



## HIGHER COGNITIVE OBJECTIVES AND ABILITIES REQUIRED FOR HIGHER ORDER THINKING SKILLS: A SYNTHESIS

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### *Abstract*

*The taxonomy developed by Bloom, et al. (1956) is analysis of cognitive tasks but is oriented more towards educational objectives than towards psychological research .Guilford's model (1959), on the other hand, is based on performance data indicating how various intellectual abilities, function in a given task/test. Author thought the blending of Bloom's model and SOI model of Guilford would provide a new synthetic model that would cover all contemporary terms/concepts used for higher order thinking skills and also would provide guiding directions to design a training programme for higher order thinking skills.*

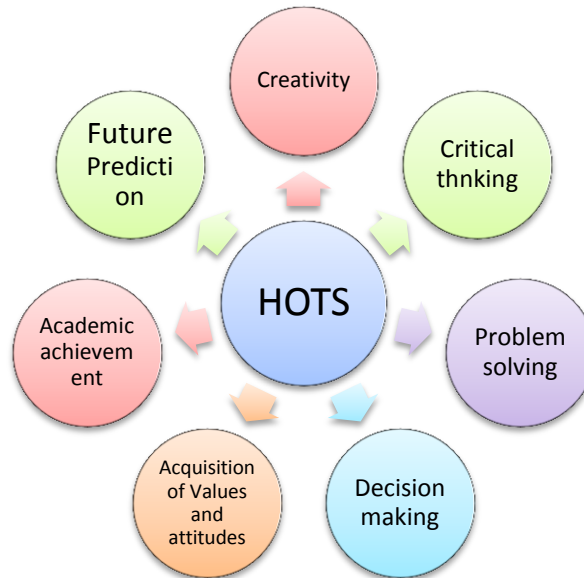
**Keywords:** higher order thinking skills, Intellectual abilities, synthetic model

### **Introduction:**

All visionary educationists are seriously thinking about thinking skills required for 21st century. A vigorous churning on thinking skills is going on, in developed as well as developing countries. The locus of educational research is “problem solving skills” and the thinking skills required for problem solving are mainly **higher order thinking skills**. In the twentieth century, the ability to engage in careful, reflective thought has been viewed in various ways: as a fundamental characteristic of an educated person, as a requirement for responsive and responsible citizenship in a democratic society, and, more recently, as an employability skill for an increasingly wide range of jobs.

According to Beyer (1991)<sup>8</sup> thinking skills are the discrete, precisely delineated mental operations used in varying combinations as we think.' De Bono (1991) describes these skills as tools of effective thinking. Each type of thinking includes a number of thinking skills or sub skills. Kagan (2003) divides thinking skills into three types: understanding information,manipulating information, and generating information. In each of the three categories are specific skills. For example, “summarize” is related to understanding information; problem solving is related to manipulating information; and questioning is related to generating information. In contrast to the above list of skills Lipman (1983) thinks

that 'Thinking skills is a catch-all phrase' because the list of skills has no end due to the abundant nature of the intellectual powers of mankind. Psychologists also promote the interest in developing students' thinking.



**Fig.1.1 Higher order thinking skills required for various tasks**

**Objectives:** To design a training programme conceptual framework based on blending of Bloom's taxonomy of learning objectives and SOI model of multiple intelligence of Guilford that would provide a new synthetic model, that would cover all contemporary term/concepts used for higher order thinking skills and also would provide guiding directions to design a training programme for nurturance of higher order thinking skills.

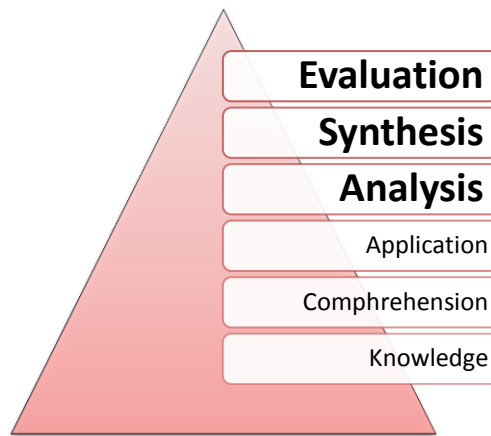
**Methodology:** Method of comparative study of literature review on Bloom's taxonomy of learning objectives and SOI model of multiple intelligence of Guilford was used to design a conceptual framework on training of higher order thinking skills.

