

Towards A New Cybernetic Interdisciplinary Approach To Pedagogic Challenge

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GOALS

We can formulate goals in several ways

- **Revolution**: Replace 50 years of pedagogic theories
- **Cybernetic**: Spirit of Ashby: Operational vs. Jargon
- **Unifying**: Explain commonality of pedagogic theories of educational hierarchy
- **Brain function**: Proposed theory rooted in current brain/mental research

OUTLINE

- I: Review: *50 years of educational theories*
- II: Cybernetics: *Definition, Ashby, operational*
- III: Executive Function: *Definitions*
- IV: New Proposed definition
 - *Multiple brain areas*
 - *Multi-parameter*
- V: Examples: *Geometry and: math, writing, law, music, literature*

Section I: Review

50 YEARS: PEDAOGIC HIERARCHIES

- 1st Generation: *The Hierarchies: Bloom, Anderson, Van-Hiele, Gagne, Marzano, Webb, Piaget, Bruner,*
- 2nd Generation: *Theories are the same! Yazdani, Pegg, Hess*
- LOTS / HOTS

1st Generation: The Hierarchies

- **BLOOM**: Knowledge, comprehension, application, analysis, synthesis, evaluation
- **ANDERSON**: Remember, understand, apply, analyze, evaluate, create
- **VAN-HIELE**: Recognize, analyze, order, deduction, rigor
- **GAGNE**: Attention, objectives, short-term memory, information, presentation, performance, guidance, feedback, assessment, transfer

Hierarchies: How mastered

- Synonym collections: Here is an example
- MARZANO: *Retrieval, Comprehend, Analysis, Knowledge Utilization*
 - Analysis-synonyms: *Match, Classify, Error analysis, generalize, specify*
- Other aspects of the hierarchies
- Van Hiele: *Fixed Sequence, adjacency, distinction, separation, attainment*

2nd Generation: Equalities

- YAZDANI: Gagne = Van-Heile
- HESS: The “Matrix” – Webb x Bloom-Anderson
- PEGG: SOLO cycle, Brunner, Van-Hiele, Piaget (Unified by *Sensory-> Abstract*)

Section II: Cybernetics

Cybernetics

- asc-cybernetics.org/foundations/definitions.htm
- *Organization of the whole; Communication between parts of a complex system independent of content*
- *Each complex field → Cybernetician*
- *Ashby / Psychology: Mechanistic/operational vs. higher order*

Section III: Executive Function

Executive Function

- Executive function = higher order brain function
- Several types
 - Performance based
 - Rating based
- Executive function correlates with brain structure: e.g. frontal lobe damage
- Focus in this paper on one type of performance based test

EF: 3 Performance Based Tests

- **STROOP**: (Adapted for this presentation)
 - apple, BALL, doll, ear, FOOT – *indicate size*
 - SMALL, big, ANT, FLY, elephant – *indicate size*
- **WCST**:
 - Row 1: [a, BB, CCC]
 - Row 2: *dd.*
 - Row 2 is similar to which item in row 1
- **TRAIL MAKING TEST**: 25 filled circles
 - Test A: Make a trail: 1,2,3,4,5,6,...
 - Test B: Make a trail: 1,A, 2,B, 3,C,...

MULTI-PARAMETER PROCESSING

- These 3 tests
 - predict a Boolean variable, Y ,
 - in terms of independent variables, x_1, x_2, \dots, x_n
- STROOP: $SIZE = f(\text{meaning, letter form})$
- WCST: $SIMILARITY = f(\text{number, size, style})$
- TRAILMAKING:
 $NEXT\ ITEM = f(\text{number, letter, current})$

Section IV: NEW PROPOSED DEFINITION

Proposed New Definition of Pedagogical Challenge/Hierarchy

- *A discipline is taught / mastered in a pedagogically challenging manner if*
 - *The discipline simultaneously addresses multiple areas of the brain/mind and*
 - *The problems of the discipline are formulated using multi-dimensional parameters*

Properties of the Definition

- **Cybernetic**: Discipline independent – depends on interaction of parameters, not on content
- **Operational**: Depends on counting brain areas and multiple parameters; easy to recognize; expertise not required

SECTION V: Examples

Verbal Modeling

<http://www.CoreStandards.org/>

Verbal – Dimension 1

- Amy purchases for her friends 4 peanut bags and 1 Quart of Orange juice for a price of \$6.
- Had Amy purchased 1 peanut bag and 4 quarts of OJ it would have priced at \$9
- How much does a peanut bag and OJ quart cost

Algebra – Dimension 2

- $4 P + 1 Q = 6$
- $1 P + 4 Q = 9$
- Solve for P and Q

FURTHER EXAMPLES OF GOOD PEDAGOGY

- Geometry and Math
 - Geometry and Writing
 - Geometry and Law
 - Geometry and Literature
 - Geometry and Music
-
- All the above use two areas of brain

Rene Descartes

Algebraic Geometry

- ALGEBRA: $Y=X$ and $Y=6-X$ has one solution

- NUMERIC:

X	0	1	2	3☺	4	5
6-X	6	5	4	3☺	2	1

- GEOMETRY:

ALGEBRA	(x,y)	0-set of equation	Solve two equations
GEOMETRY	Point	Line	Intersect two lines

- RULE OF FOUR Debbie Hughes-Hallett:
- Teach math using: *Algebra, geometry, verbal, computational*

Writing and Geometry

- Paper of *Nair et al*, *Asian Social Science*, 8(7)
- IDEA: Draw outline of essay as graph with tree like nodes with various connections.
Write essay from graph
- Emotional + Intellectual affect: *graph strategy*->*mastery*->*anxiety removal*->*self efficacy* → *more writing*-> *improved writing*

Geometry and Law

- Tzvi Kanarek – SVT (Self study, *visual*, *technology*) = Rule of 2
- Kanarek advocates visual use of the *list*
- Illustration –Laws of lost and found

Lost articles belonging to you	Scattered fruit	Scattered money	Small sheaf bundles in public
Lost articles you have to return	Fruit in a vessel	wallets	(arranged) heaps of fruit/money

■ Increased comprehension and satisfaction

Geometry and Biblical Literature

- Parallelism: David Kugel, Russell Hendel

- Gn49-11

Washing	In wine	His garments
-----	In the blood of graphs	His <u>suth</u>

- Ex20-07, Lv19-12

Do not	Bear	The Name of God	For <u>naught</u>
Do not	Swear	In my name	<u>Falsely</u>
Adverb	Verb	Object	Indirect Object

Music and Geometry

- Orchestra = *multiple* players
- Piano = *multiple* hands
- *Geometry* of Music, Tymockzko
- *Geometry* of Rhythm, Toussaint

CONCLUSION

- New definition
 - Is Cybernetic (Interdisciplinary)
 - Operational (Count modalities and parameters)
- Supplements not replaces old definition
 - If you were teaching verbal problems
 - Continue to do so; Justification changes
- Encourages simple focus (multiple modalities, multiple parameters) for pedagogic challenge