Developing Rich Learning Experiences for Medical Physics Education

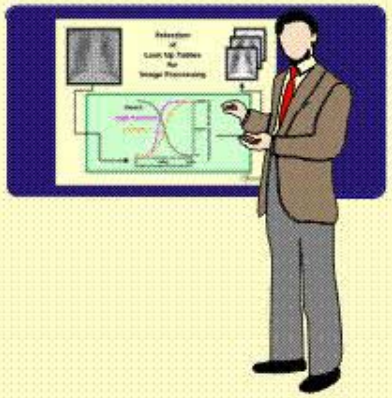
Perry Sprawls, Ph.D.

Emory University

and

Sprawls Educational Foundation

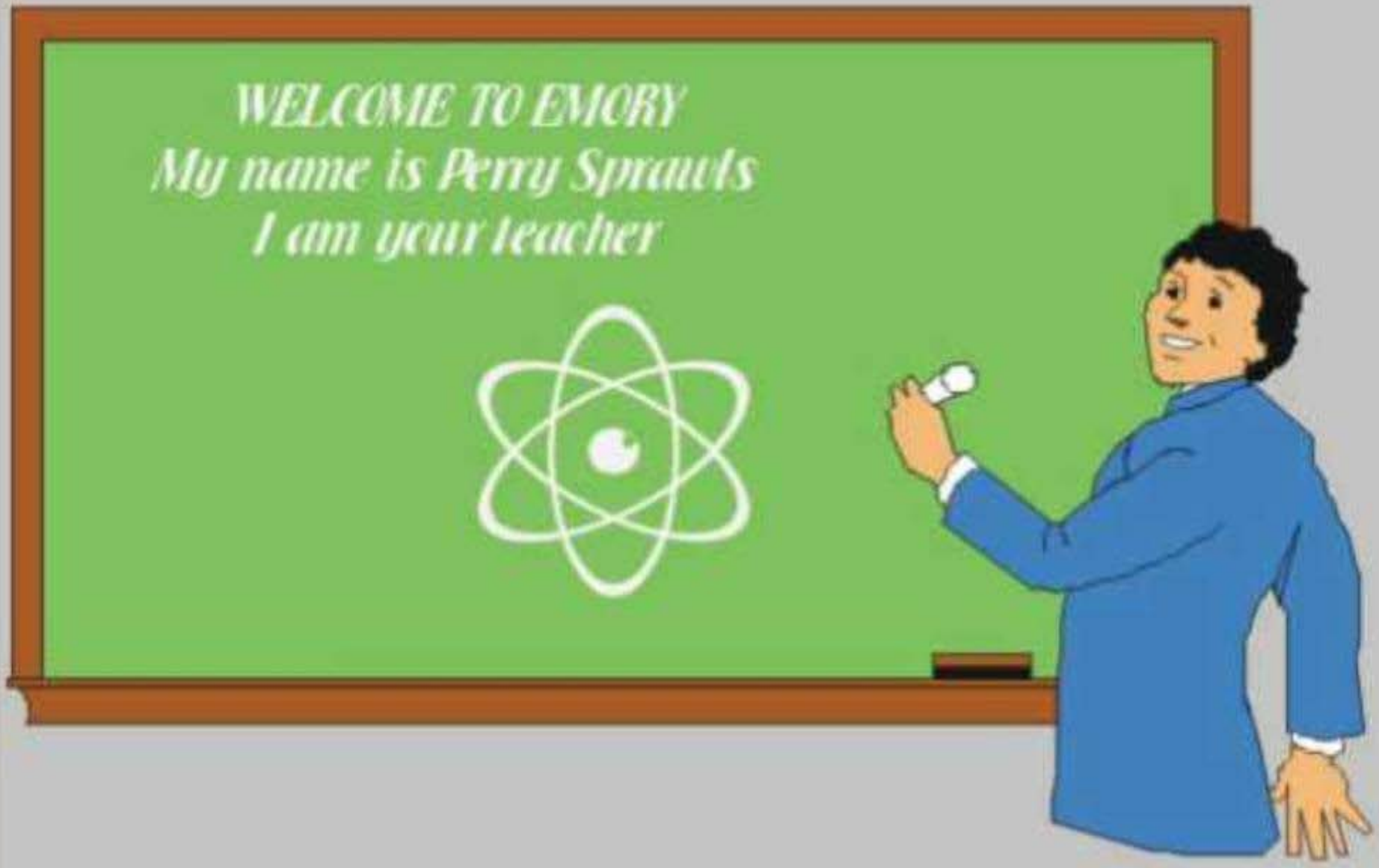
Xhttp://www.sprawls.org



This Course Web Site

http://www.sprawls.org/learning

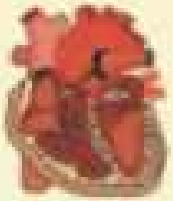
1960





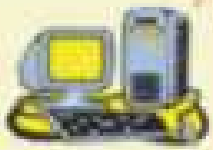


LEARNING IS A NATURAL PROCESS







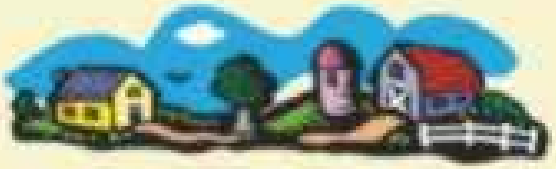




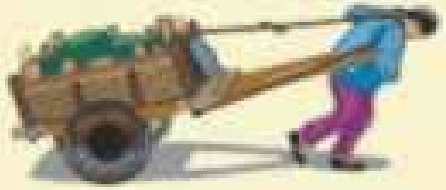


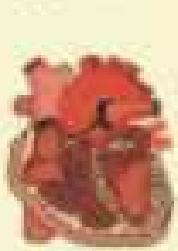
ENCOUNTER and EXPERIENCE



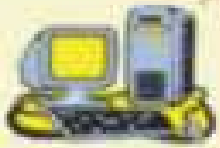



Sprawls











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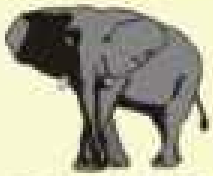
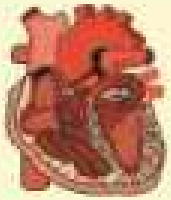
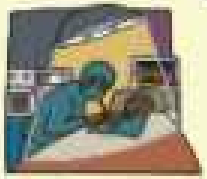
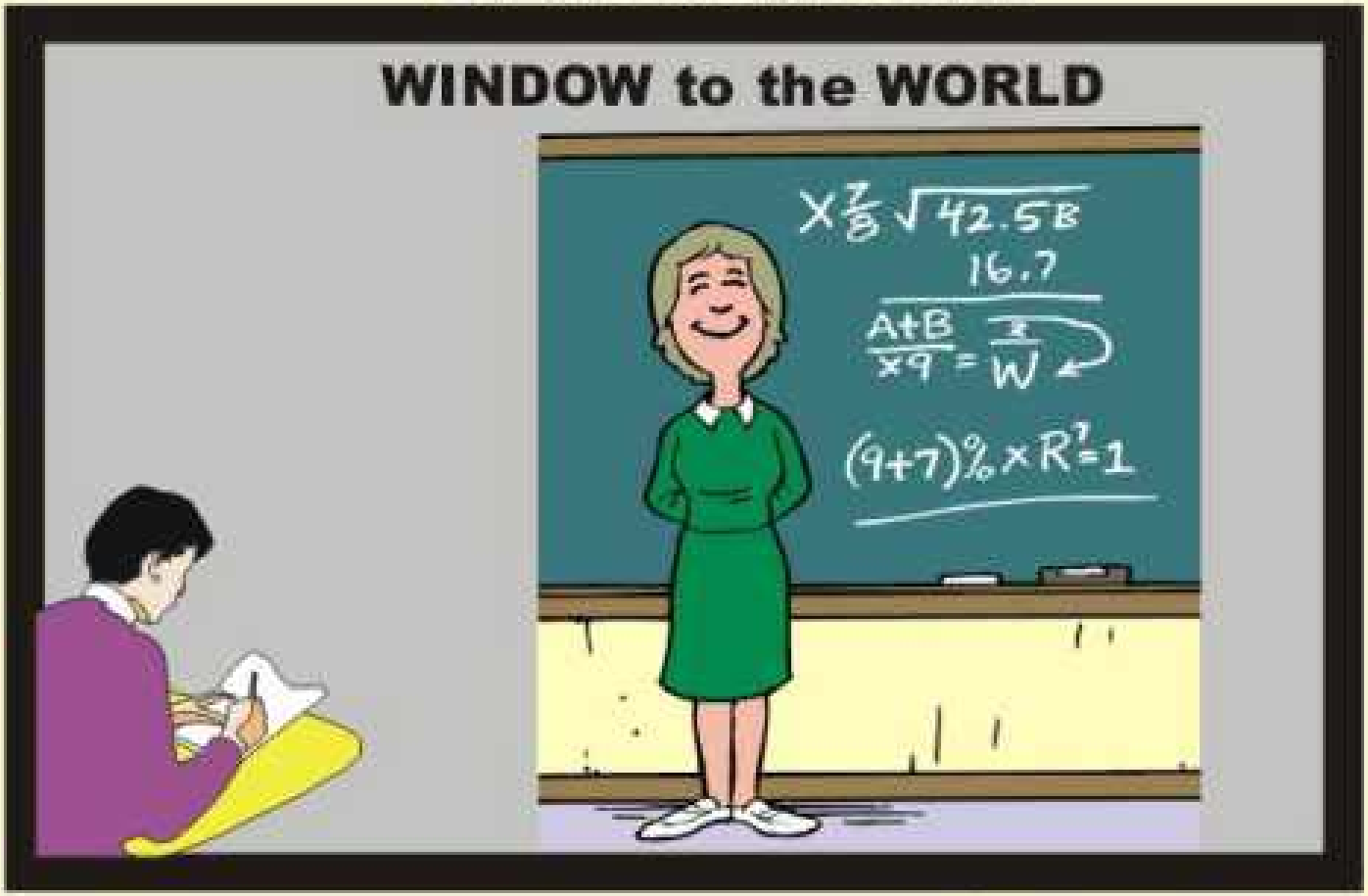


CLASSROOM












Sprawls

Learning is....

Building knowledge structures in the brain

Image: UCDavis

Sprawls

Learning Physics is by..