Higher Order Thinking Skills include skills such as creative and critical thinking, analysis, problem solving and decision making. The term first became popular with the publication of Bloom's Taxonomy of Educational Objectives (1956)<sup>3</sup> which set out an educational reform that included Higher Order Thinking Skills. Today such skills are also commonly referred to as Advanced Thinking Skills. The concept of higher order thinking skills (HOTS) became a major educational agenda recently.

Popular educational instructional model was developed by the prominent educator Benjamin Bloom. It categorizes thinking skills from the concrete to the abstract—knowledge,

comprehension, application, analysis, synthesis, evaluation. The **last three are** considered HIGHER-ORDER skills.

Bloom's taxonomy is a kit of tools that can help educators broaden the depth of their students' learning. The use of Bloom's Taxonomy (Bloom, Engelhart, Fürst, Hiss, & Krathwohl, 1956)<sup>3</sup> has been shown to enhance student mastery of skills and concepts and critical thinking (Bissell & Lemons, 2006).



**Fig 1.2 Bloom's Model of learning objectives (cognitive domain)**

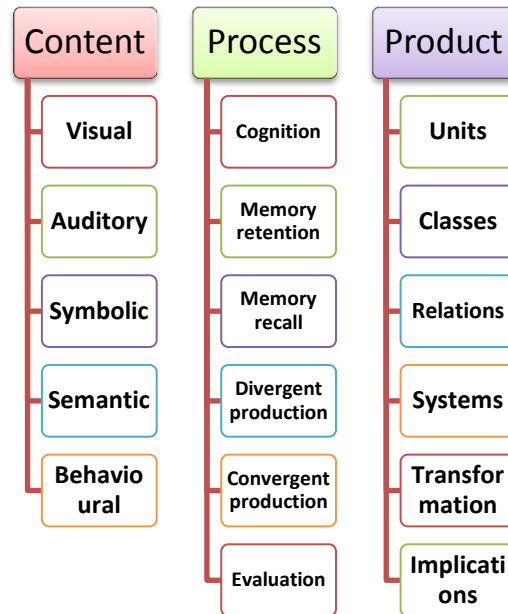
Benjamin S. Bloom, then Associate Director of the Board of Examinations of The University of Chicago, initiated the idea, hoping that it would reduce the work load of preparing annual comprehensive examinations. This group met about twice a year beginning in 1949 to consider progress, make revisions, and plan the next steps. Their final draft was published in 1956 under the title, *Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain* (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). Bloom's Taxonomy provides an excellent structure for designing, assessing planning, and evaluating training and learning effectiveness. The model also serves as a sort of **checklist**, by which one can ensure that training is planned to deliver all the necessary development. His hierarchy has been a major aid to educators planning for and considering all levels of thinking and focusing on the inclusion of higher-order thinking in lessons, units of instruction, and even state-wide and national curricula. Its emphasis on cognitive objectives has helped educators create meaningful learning events and, consequently, worthwhile learning outcomes in students.

#### **Contribution of Guilford to higher order thinking skills:**

During World War II, Dr. J.P. Guilford was called on to help select future pilots for the Army's rigorous training. He identified specific cognitive abilities necessary for prospective pilots. Currently the SOI is being used for gifted children, children with learning disorders,

and adults with learning problems as well as helping to identify career choices that fit one's cognitive profile. SOI is one of the best methods of enhancing learning abilities. It is the only remediation program that was developed based on a theory of intelligence (Guilford's Model). Structure of Intellect's philosophy is that intelligence is not "fixed," as has been generally supposed. Intellectual abilities can be taught.  $5 \times 6 \times 6 = 180$  Abilities Guilford's "Structure of Intellect" model organized these various abilities along three dimensions: content, product, and process. He sought to develop tests for each combination of the possibilities on these three dimensions, expecting that a person could be high on some of these abilities while being low on others. In *The nature of human intelligence* (1967)<sup>2</sup> and *Way beyond the IQ* (1977)<sup>1</sup>, he lays out the results of his efforts and the modified model which evolved from his research. Guilford (1983) suggested that although much of the work on increasing creativity had focused on the various divergent production skills there seems to be a strong argument in favour of focusing upon the various skills related to transformations, which would support the idea of focusing some attention upon shifts in insight. Three fundamental dimensions (Guilford, 1966) underlying the SOI model can be compared with Bloom's taxonomy.

