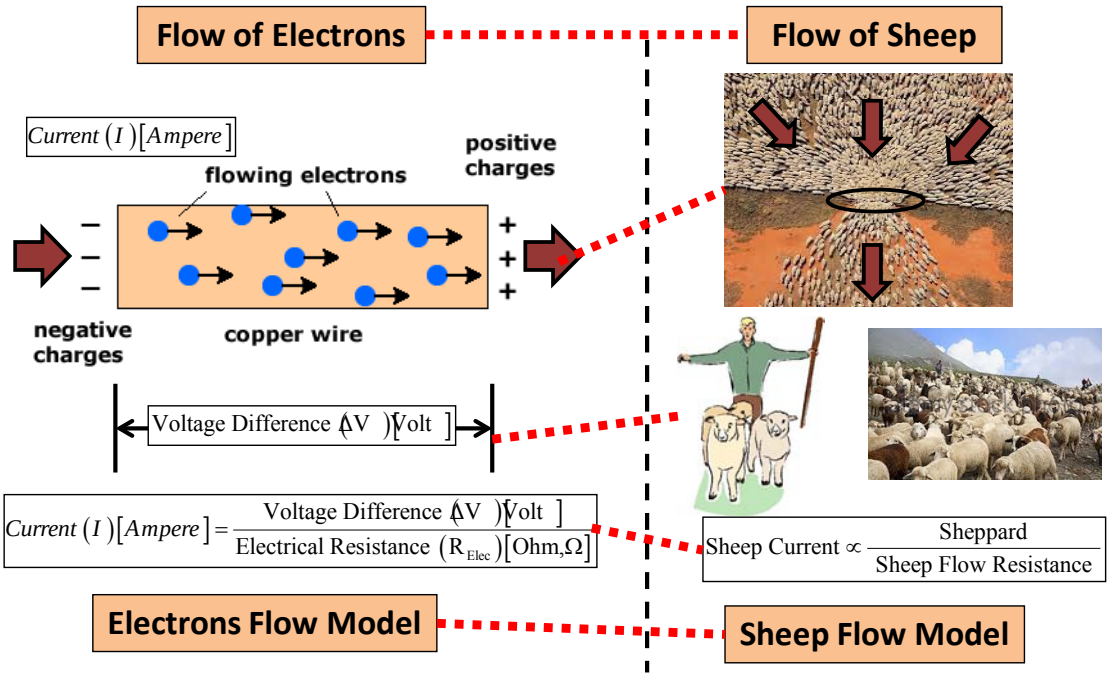
FIGURE 21
ANALOGICAL MANEUVERING OF FLOW CONCEPT



Cultural Analogical Modeling Using Animal-Electric Analogy

As discussed before, Analogy is considered as one of the most important cognitive devices that helps learners to transfer deep understanding from the analog domain to the target domain. Flow of sheep in herds is a familiar experience for most of the learners. Electrons are not seen entities so their flow is *not easily visualized and intuitively felt* by the learner. The sheep flow is employed to help learners form an *intuitive feeling* of flow of electrons as they already developed a *sheep flow intuitive feeling*, as illustrated by FIGURE 22. Sheep, pasture obstacles, and sheppard are corresponding to electrons, resistance and voltage. Pasture obstacles are similar to resistance in controlling the magnitude of flow, and Sheppard or dogs are considered as the driving force (Voltage) for the flow of electrons. As mentioned before, analogy device is a double-blade sword that should be used carefully in order not to be *slipped into the false analogy*. Electrons are similar to sheep in terms of flow, but the nature of these two entities are different. Therefore, It not safe to jump to conclusion that we should have a similar version of Ohm's Law that can be applied to sheep herd flow.

FIGURE 22
ANALOGICAL MANEUVERING BETWEEN FLOW OF ELECTRONS AND FLOW OF SHEEP



CONCLUSION: PAVING THE ROAD FOR TTA OPERATIONALIZATION PHASE

TTA is an *innovative* and *unique Thinking-Based Educational Reform Approach* that took *long time* and *daunting efforts* till the conceptualization phase is accomplished (Aliedeh, M. A., 2015a, b, c). Before being able to start the formal *Operationalization Phase*, **TTA** should be customized by constructing an appropriate *thinking toolboxes* that are needed for *the diffusion* of **TTA** in all domains. This paper *paved the road* for ***TTA*** *Diffusion* by adequately accomplishing the needed ***TTA*** *Customization phase*. Generic **TTA** Toolbox is presented with all its tools. **TTA** *Life theater* is constructed to show the harmonic way of maneuvering between different transparent perspective and modeling tools while seeking an optimum transparent diagnosis. I think that the **TTA** Theater Modeling stage is ready for starting the first formal *Operationalization Domain-specific experiment*.

