Reflection

“The goal of intellectual education is not how to repeat or retain ready-made truths. It is in learning to master the truth by oneself at the risk of losing a lot of time and going thru all the roundabout ways that are inherent in real activity.”

(Jean Piaget, Swiss cognitive psychologist, 1896-1980)
The Math jargon (or conciseness?)

Wien's Displacement Law

\[ \lambda_{\text{max}}T = \text{constant} = 2.898 \times 10^{-3} \text{ mK} \]

Math Conciseness (or driving force?)

Planck's Law of blackbody radiation

\[ I(\nu) = \frac{2\nu^3}{c^2} \frac{1}{e^{\frac{\nu}{kT}} - 1} \]

Total Power emitted by a black body

\[ P_{\text{net}} = P_{\text{emit}} - P_{\text{absorb}} \]

Total Power emitted by a black body

\[ P_{\text{net}} = A\sigma(T_{\text{body}}^4 - T_{\text{surr}}^4) \]

Human body shielded by clothing:

\[ T_{\text{body}} = 301\text{K}, T_{\text{surr}} = 305\text{K}, \text{ emissivity} = 1, \text{ Area} = 2 \text{ m}^2 \]

\[ P_{\text{net}} = 95 \text{ W} \]

Wien's Displacement Law

\[ \lambda_{\text{peak}} = \frac{2.898 \times 10^6 \text{ K} \cdot \text{nm}}{305 \text{ K}} = 9500 \text{ nm} \]
Reflection

To those who do not know Mathematics it is difficult to get across a real feeling as to the beauty, the deepest beauty of nature. ... If you want to learn about nature, to appreciate nature, it is necessary to understand the language that she speaks in


“Universities are full of knowledge, the freshmen bring a little in and the seniors take none away, and knowledge accumulates.” Abbot Lowell
Understanding Information & Knowledge Formation

Descriptive

A car moving to the right with a velocity 20 m/s crashed into a stationary lorry. The total momentum must be conserved in the collision.

Pictorially/Graphically

Symbolically: Mathematical representation

\[ p_i = p_f: (m_1v_1 + m_2v_2)_i = (m_1v_1 + m_2v_2)_f \]
Know Yourself!!
Learning Styles/preferences
simplified MI

“is the way in which each learner begins to concentrate on, process, and retain new and difficult information.” (Dunn)

What makes meaningful learning difficult??- Learning Preferences
Learning Styles

"...a biologically and developmentally imposed set of personal characteristics that make the same teaching method effective for some students and ineffective for others,..." (Dunn, Beaudry, and Klavas, 1989)
What makes meaningful learning difficult? - Learning Preferences

Felder’s Model - 4 domains of information handling: to understand new knowledge

Input

New knowledge

Processed

Understood

---

**USA findings, ** DR. J.J’s (N = 1122)

**42, ** Intuitive prefer theories & interpretations of factual information.

**57, ** Sensing prefer data and facts. like facts & solve well establish methods, resent being tested on materials that has not been explicitly covered in class.

**30, ** Verbal prefer the spoken or written word.

**69, ** 87 Visual prefer charts, diagrams and pictures.

**57, ** 58 Sensing

**69, ** 87 Visual

**30, ** 13 Verbal

**95, ** 95 Auditory

**100, ** 100 Tactile
Students’ Learning Preferences: Information Handling Domains (Felder’s)

*USA findings, ** DR J.J.’s (N = 1122)

<table>
<thead>
<tr>
<th>Processing</th>
<th>Understanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active *67, **60</td>
<td>Sequential *71, ** 60</td>
</tr>
<tr>
<td>learn best by doing something physical with the information</td>
<td>easily make linear connections between individual steps</td>
</tr>
<tr>
<td>Reflective *32, **40</td>
<td>Global *28, ** 40</td>
</tr>
<tr>
<td>do the processing in their heads</td>
<td>must get “big picture” before individual pieces fall into place</td>
</tr>
</tbody>
</table>

Research on Learning Preferences

Implications:

Percentage of Students' Preferences Addressed By the Traditional Passive Lecture Method

- USA
- This work

Learning Preferences

Reflective Intuitive Verbal Sequential
Research on Learning Preferences

Implications:

Percentage of Students' Preferences Addressed by the Traditional Passive Lecture Method According to CGPA

- Less than 2: N=12
- Less than 3: N=90
- Less than 4: N=49

Learning Preferences:
- Reflective
- Intuitive
- Verbal
- Sequential

% of students
0 10 20 30 40 50 60 70

CGPA
Reflection

Passive vs Active Learning

STUDIES SHOW THAT OVER A PERIOD OF 3 DAYS, THE RETENTION OF LEARNING IS AS FOLLOWS:

10% OF WHAT WE READ

20% OF WHAT WE HEAR

30% OF WHAT WE SEE

50% OF WHAT WE SEE AND HEAR

70% OF WHAT WE SAY

90% OF WHAT WE SAY AS WE DO

ADULTS CAN LEARN BY READING, LISTENING, AND WATCHING, BUT THEY WILL LEARN BETTER IF THEY ARE ACTIVELY INVOLVED IN THE LEARNING PROCESS.
What is a Concept Map??