Encounter and Experience

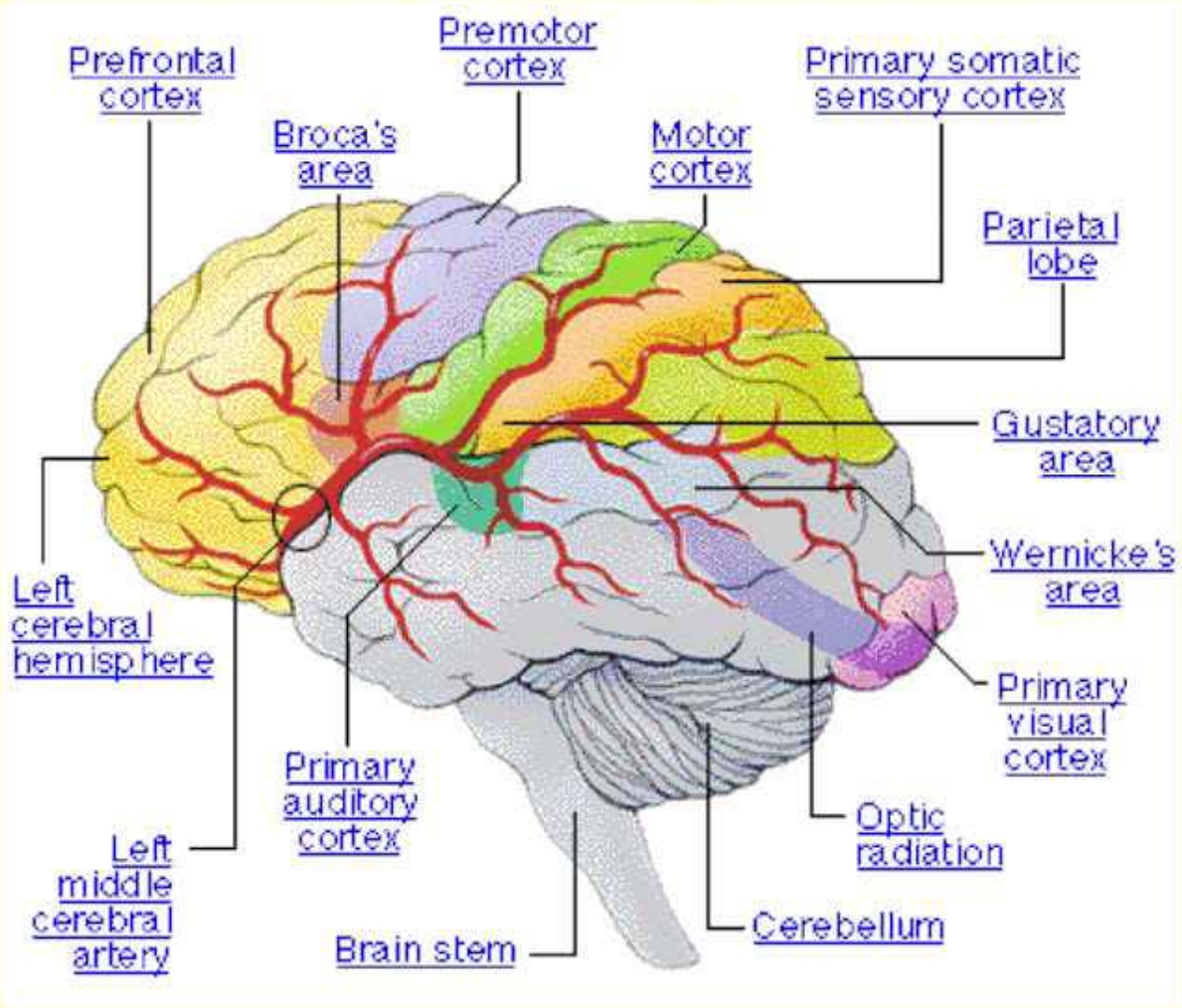
Physical Universe

Brain

Images: BYU and Howstuff works

Sprawls

The Brain...

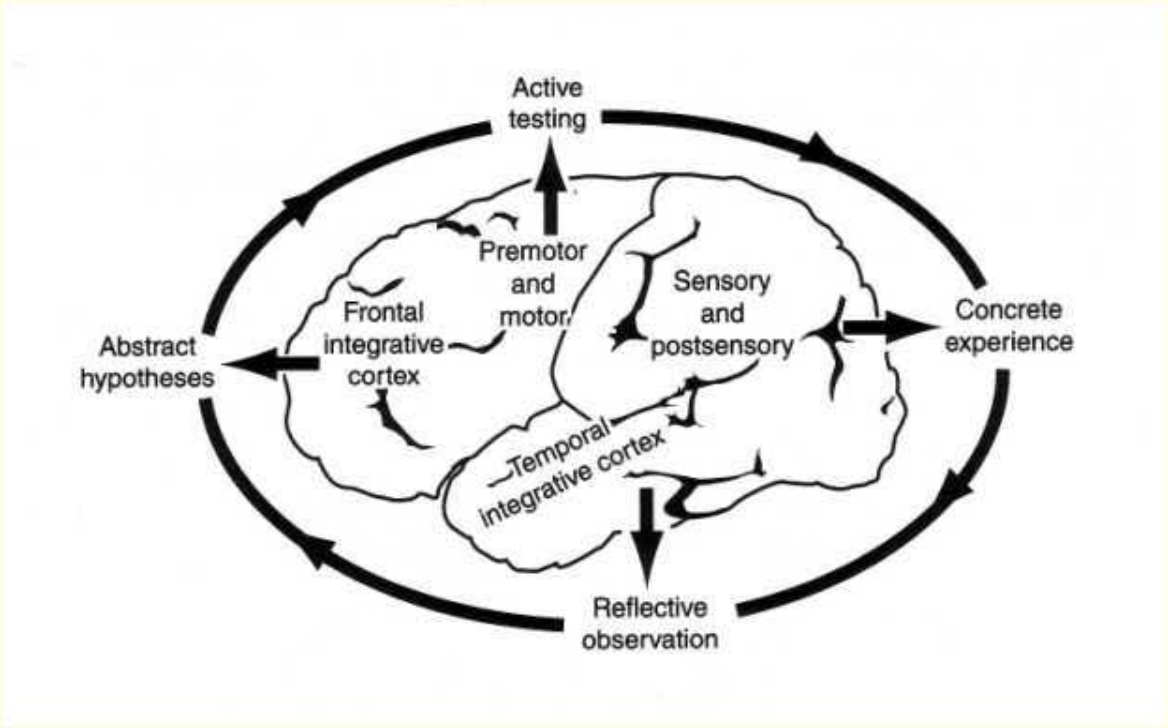


Structure and Function

Image: AMA

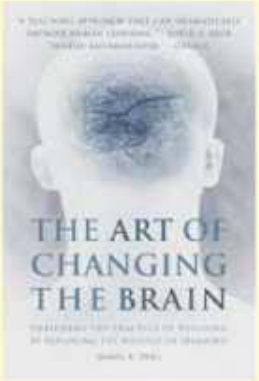
Sprawls

Zull's Model of Brain Function

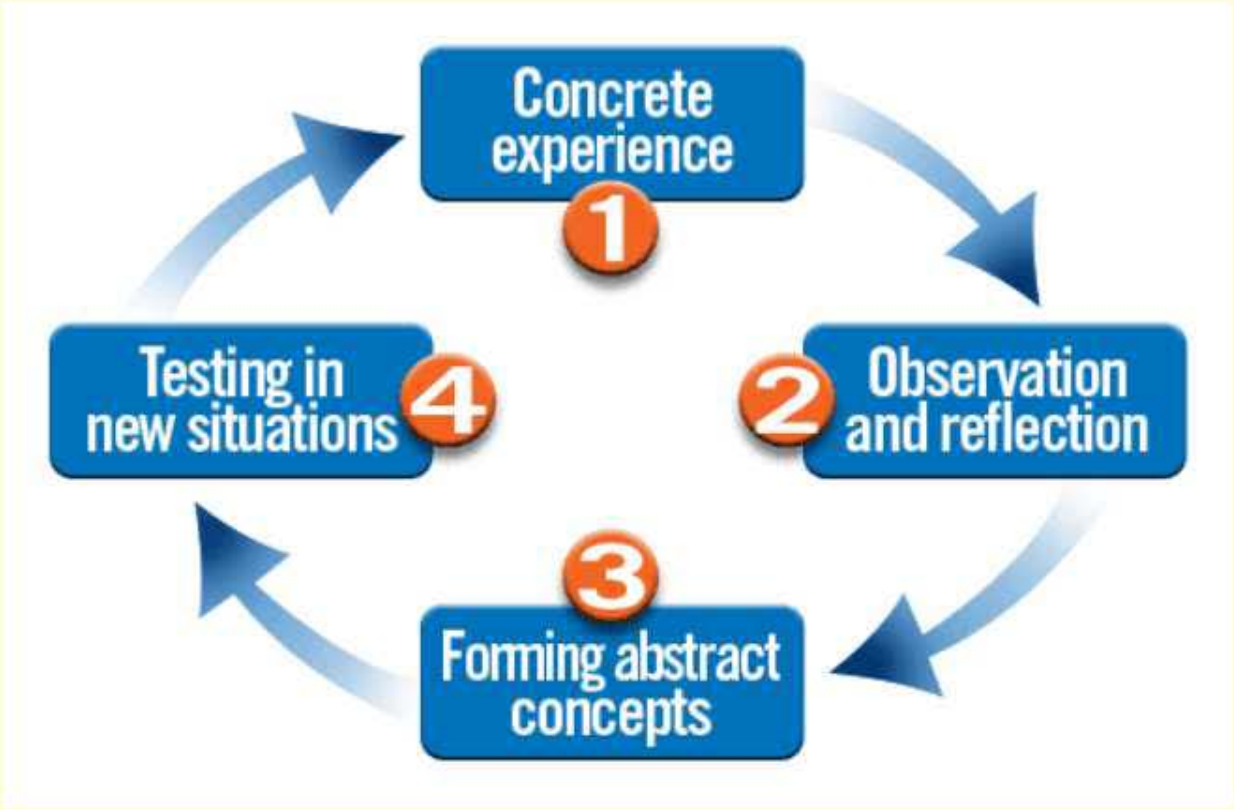


James Zull, Ph.D.
Professor of Biology
Professor of Biochemistry
Director of University Center for Innovation in Teaching and Education
Case Western Reserve

Reference:



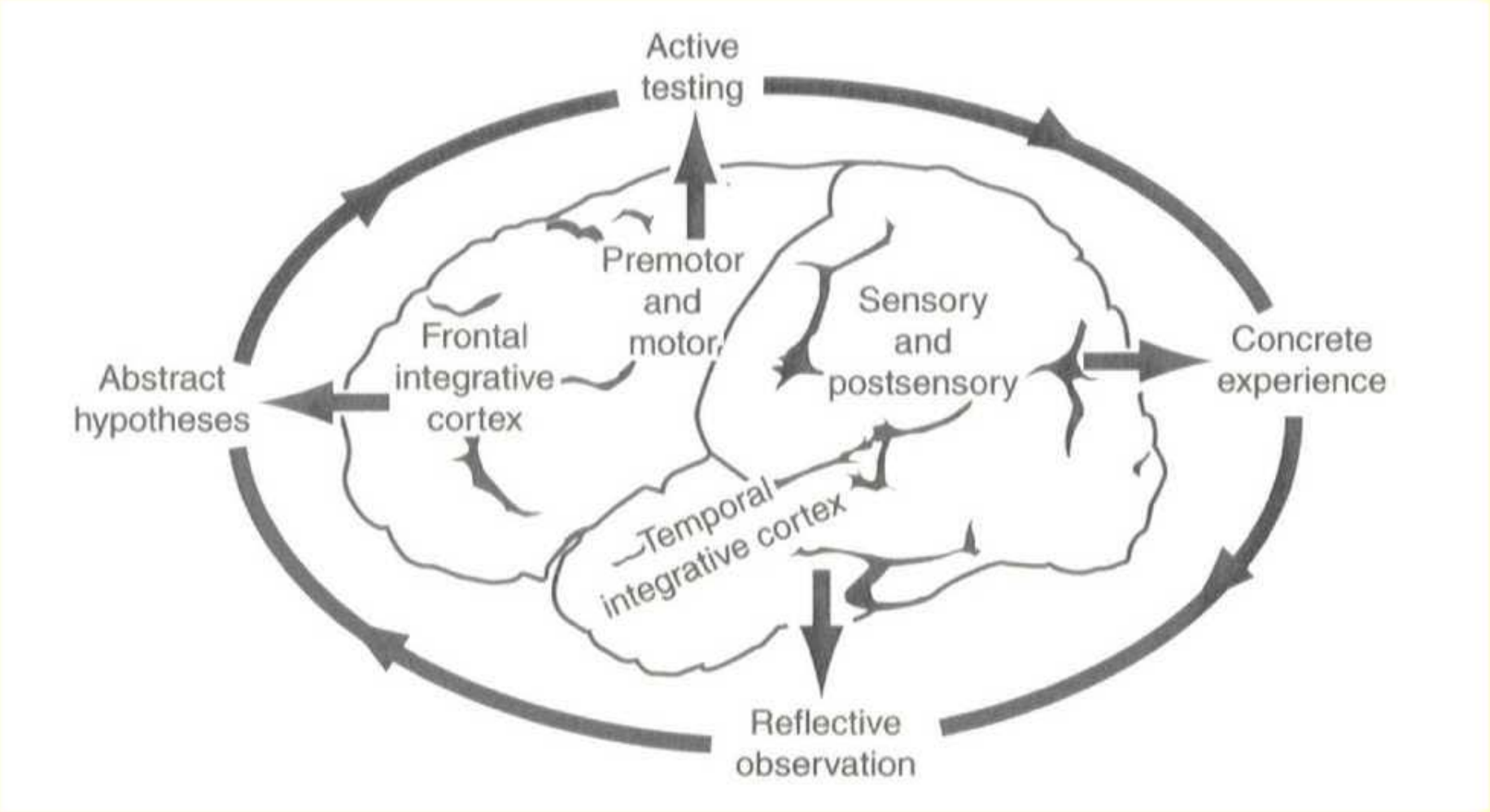
Kolb's Experiential Learning Model



David A. Kolb, Ph.D.
Professor of Organizational Behavior
Case Western Reserve

Website: http://www.learningfromexperience.com

Zull's Model of Brain Function



Brain Functions for Learning Physics

Control

Sensory

Back Integrative Cortex

Where

(Relationships)

(Characteristics)

What

(Identification)

Language

Comprehension

Frontal Integrative Cortex

Making Plans
Evaluating
Problem Solving

Language

Assembly

Motor

Emotions

Sprawls

Brain Functions for Learning Physics

Control

Sensory

Back Integrative Cortex

Records of the Past

Reflection

Frontal Integrative Cortex

Preparation for the Future

Hypotheses

Motor

Emotions

Sprawls

Brain Functions for Learning Physics

Control

Sensory

Back Integrative Cortex

Records of the Past

Knowing

Frontal Integrative Cortex

Preparation for the Future

Doing

Motor

Emotions

Sprawls

Let's Think about lunch.