REFERENCES

Aliedeh, M. A. (2015a). Call from the south for Transparent Higher Education (THE) Part 1: Transparent Thinking Approach (TTA) Core Conceptual Framework, Journal of Higher Education Theory and Practice, 15(5).

Aliedeh, M. A. (2015b). Call from the south for transparent higher education (THE) Part 2: Extended Transparent Thinking Approach (TTA) Conceptual Framework, Journal of Higher Education Theory and Practice, 15(6).

Aliedeh, M. A. (2015c). Call from the south for transparent higher education (THE) Part 3: Expanded Transparent Thinking Approach (TTA) Conceptual Framework and its Applications in Math, Science, and Engineering Education, Journal of Higher Education Theory and Practice, 15(7).

Badcock P. B. T., P. E. Pattison, and K., Harris (2010). Developing generic skills through university study: a study of arts, science and engineering in Australia, Higher Education, Volume 60, Number 4, Page 441.

Chung, C., (2005). Connecting Public Schools to Community Development, Communities & Banking, Winter 2005.
Costa, A. (Ed.). (1991). Developing Minds: A Resource Book for Teaching Thinking, Association for Supervision and Curriculum Development, Alexandria, Virginia
Curriculum Development Council. (2000) Learning to Learn: Key Learning Area, Technology Education, Consultation Document. Hong Kong: The Council, 2000.
Dodrige, M., (1999). Generic skill requirements for engineers in the 21st century, 29th ASEE/IEEE Frontiers in Education Conference, November 10 - 13, 1999 San Juan, Puerto Rico.
Duit, R., Roth, W.-M., Komorek M., & Wilbers J. (2001). Fostering conceptual change by analogies – between Scylla and Carybdis. Learning and Instruction, 11(4), 283-303.
Ennis, R. (1987). A taxonomy of critical thinking abilities and dispositions', in J. Baron and R. Sternberg, eds, Teaching Thinking Skills (New York: W.H. Freeman), 9–26.
Glynn, S. M. (2007). Methods and strategies: Teaching with analogies. Science and Children,44(8), 52-55.
Glynn, S. M. (2008). Making science concepts meaningful to students: Teaching with analogies. In S. Mikelskis-Seifert, U. Ringelband, & M. Brückmann (Eds.), Four decades of research in science education: From curriculum development to quality improvement (pp. 113- 125). Münster: Waxmann.
Haile, J. M., Balancing Text and Graphics, http://www.macatea.com/atc/articles/text_figs.php. 29 July 2016.
Harpaz, Y., (2014). Teaching and Learning in a Community of Thinking: The Third Model, Springer Netherlands.
Harrison, A. G., Treagust, D. F. (2006), Teaching and learning with analogies. In Aubusson et al. (Eds.). Metaphor and Analogy in Science Education (pp. 11–24). 11 Springer.
Jonāne, Lolita. (2015). Analogies in science education. Pedagogy Studies / Pedagogika. 2015, Vol. 119 Issue 3, p116-125.
Lipman, M. (2003). Thinking in education . 2nd edition, Cambridge, MA: Cambridge University Press.
Mandela, N. (1995). Long walk to freedom: The autobiography of Nelson Mandela. Boston: Back Bay Books.
Marzano, R., Brandt, R., Hughes, C., Jones, B., Presseisen, B., Rankin, S., & Suhor, C. (1988). Dimensions of thinking: A framework for curriculum and instruction . Alexandria: Association for Supervision and Curriculum Development.
McPeck, J. (1992). Thoughts on subject specificity, in S. P. Norris, ed., The Generalizability of Critical Thinking: Multiple Perspectives on an Educational Ideal (New York: Teachers College Press), 198–205.
Mitroff, I. I. and Linstone, H. A. (1993). The Unbounded Mind, Oxford University Press, New York.
Moore, T. J., (2011). Critical Thinking and Language: The Challenge of Generic Skills and Disciplinary Discourse, London: Bloomsbury.
Powers, C., (2015) Chapter 10: Higher Education: The Engine of Development, in Powers, C., (2015) The Power of Education: Education for All, Development, Globalisation and UNESCO, Springer Singapore.
Smith, G. F., (2002). "Thinking skills: The question of generality", *Journal of Curriculum Studies,* Vol. 34, Iss. 6.
Sternberg, R., & Spear-Swerling, L. (1996). Teaching for thinking . Washington, DC: American Psychological Association.