Guilford's model is morphological (Gowan, Khatena, & Torrance, 1979); whereas, Bloom's is hierarchical. That is, Bloom assumes that learning progresses uniformly upward from level to level in sequential fashion, while Guilford holds that each intellectual ability is independent of others, and a person can display strengths in one intellectual area without necessarily displaying strengths in other related areas. Guilford assumes that there are many different types of intelligence; whereas, Bloom's taxonomy assumes intelligence is a unidimensional concept. Guilford believes that these intellectual capacities can be developed through alternative, definite strategies; while Bloom provides only general strategies. The taxonomy developed by Bloom, et al. (1956)<sup>2</sup> is analysis of cognitive tasks but is oriented more toward educational objectives than towards psychological research. Guilford's model (1959), on the other hand, is based on performance data indicating how various tasks /tests cluster. ***Author though the blending of Bloom's model and SOI model of Guilford would provide a new synthetic model that would provide guiding directions to design a training programme for higher order thinking skills.*** The higher order thinking skills stated by Bloom are: ***Analysis, synthesis and Evaluation.***



**Fig 1.3 System of Intelligence (SOI) model of J.P.Guilford.**

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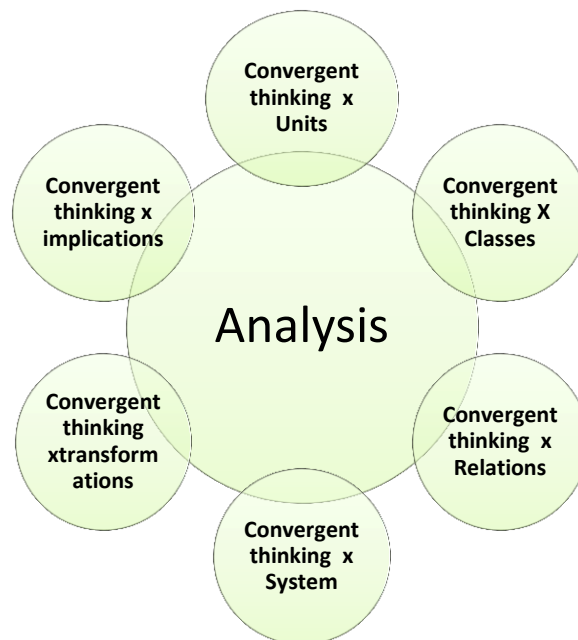
#### **Analysis and convergent thinking**

According to Bloom, 'Analysis' emphasizes the breakdown of the elements in to its constituent parts and detection of its relationships of the parts and the way they are organized .It may also be directed at the techniques and devices used to convey the meaning or to establish the conclusion of a communication (Bloom, page 145)<sup>2</sup>.He divided analysis in to three categories and author found a similarity with convergent thinking of products unit, relations, and system stated by J.P. Guilford (Guilford,1967)<sup>1</sup>.

1. Analysis of elements which is similar to convergent thinking of Units (SOI)
2. Analysis of relationships which is similar to convergent thinking of relations (SOI)
3. Analysis of organizational principles which is similar to convergent thinking of system (SOI).