Brain Functions for Preparing Lunch

Control

Back Integrative Cortex

Frontal Integrative Cortex

Emotions

Sprawls

Brain Functions for Preparing Lunch

Control

Back Integrative Cortex

Frontal Integrative Cortex

Emotions

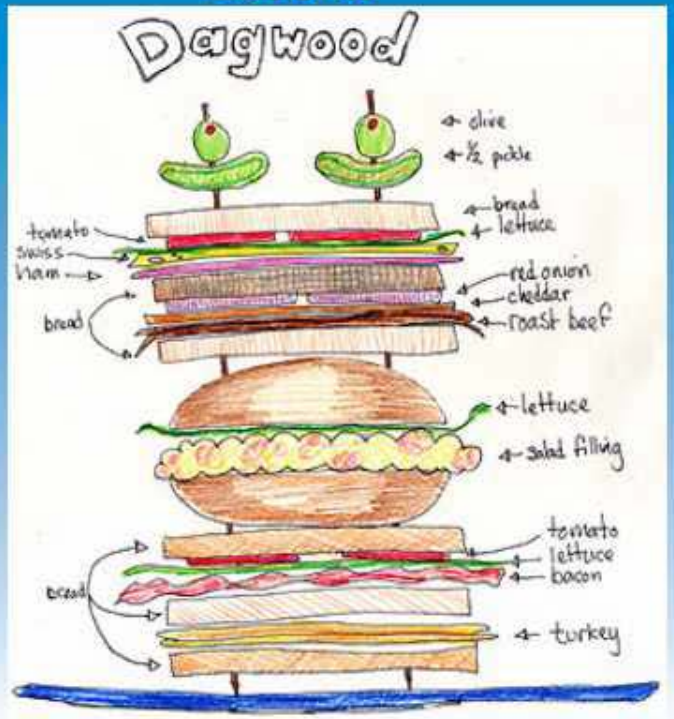
Sprawls

Brain Functions for Preparing Lunch

Control

Back Integrative Cortex

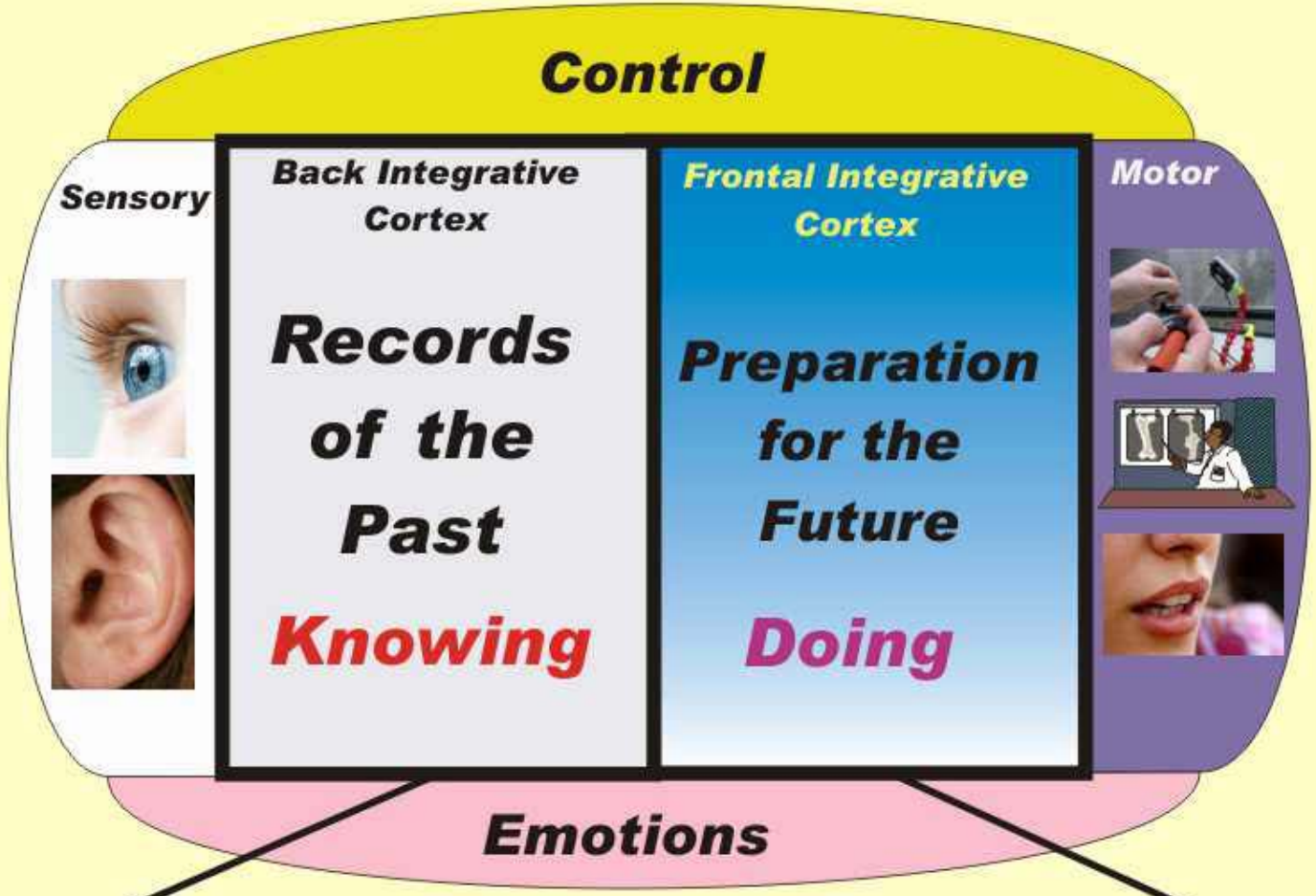
Frontal Integrative Cortex



Emotions

Sprawls

Brain Functions for Learning Physics



Balanced Education

Sprawls

Forming Knowledge Structures

Physical Universe

Back Integrative Cortex

Sensory

Visible Physical Objects

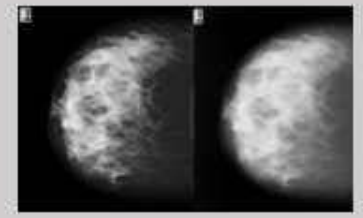
Sprawls

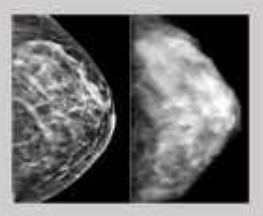
Forming Knowledge Structures

Physical Universe

Back Integrative Cortex

Sensory





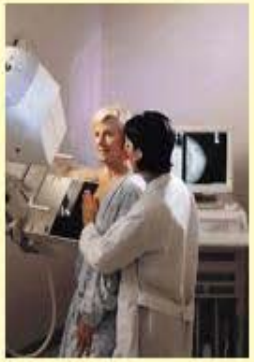
Visible Physical Objects

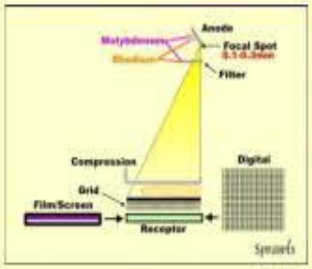
Sprawls

WINDOW or BARRIER

THE LEARNERS

PHYSICAL UNIVERSE





Sprawls

WINDOW or BARRIER

THE LEARNERS

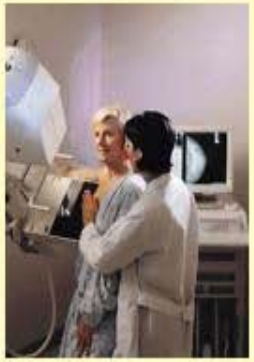
Distance

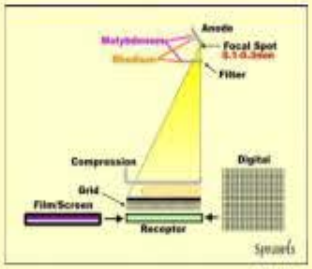
Availability

Time

Cost

PHYSICAL UNIVERSE

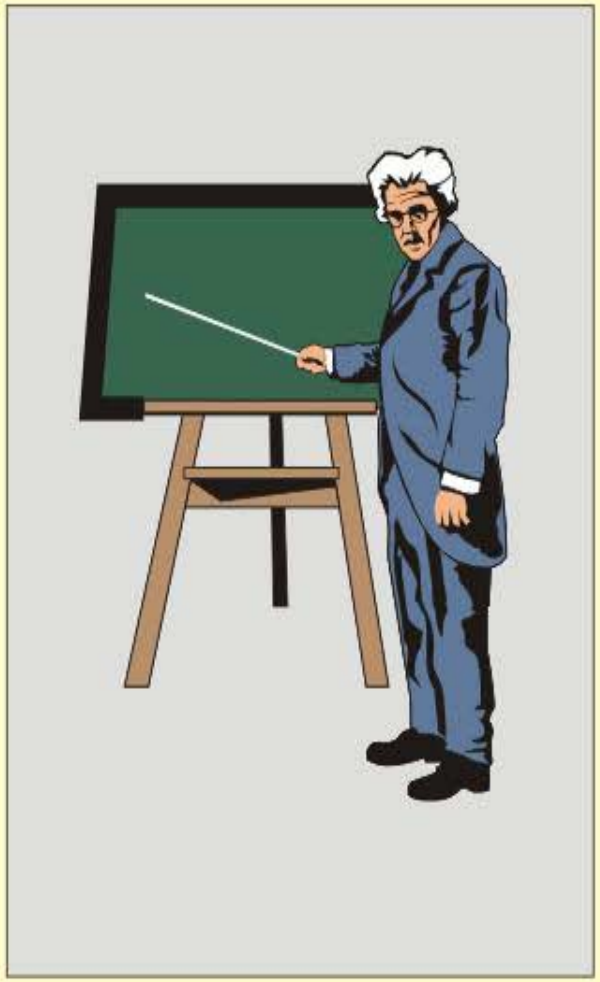




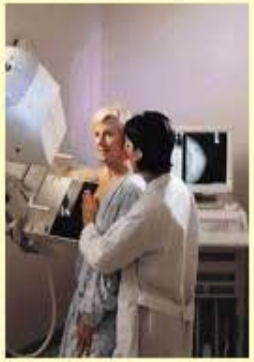
Sprawls

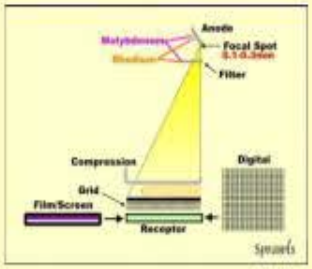
WINDOW or BARRIER

THE LEARNERS



PHYSICAL UNIVERSE



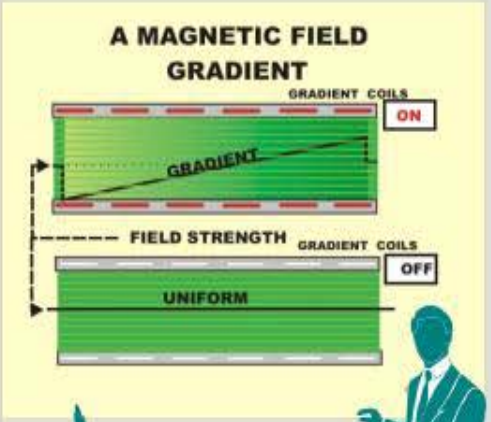


Sprawls

WINDOW or BARRIER

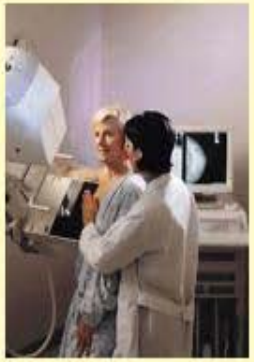
THE LEARNERS

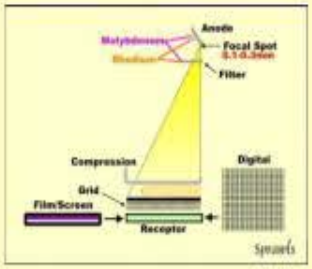
Visuals



Physicists

PHYSICAL UNIVERSE





Sprawls

Forming Knowledge Structures

Physical Universe

Back Integrative Cortex

Sensory

Radiation
Electrons
Magnetic
Atomic
Nuclear

Invisible Physical Objects

Sprawls

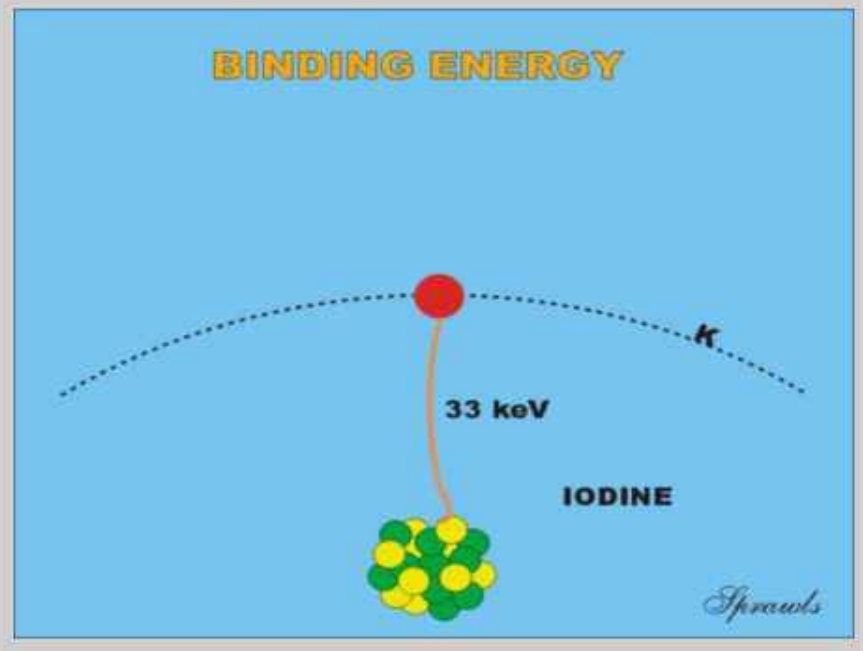
Forming Knowledge Structures

Physical Universe

Back Integrative Cortex

Sensory

Radiation
Electrons
Magnetic
Atomic
Nuclear



Invisible

Physical Objects

Visuals

Sprawls

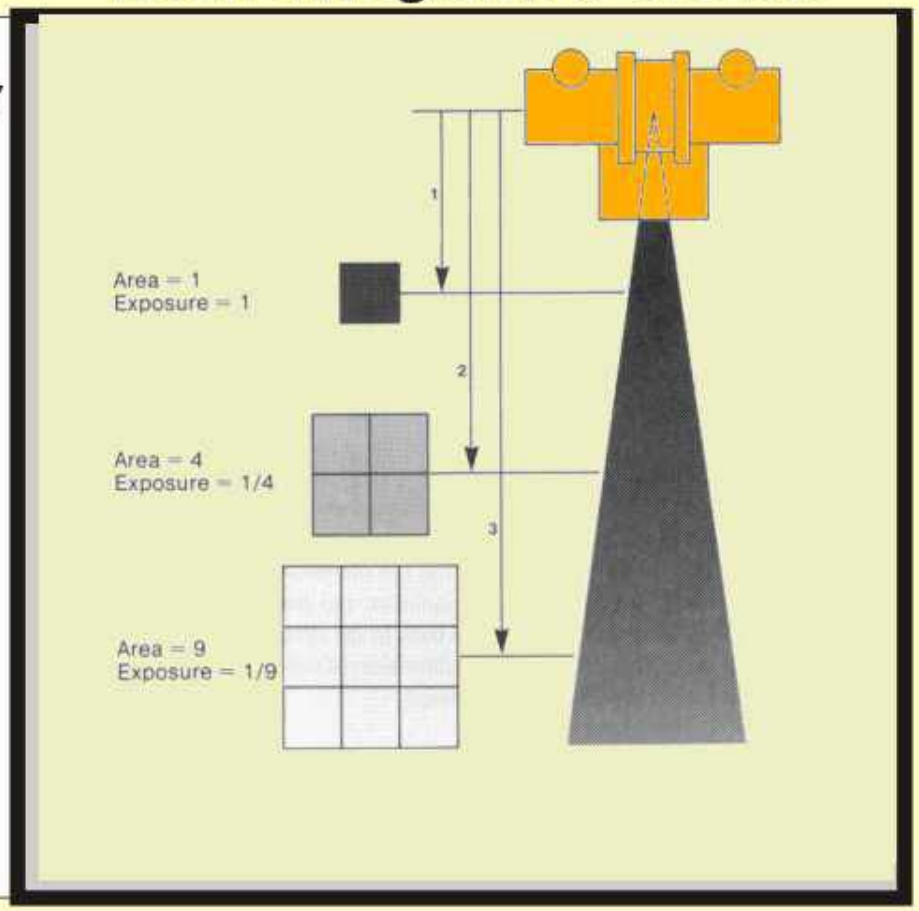
Forming Knowledge Structures

Physical Universe

Back Integrative Cortex

Inverse Square Effect

Sensory



Invisible

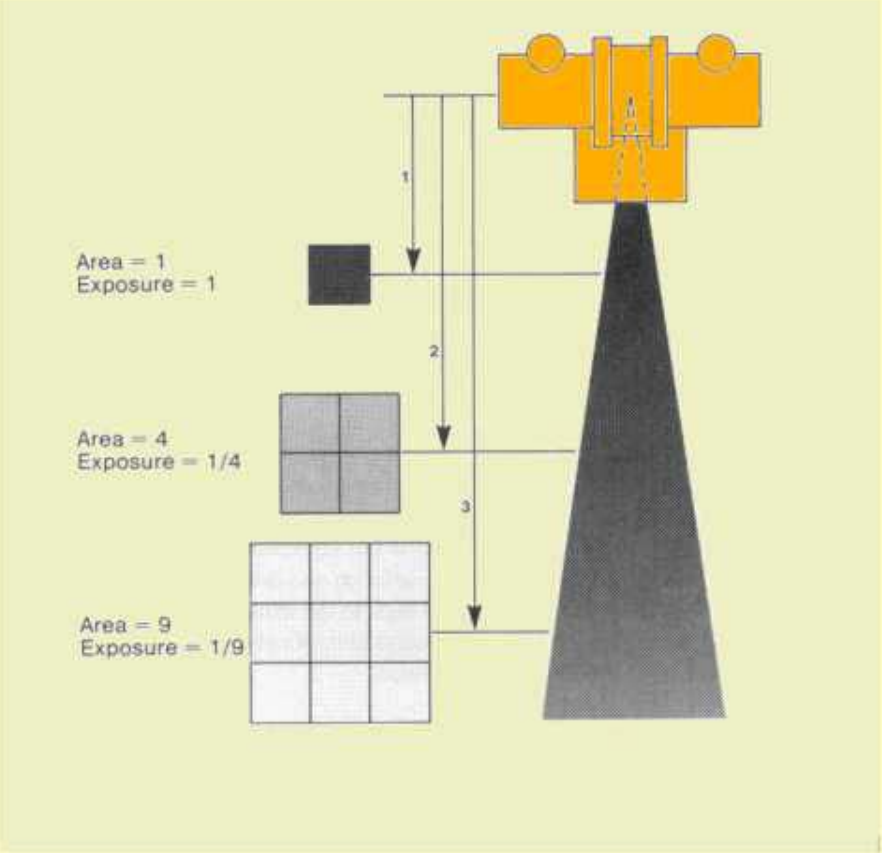
Concepts

Ideas

Visuals

Sprawls

Forming Knowledge Structures



Intensity = Power / Area

Surface area of a sphere = $\frac{4\pi r^2}{3}$

So, the luminous intensity on a spherical surface a distance r from a source radiating a total power P is:

$$I = 3P / 4\pi r^2$$

As P and pi remain constant, the luminous intensity is proportional to the inverse square of distance:

$$I \sim 1 / r^2$$

Visual

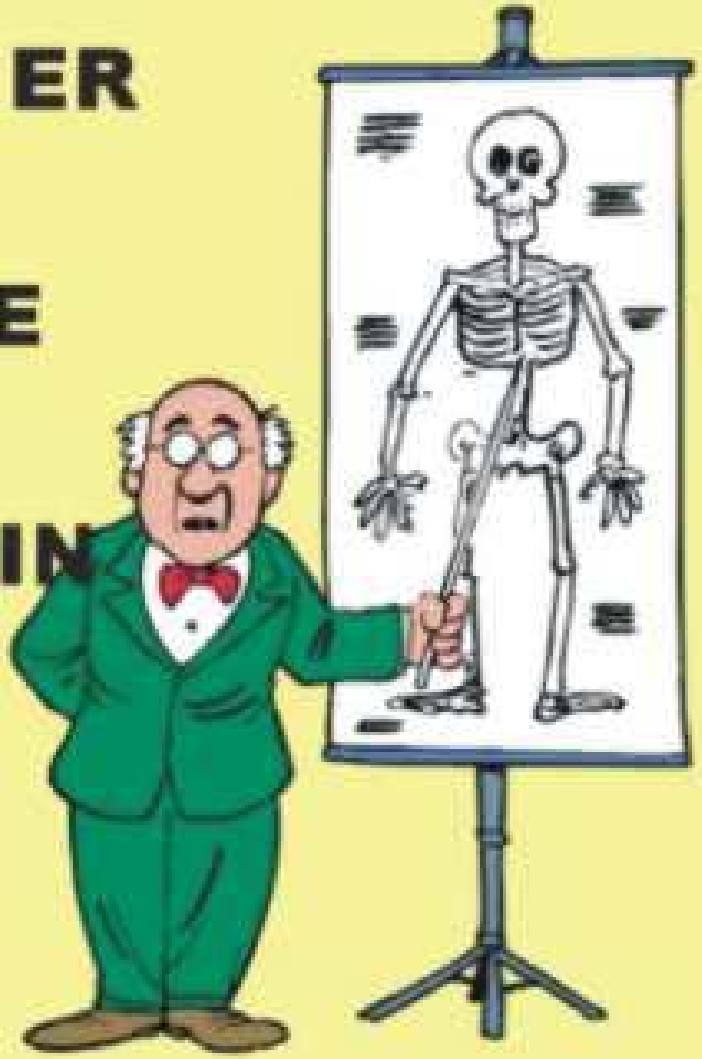
Verbal and Symbolic

Sprawls

EFFECTIVE TEACHING

Requires....

TEACHER to GUIDE and EXPLAIN



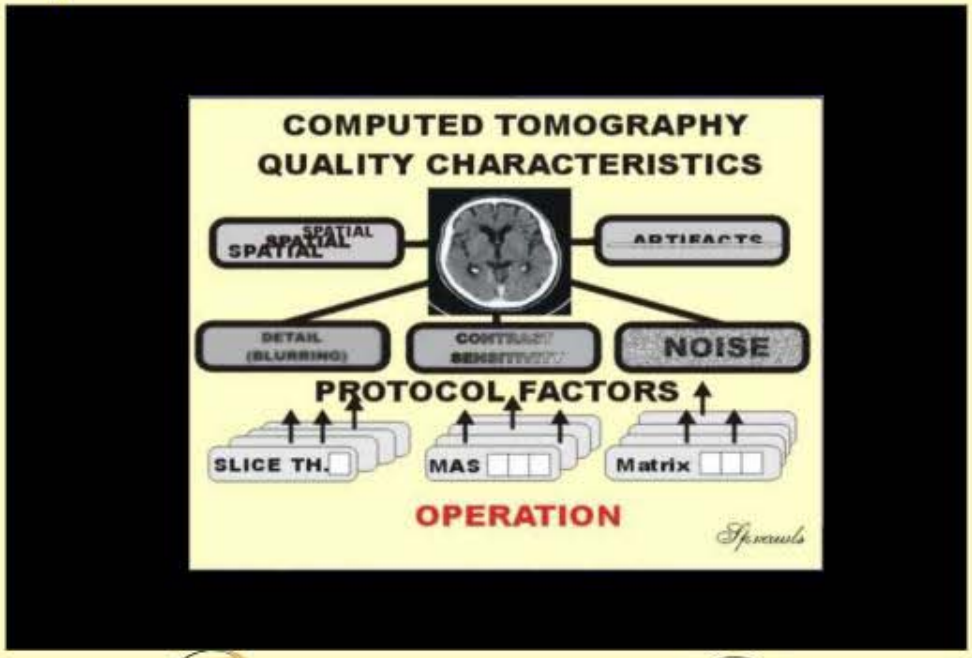
Visual Representation of Reality (Media)

Sprawls

Interactive Group Learning Activity

(Classroom, Conference, Small Group)

Representation of Reality



Guide

(Teacher)