- Associated Feelings or Affect
  - includes
  - comprised of
- Concept Maps
  - represent
  - needed to answer
- “Focus Question(s)”
  - may be
- Effective Teaching
  - necessary
- Effective Learning
  - are
- Context Dependent
  - are
  - needed to answer
- Personal
  - add to
  - are
- Social
  - linked using
  - are

Structure & Growth of Knowledge

- Associated Feelings or Affect
  - begin with
  - need to see
- Concept Maps
  - help to answer
- “Focus Question(s)”
  - may be
- Effective Teaching
  - necessary
- Effective Learning
  - are
- Context Dependent
  - are
  - needed to answer
- Personal
  - add to
  - are
- Social
  - linked using
  - are
What is a Concept Map??

What makes concept maps such a strong tool in mathematics?

- Concept Mapping
  - can be a useful tool in
  - encourages users to determine
  - can be used by
    - Teachers
    - Individuals or Groups
    - Students

- Assessment
- Classroom Activities
- Planning
- Meaningful Connections
- Student Accountability for Learning
- Retention of Mathematical Concepts
- Meaningful learning
  - is related through
  - is limited with only
  - requires understanding of
  - Diverse Mathematical Concepts
  - Rare Memory Learning Strategies
Meaningful Vs Rote Learning

**Meaningful Learning**
- Concept mapping
- Lectures
- Most textbook presentations
- Multiplication tables
- Reception instruction

**Examples**
- Scientific research
- Well designed multimedia studies
- Most routine research or intellectual production
- Most school laboratory work
- Applying formulas to solve problems
- Trial and error puzzle solutions

**Rote Learning**
- Autonomous instruction

Key Memory Systems & How they Interact
What is a Concept Map??

- A concept map is a special form of a web diagram for exploring knowledge and gathering and sharing information. **Concept mapping** is the strategy employed to develop a concept map. A concept map consists of nodes or cells that contain a concept, item or question and links. The links are labeled and denote direction with an arrow head. The labeled links explain the relationship between the nodes. The arrow describes the direction of the relationship and reads like a normal sentence.
Example: What is a CMAP

- CMAP represents organized knowledge, which are/is composed of concepts and propositions, which are perceived regularities.

- Are necessary for effective learning.

Why do Concept Maps

- To organize material
- To assess understanding or diagnose misunderstanding
- To communicate complex ideas
- To generate ideas (brainstorming, etc.)
- To design a complex structure (long texts, hypermedia, large web sites, etc.)
Why do Concept Maps

- to integrate large body of materials
- to insert new concepts within existing knowledge structure
- to fix learned materials into long-term memory
- to revise effectively for examinations

How To Do Concept Maps

- Begin with domain of knowledge that is familiar
- Identify segment of text or lab activity or a particular problem or question that you are trying to understand.
- Identify key concepts in this domain by listing them.
What is a force??
- Push, pull, frictional
- Touch, at-a-distance
- Gravitational, magnetic, electrical
- Field
- Charge, mass, radius, length, time interval
- Newton’s Laws, motion
- Acceleration, linear, angular
- Velocity, position, position change, clock reading
- Inertia, moment of inertia, torque
- Newton, meter, seconds, radians

What is A Wave??
- Party
- Water
- Ripples, Boats
- Sound
- Interference
- Amplitude, Frequency
Brainstorm/list out concepts

- graphs
- position change
- distance travelled
- area
- unit squares
- perimeter
- surface
- domains
- codomains
- objects
- image
- range
- clock reading
- time interval
- Focus Question
  - What is a FUNCTION?

CMAP

How To Do Concept Maps

- Approximately, rank order the concepts from most general most inclusive to most specific least general concept.

- Construct a preliminary concept map. Best done by writing concepts on sticker notes for ease of moving it around during building the hierarchy.

- Revise the map - more than 3X.
Rank the concepts

General to specific

- distance travelled
- position change
- area
- associate
- arrow diagrams
- ordered pairs
- graphs
- unit squares
- domains
- codomains
- objects
- image
- perimeter
- range
- time interval
- surface

CMap

How To Do Concept Maps

- Find the cross-links (concepts linked across domains)
- Add domains and more cross-links every time new knowledge is learned.
CMAP-Your task

What is A Circle?!!

Construct a CMAP

Focus Question
What is a Circle

Circle  radius  center

diameter  circumference  perimeter

arc length  minor  major  angle

subtended  whole turn  sector  segment

degrees  pi  area  chord  radians
What is a Concept Map??

Example: Hierarchical Concept Maps

Your Assignment: Group-work

Focus Question: What is a force??

- Brainstorm at least 20 concepts associated with the question.
- Rank-order them hierarchically with the question being at the top and the more specific concepts at the bottom.
- Write each concept on a piece of post-it and place them on a mahjung paper according to the hierarchy. Now link up the concepts by writing down the linkwords and drawing the arrowheads. You are now mapping the concepts.

- REVISE, REVISE, REVISE
Example: Hierarchical Concept Maps

Your Take-home Assignment: Group-work

Focus Question: What is electrostatics??

➢ Brainstorm at least 20 concepts associated with the question.
➢ Rank-order them hierarchically with the question being at the top and the more specific concepts at the bottom.
➢ You are now mapping the concepts.
➢ Submit at the beginning of next class.

➢ REVISE, REVISE, REVISE

Conclusion

"One who learns by finding out has sevenfold the skill of the one who learned by being told."
- Arthur Gutterman

"The roots of education are bitter, but the fruit is sweet." - Aristotle
Concept Maps Activities

Chemical Bonding

Electro-chemistry

Photon  Photon

Light  Light

Electromagnetic Induction