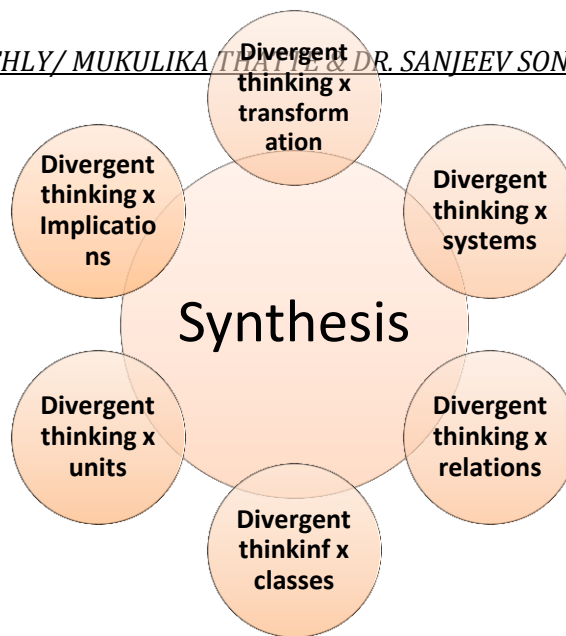
With convergent production, one uses analytical and logical thinking to arrive at one accepted response, Convergent thinking emphasizes speed, accuracy, and logic and focuses on recognizing the familiar, reapplying techniques, and accumulating stored information.

**Synthesis and divergent production:** Bloom defined synthesis as ‘the putting together of elements and parts so as to form a whole. This is a process of working with elements, parts etc. and combining them in such a way as to constitute a pattern or structure not clearly there before.’ Generally this would involve a combination of parts of previous experience with new material, reconstructed in to a new and more or less well integrated whole. This a category in the cognitive domain which most clearly provides for creative behaviour on the part of the learner .But Bloom limited this term to work within the limit set by particular problems, materials or some theoretical and methodological framework.



**Fig 1.4 describes the synthesis of Bloom’s model and J.P. Guilford’s SOI model which shows thinking abilities required for the objective ‘analysis’**

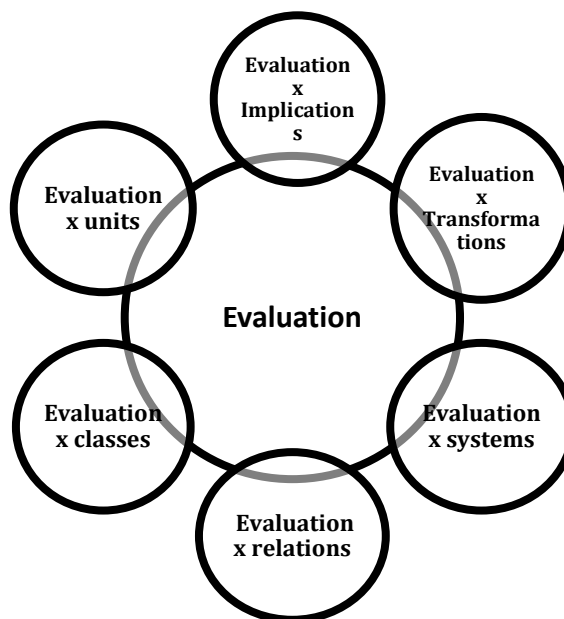
‘Divergent production’ is a thought process or method used to generate creative ideas by exploring many possible solutions. It is often used in conjunction with its cognitive opposite, convergent thinking, which follows a particular set of logical steps to arrive at one solution, which in some cases is a ‘correct’ solution. By contrast, divergent thinking typically occurs in a spontaneous, free-flowing manner, such that many ideas are generated in an emergent cognitive fashion. Amount of time, and unexpected connections many possible



**Fig 1.5 describes the synthesis of Bloom’s model and J.P. Guilford’s SOI model which shows thinking abilities required for the objective ‘synthesis’**

solutions are explored in a short are drawn. The greatest importance of divergent production abilities is in connection with creative thinking, where many alternative ideas need to be brought to light with ease. Since creative thinking is an important aspect of problem solving, these abilities are also important in that connection, factors measured by IQ.

**Evaluation (Bloom, 1956), Evaluation (J.P. Guilford, 1959) and Decision making**



**Fig 1.6 describes the synthesis of Bloom’s model and J.P. Guilford’s SOI model which shows thinking abilities required for the objective ‘Evaluation’**

It comprises developments of opinions, judgments, or decisions, make choices based on reasoned argument, verify value of evidence, recognize subjectivity & assess value of



theories. Both Bloom and Guilford tried to confine the 'evaluation' process of thinking within the cognitive domain.