Engage

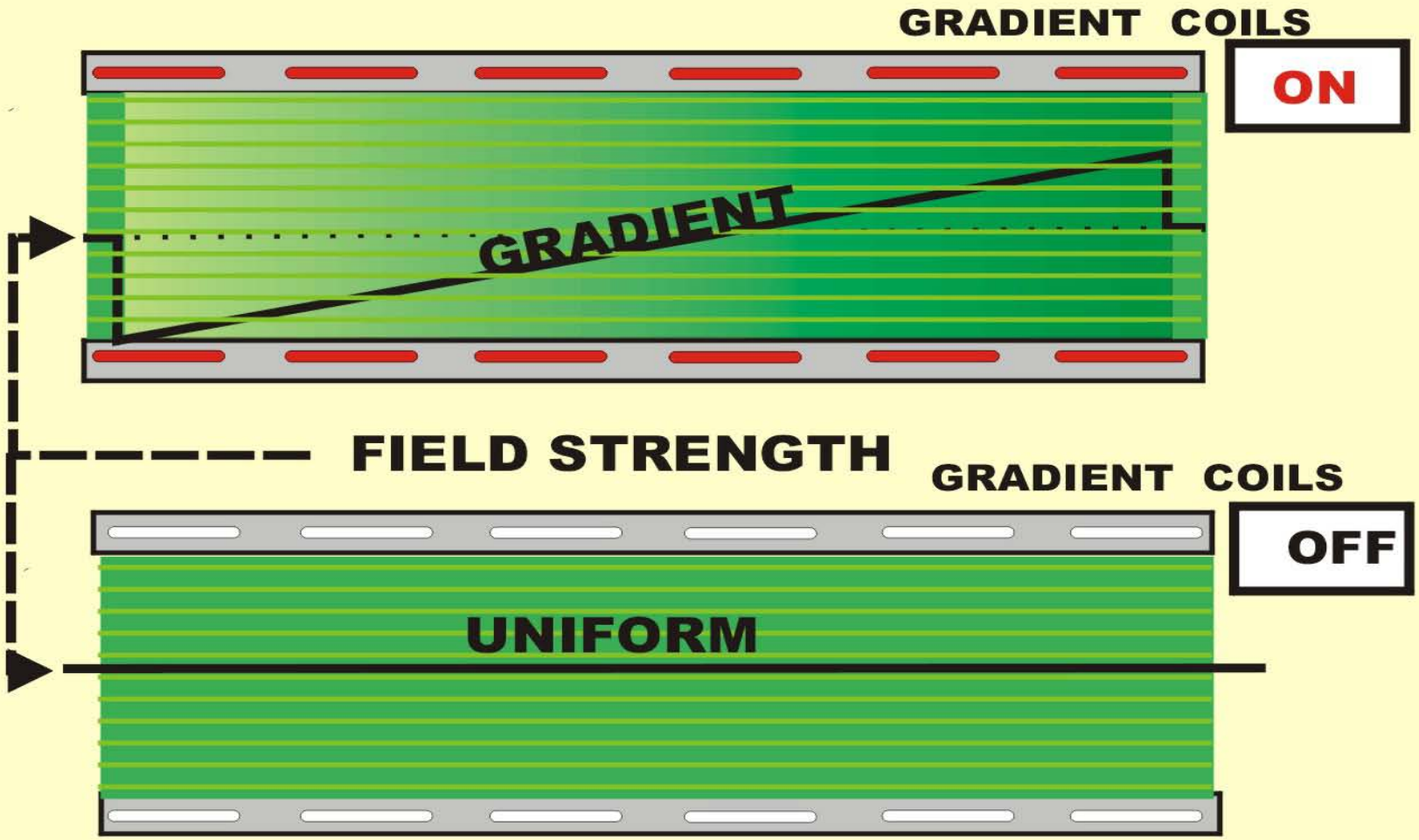
Motivate

Provide Structure and Organization

Learners

Sprawls

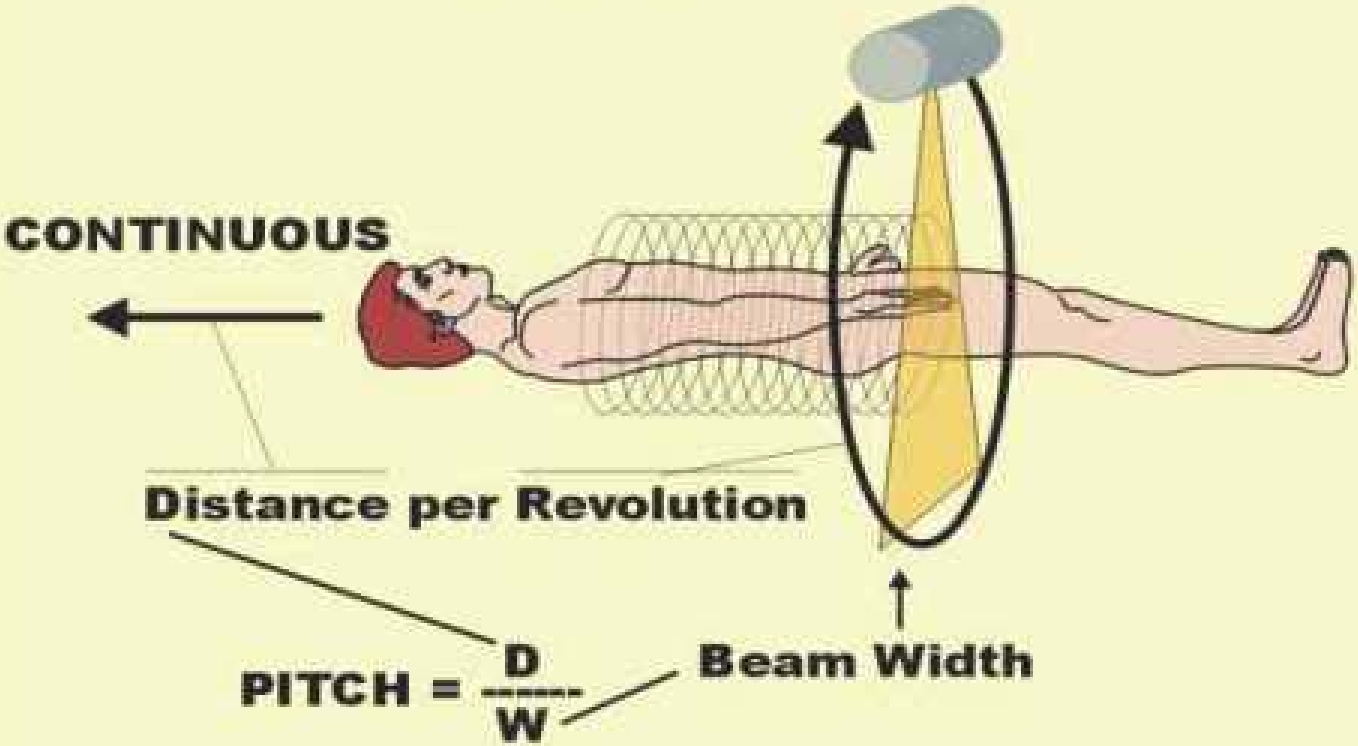
A MAGNETIC FIELD GRADIENT



Sprawls

Spiral (helical) scanning moves the body continuously through the beam.

SPIRAL SCAN



Sprawls

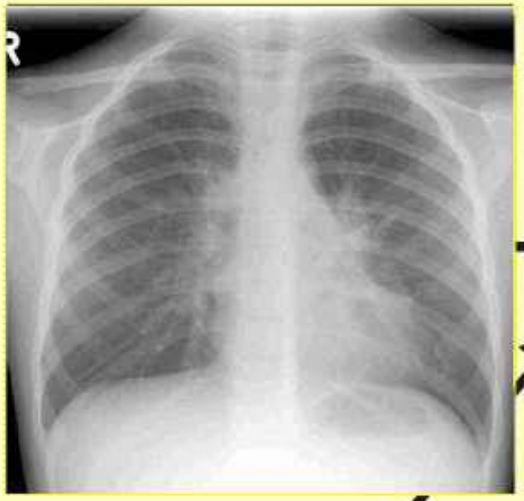
IMAGE NOISE

LOW

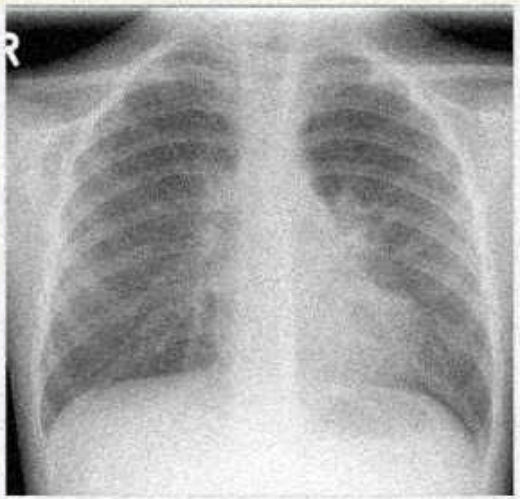
HIGH

Sprawls

Visibility of Low Contrast Anatomy Limited By



NOISE



Electronic

Receptor/Display Structure

X-Ray Beam

Receptor Exposure

Reduced By

BLUR

(Pixel Size)