### ***A synthesis***

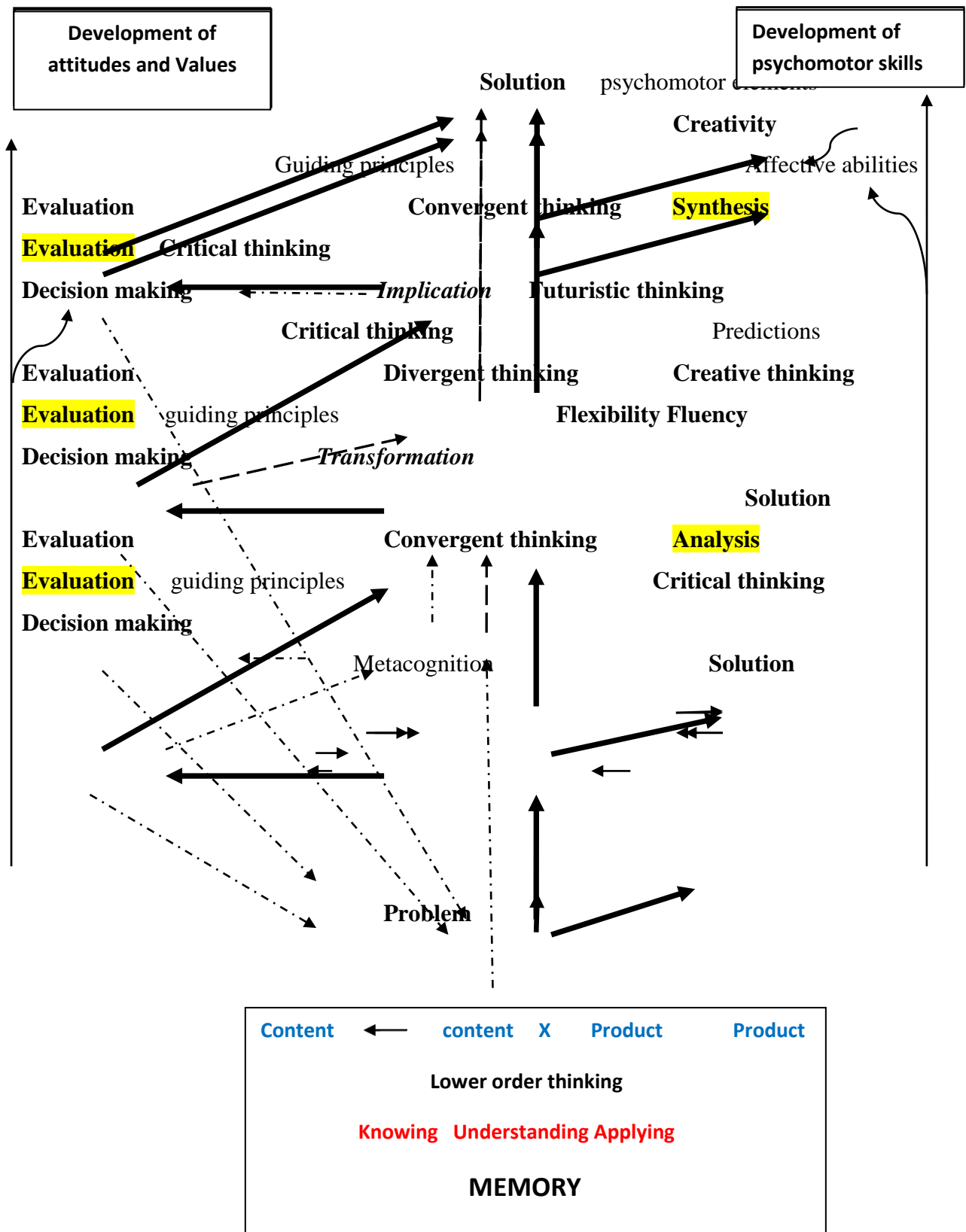
But some of the abilities required for evaluation are related to affective domain in their true sense. The 'realization' of criteria or evaluation principles is stored in the memory as belief or guiding principles which are classified under affective domain as values and attitudes. While describing evaluation operation Guilford accepted the limitations of its true meaning in cognitive system. He asserted "Because criteria for evaluation are logical in nature, the intellectual abilities probably do not apply to ethical and aesthetic judgment."<sup>2</sup> In case of aesthetic judgment the selection of unit or any object purely on logical process is not possible. One's aesthetic sense or affinity towards an object or thing, make more or less impact on the process of criterion setting (realization). Just to maintain purity of each domain or discipline we cannot deny interdomain connections. The *Limbic system*, composed of several small interconnected structures, *is our brain's principal regulator of emotion and plays important roles in processing memory*. This may explain why emotion is an important ingredient in many memories. The limbic system is powerful enough to override both rational thought and innate brain stem response patterns. In short, we tend to follow our feelings<sup>5</sup>. Affect and cognition have long been treated as independent entities, but in the current review it is suggested that affect and cognition are in fact highly interdependent.<sup>12</sup> Benjamin Bloom stated the meaning of 'evaluation' as cognitive objective as "Judgment about the value of material and methods for given purposes qualitative and qualitative judgments about the extent to which material and methods satisfy criteria .Use of a standard appraisal. The criteria may be those determined by the student or those which are given to him"<sup>3</sup> Further he classified two categories of evaluation as internal evidence and external criteria. In spite of so many controversies Bloom's educational taxonomy has been a practical solution for evaluation and instruction systems of education. The higher objectives such as analysis, synthesis and evaluation become too complex and vague at its higher end. Each objective does not remain as a single component that requires clusters of cognitive and few affective abilities to function as to achieve the goal.

**Mechanism of higher order thinking :** "Underlying everything is the memory store, memories in various contents such as visual, auditory, semantic, symbolic, and behavioural. And the contents in the various forms (products) like unit, classes, relations, and systems. The process of thinking begins with a stimulus, like a problem as an input .Arrows shown is processing of memory to perform a specific operation. Events in thinking begin with an input



from environment in the body which takes care of feelings, emotions metacognition attitudes interest etc. The first step includes two important events, awareness that a problem exists and comprehension of the nature of the problem. Higher order thinking occurs when a person takes new information and information stored in memory and interrelates and/or rearranges and extends this information stored to achieve a purpose or find possible answers in perplexing situations \*(Arthur Lewis., David Smith page.136,Theory in to practice ,Volume 32,summer 1993).further he clarified that these would include :deciding what to believe ; deciding what to do; creating a new idea, a new object, or an artistic expression; making a prediction; and solving a non routine problem. According to Guilford (1967), divergent and convergent thinking are two types of human response to a set problem. Guilford defined divergent or “synthetic thinking” as the ability to draw on ideas from across disciplines and fields of inquiry to reach a deeper understanding of the world and one's place in it. He, thus, associated divergent thinking with creativity, appointing it with several characteristics. Diagnosing the problem leads further steps of cognition .this step is very important in higher order thinking required to solve a complex problem. At first a step of convergent production is done to select a solution from previous experiences. Then the solution is evaluated whether this appropriate or not. If the solution is not suitable as per evaluation, then the further step divergent thinking is followed. In this operation many solutions are generated even by transforming content and product of the thinking. In the case of divergent production some retrieve items escape evaluation by bypassing that operation. This kind of retrieval occurs with what is known as ‘suspended judgment’ which Alex Osborn recommended as a very important tactic in creative thinking, even called as brain storming (Guilford, page 164).Further Guilford says “ Applying evaluation while engaged in divergent production can put a damper on retrieval of information from storage. Possibly very good ideas thus are nipped in the bud. In his 1950 Presidential Address to the American Psychological Association (Guilford, 1987), he pointed out the very important nature of creativity as a research topic and the scarcity of published research related to creativity. He felt that people were assuming that creativity was a natural result of intelligence as measured by IQ, and as a result had not begun to look at creativity. Guilford gave his perspective on the field and announced his intention to use a factor analytical technique to begin isolating the various factors of thinking, to separate out creativity and other problem solving skills

**Synthetic Model of Higher order thinking**



## **A synthetic model synthesis of Higher Order Thinking From Bloom's Taxonomy, Guilford's SIPS model and contemporary terms**

Most of all problem solving models show similar kind of problem solving episodes. The first event is awareness that a problem exists (cognition) i.e. cognition of relations and systems the problem is structured or understood , with specified needs for certain kinds of items of information in order to begin solving it . The contemporary term for this thinking process is called as Critical thinking Beyer defined this term as 'The process of determining the authenticity, accuracy and worth of information or knowledge claims (Beyer 1985, p. 276).