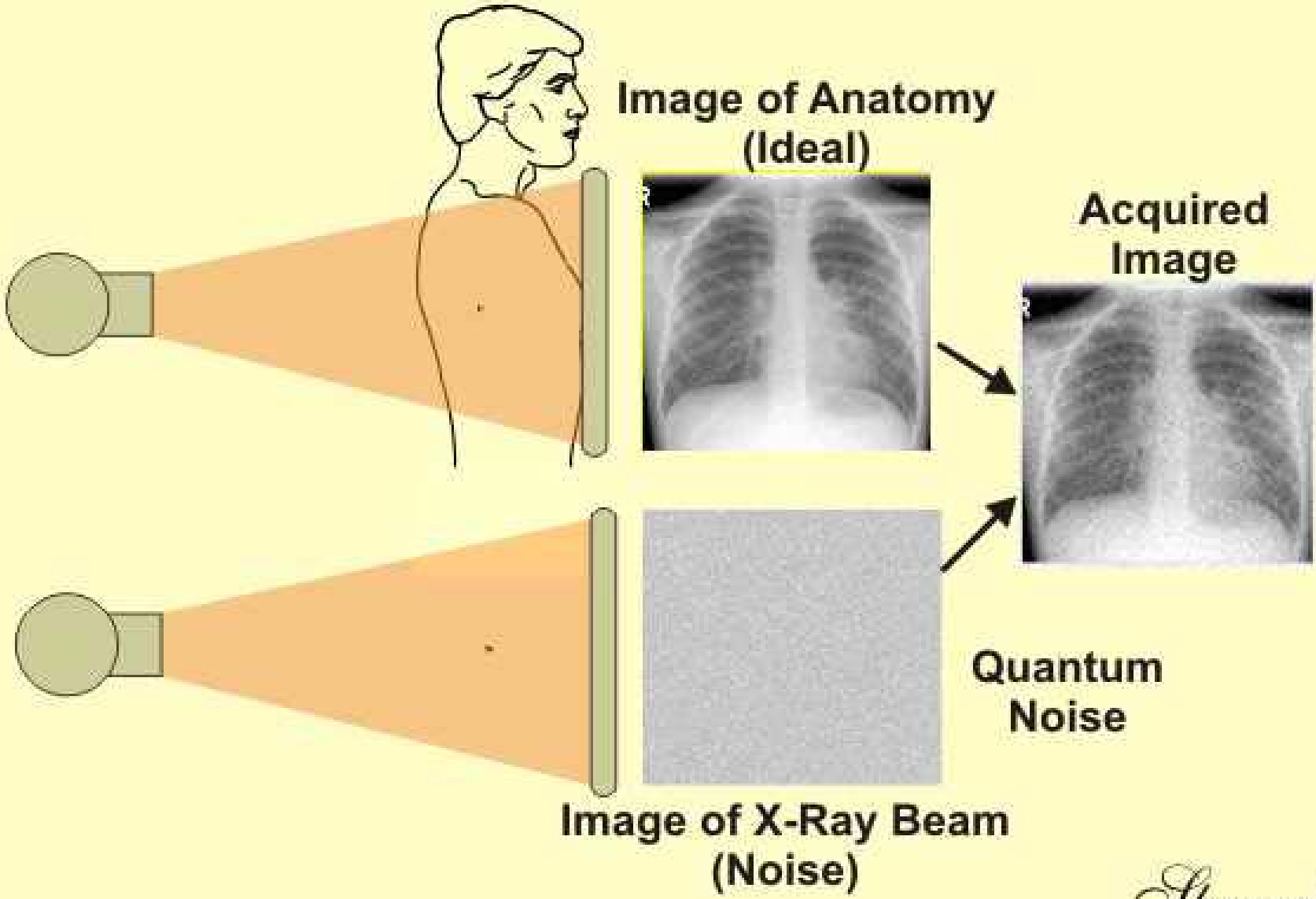
Digital Processing

Sprawls

NOISE

Sprawls

X-Ray Image Noise

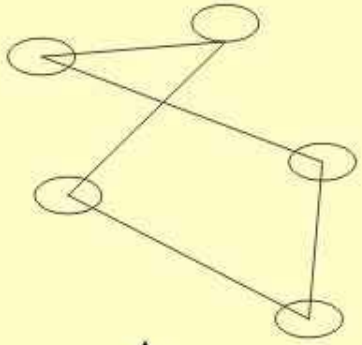


Sprawls

Forming Knowledge Structures

Physical Universe

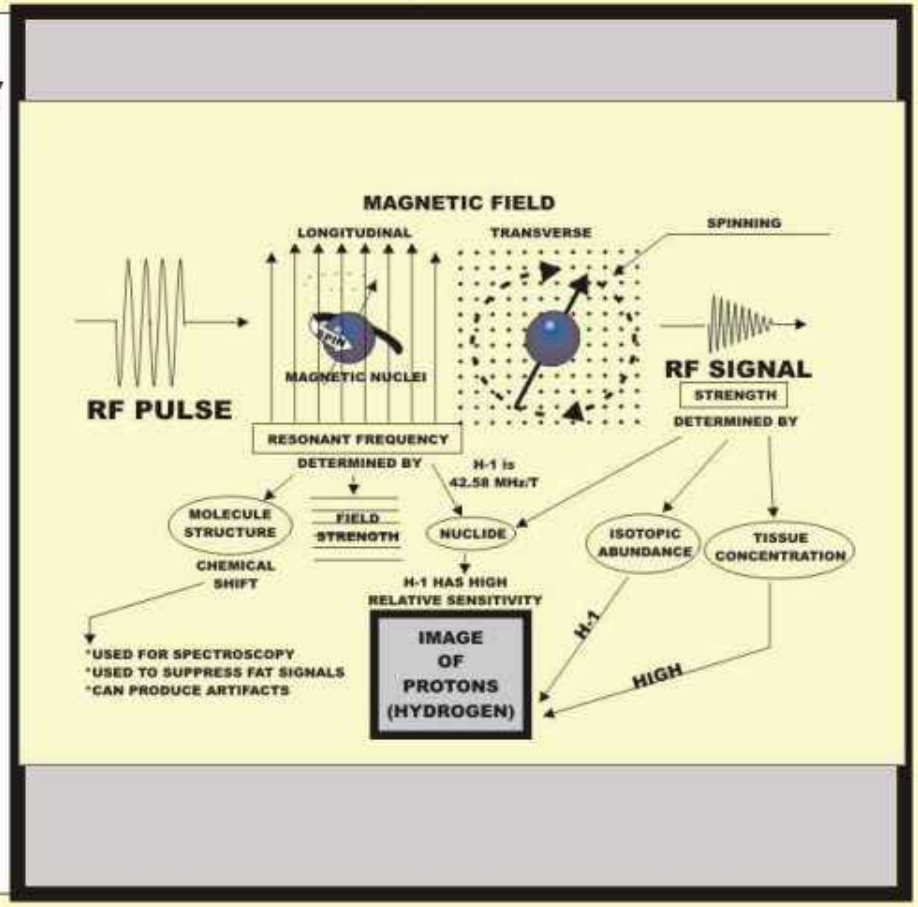
NMR Process



Elements and Relationships

Back Integrative Cortex

Sensory



Visuals

Mindmaps

Sprawls

Mind Map of the NMR Process

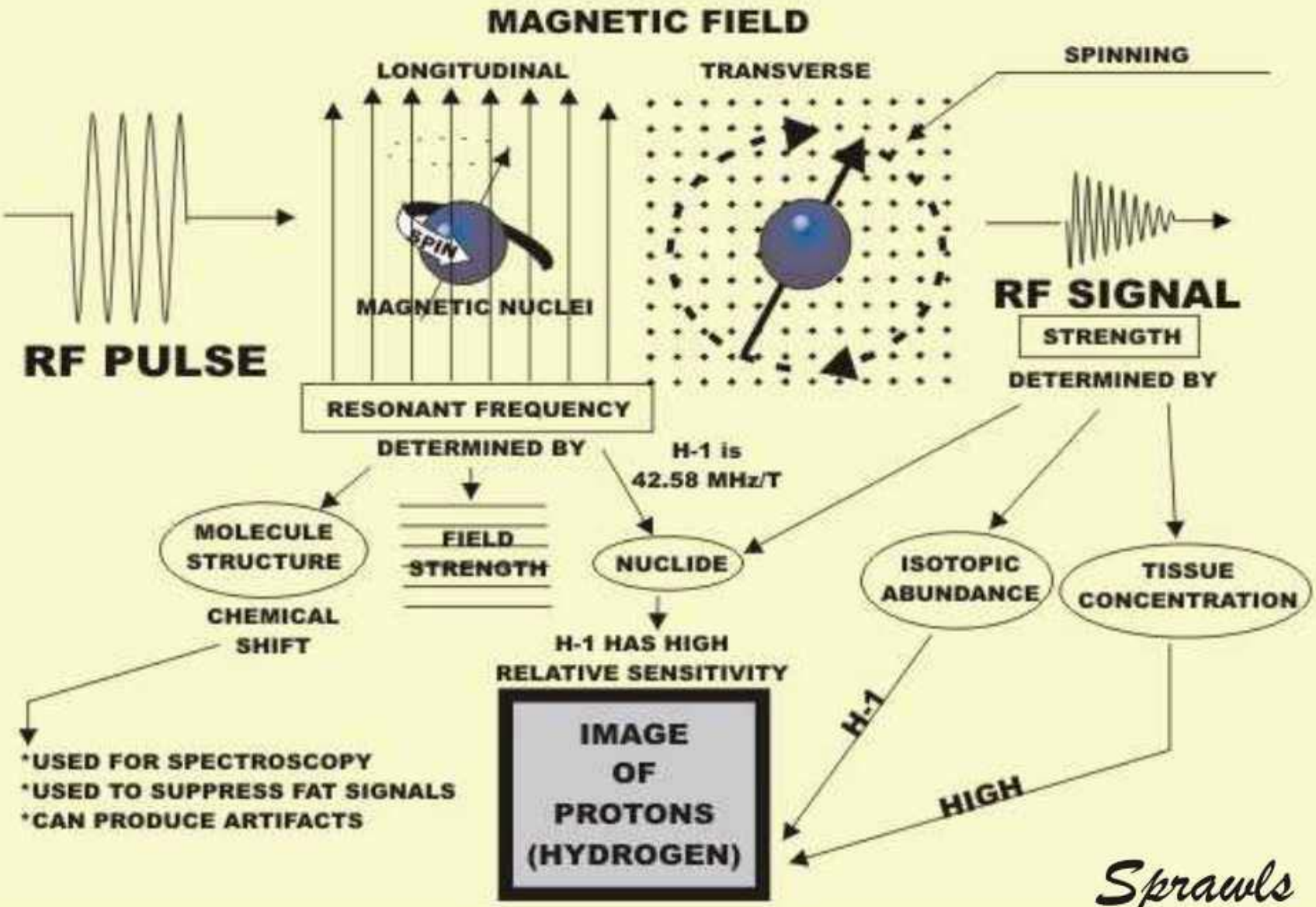
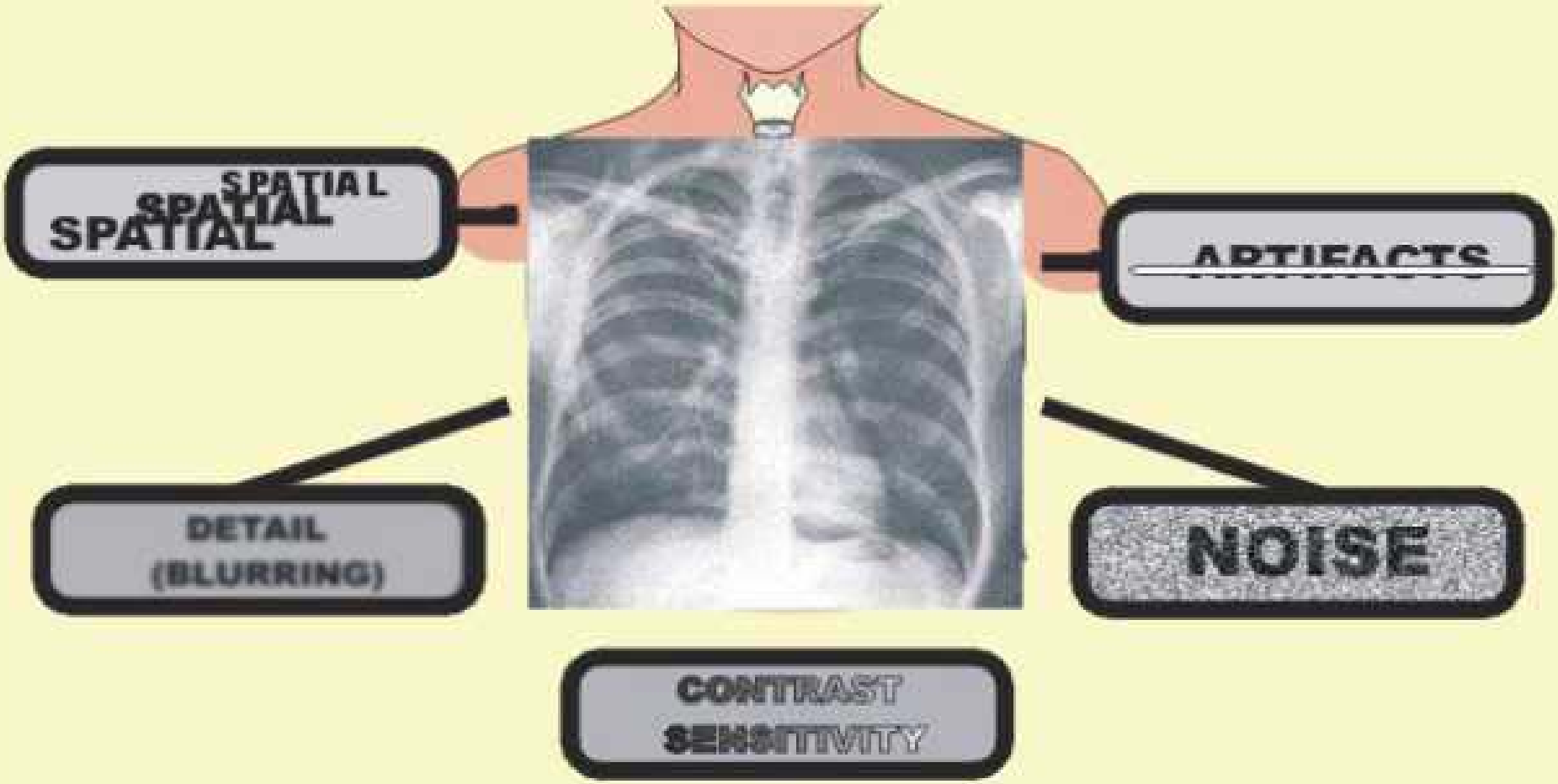