Norris (1985) agrees, stating that: Having a critical spirit is as important as thinking critically. The critical spirit requires one to think critically about all aspects of life, to think critically about one's own thinking, and to act on the basis of what one has considered when using critical thinking. Both the conception of the problem and suggested solutions are judged to be good or bad evaluation. Then the flow of information is possibly put in to storage for later use, immediately or delayed (memory).

Creative thinking skills are novel ways of seeing or doing things that is characterized by four components— FLUENCY (generating many ideas), FLEXIBILITY (shifting perspective easily), ORIGINALITY (conceiving of something new), and ELABORATION (building on other ideas). While writing about Bloom's taxonomy Guilford (Page 67)<sup>2</sup> reflected that the productive thinking operations have the most obvious place in the taxonomy's major category called synthesis. The six major category of evaluation comes nearest to a one to one parallel with SI operations.

Decision-making is the thinking of identifying and choosing alternatives based on the values and preferences of the decision maker. Decision-making is one of the central activities of management and is a huge part of any process of implementation.(WIKI) Decision making is the study of identifying and choosing alternatives based on the values and preferences of the decision maker. Making a decision implies that there are alternative choices to be considered, and in such a case we want not only to identify as many of these alternatives as possible but to choose the one that best fits with our goals, objectives, desires, values, and so on(Harris (1980).George Loewenstein and Jennifer S Lerner ( Handbook of Affective sciences page 619 Oxford university Press ) explained how the elements of affect enter in to the process of decision making .The first influence—of *expected emotions*-consists of predictions about the emotional consequences of decision out comes and the second type, immediate emotions can influence decisions indirectly by altering the decision

maker's perception of probabilities or outcomes or by altering the quality and quantity of processing of decision relevant cues.

After the process of divergent thinking has been completed, ideas and information are organized and structured using convergent thinking. The impact of positive and negative affect on cognitive processes has been shown in several studies. For example, positive affect enhances cognition of associative (Bar, 2009), and semantic priming (Haänze & Hesse, 1993), and negative affect narrows the focus of attention, increasing analytical processing, causal reasoning, and reliance on systematic processing (Pham, 2007). There is general agreement that tasks of creative thinking are mood sensitive, and among the many variables that have been shown to predict creativity, mood stands out as one of the most widely studied and least doubtful predictors (e.g., George & Brief, 1996; Isen & Baron, 1991; Mumford, 2003). For example, Ashby et al. (1999)<sup>6</sup> noted that:

*“It is now well recognized that positive affect leads to greater cognitive flexibility and facilitates creative problem solving across a broad range of settings. These effects have been noted not only with college samples but also in organizational settings, in consumer contexts, in negotiation situation....and in organizational on coping and stress (p.530).”*

**Conclusions:** . In short in problem solving situation more or less one can need all aspects of higher order thinking along with some affective and psychomotor elements. The researcher's synthetic design would be effective as:

- ✚ It reduces the drawbacks of educational higher order objectives; Analysis synthesis and Evaluation stated by Bloom .As they are criticized as vague concepts to attain.
- ✚ It envelops all popular terms; old and cotemporary which are related to higher order thinking skills and even shows interconnections between these.
- ✚ It may serve as more inclusive model for training of higher order thinking skills.
- ✚ This synthetic model shows inter connections of some affective and psychomotor elements with cognitive processes required for complex problem solving
- ✚ It keeps higher order cognitive abilities stated by Dr. J.P. Guilford in an hierarchical and a proper logical position in the model

[Researcher is supervisor and secondary school science teacher of Jnana Prabodhini Prashala Pune, India, a special category school for intellectually gifted students. She is science post graduate, with 20 years of experience of teaching of gifted students.]

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