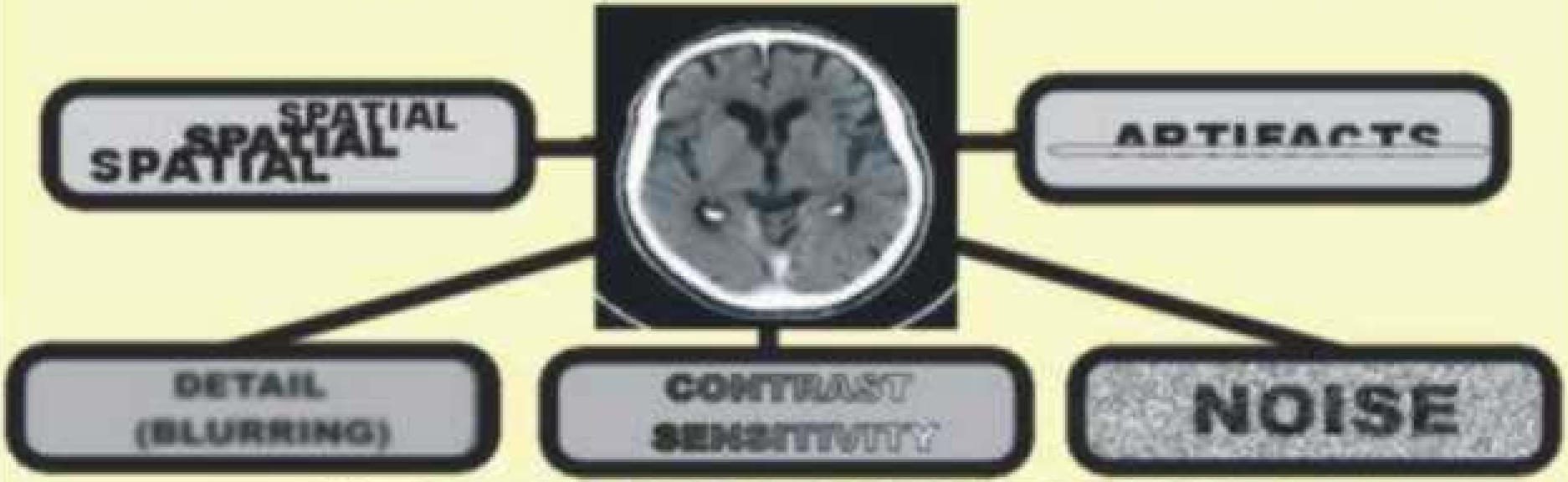
IMAGE QUALITY CHARACTERISTICS



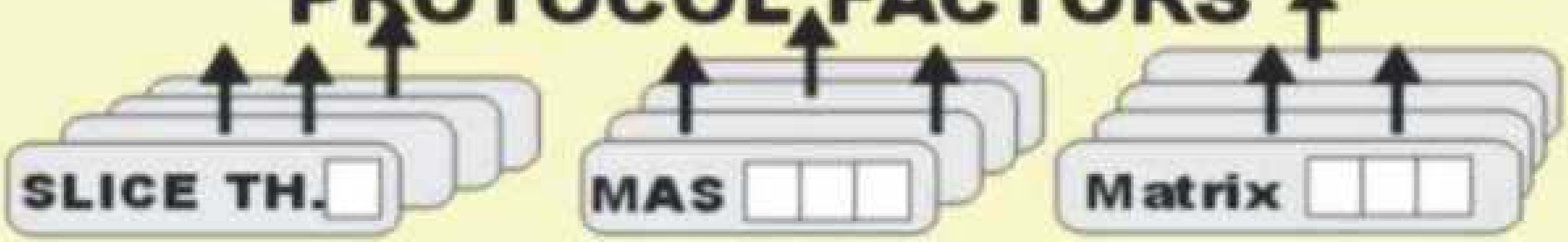
THAT AFFECT VISIBILITY

Sprawls

COMPUTED TOMOGRAPHY QUALITY CHARACTERISTICS

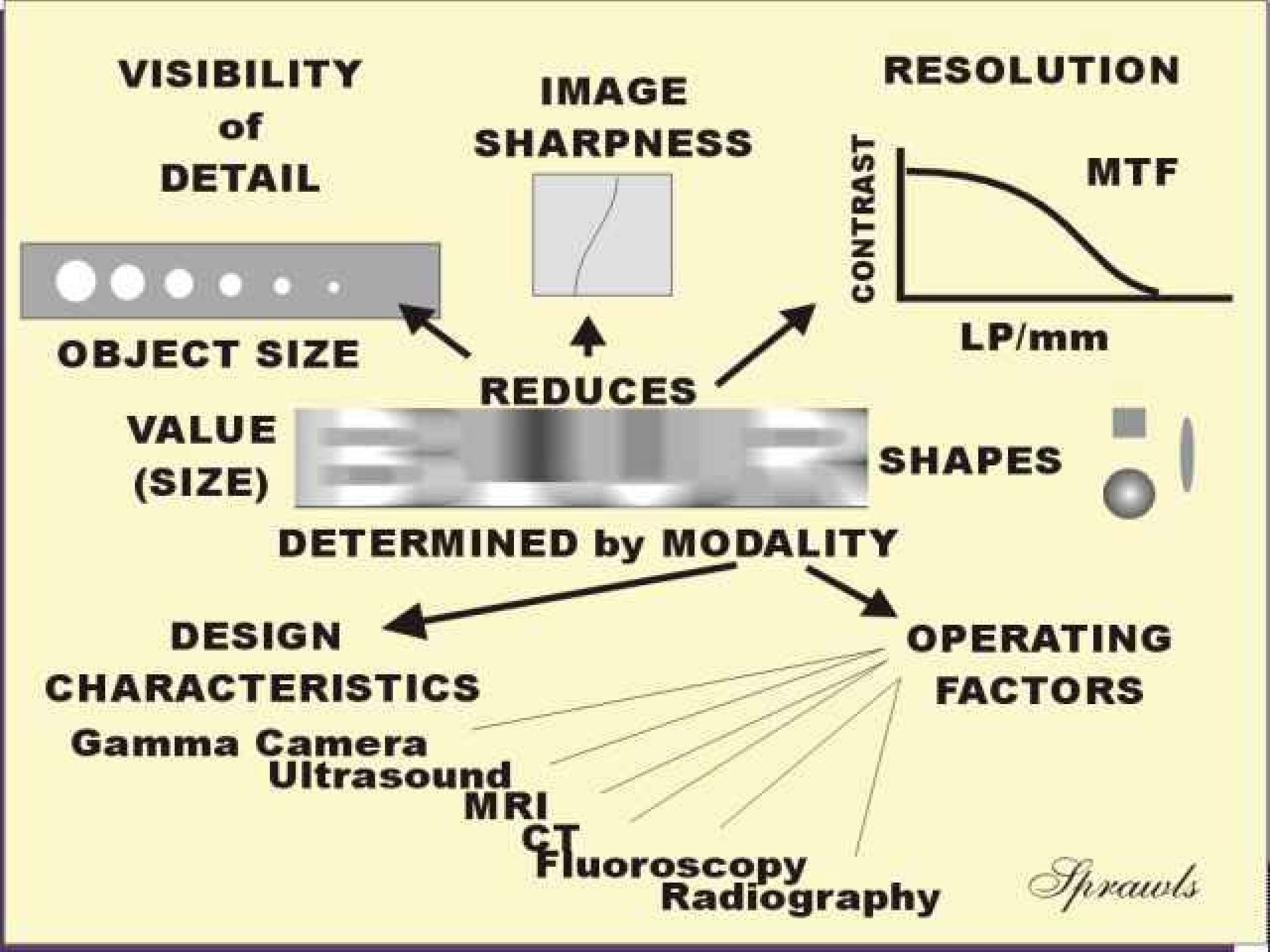


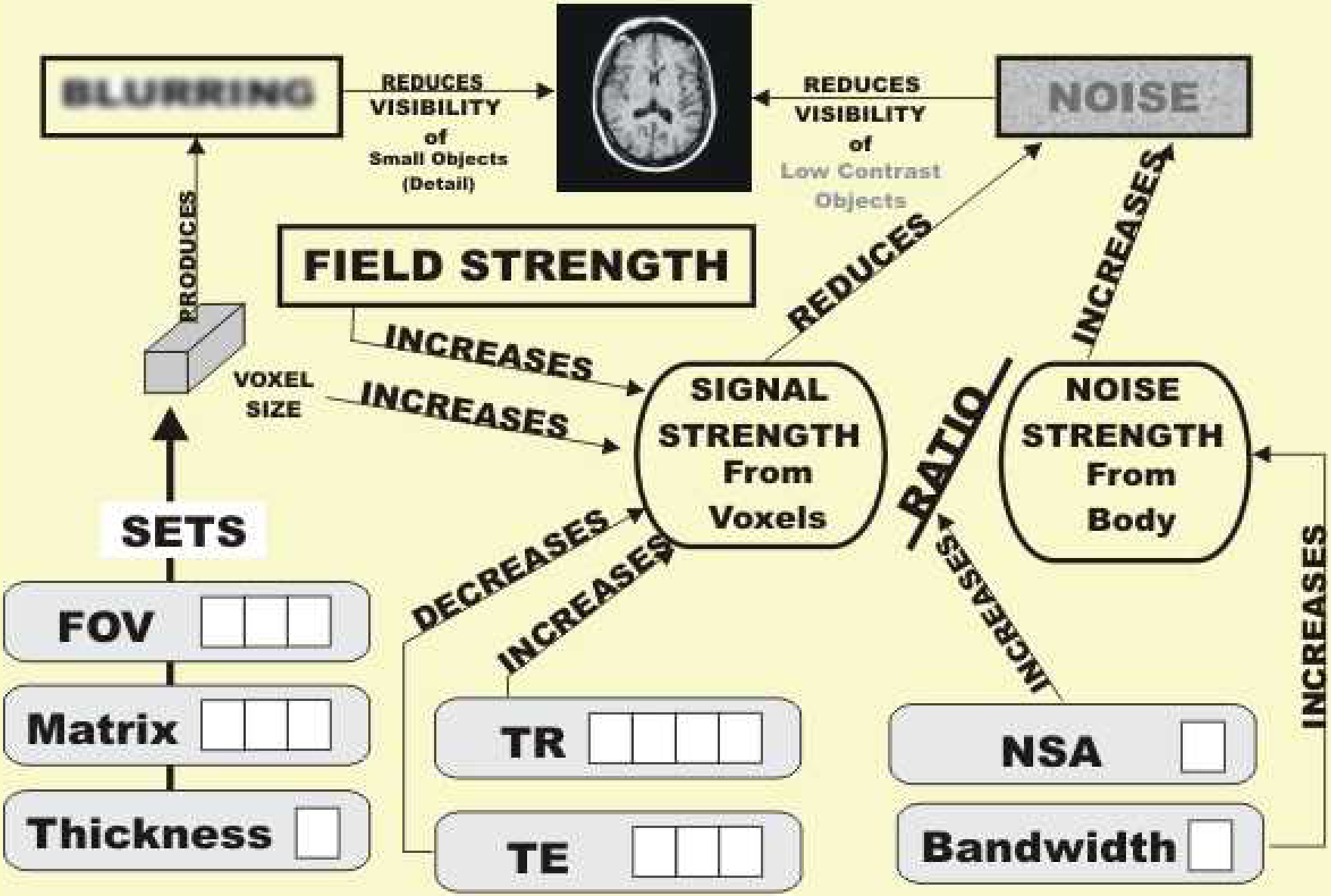
PROTOCOL FACTORS



OPERATION

Sprawls


VISIBILITY of DETAIL
IMAGE SHARPNESS
RESOLUTION
CONTRAST
MTF
LP/mm
OBJECT SIZE
REDUCES
VALUE (SIZE)
BLUR
SHAPES
DETERMINED by MODALITY
DESIGN CHARACTERISTICS
OPERATING FACTORS
Gamma Camera
Ultrasound
MRI
CT
Fluoroscopy
Radiography
Sprawls

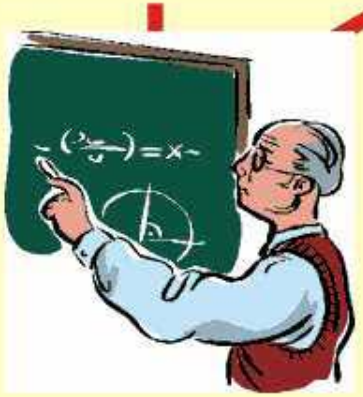

BLURRING
REDUCES VISIBILITY of Small Objects (Detail)
REDUCES VISIBILITY of Low Contrast Objects
NOISE
PRODUCES
FIELD STRENGTH
INCREASES
REDUCES
INCREASES
VOXEL SIZE
INCREASES
SIGNAL STRENGTH From Voxels
RATIO
NOISE STRENGTH From Body
SETS
DECREASES
INCREASES
INCREASES
INCREASES
FOV
Matrix
Thickness
TR
TE
NSA
Bandwidth

Forming Knowledge Structures

Physical Universe

Back Integrative Cortex

Inverse Square Effect



Sensory

Intensity = Power / Area

Surface area of a sphere = $\frac{4\pi r^2}{3}$

So, the luminous intensity on a spherical surface a distance r from a source radiating a total power P is:

$$I = 3P / 4\pi r^2$$

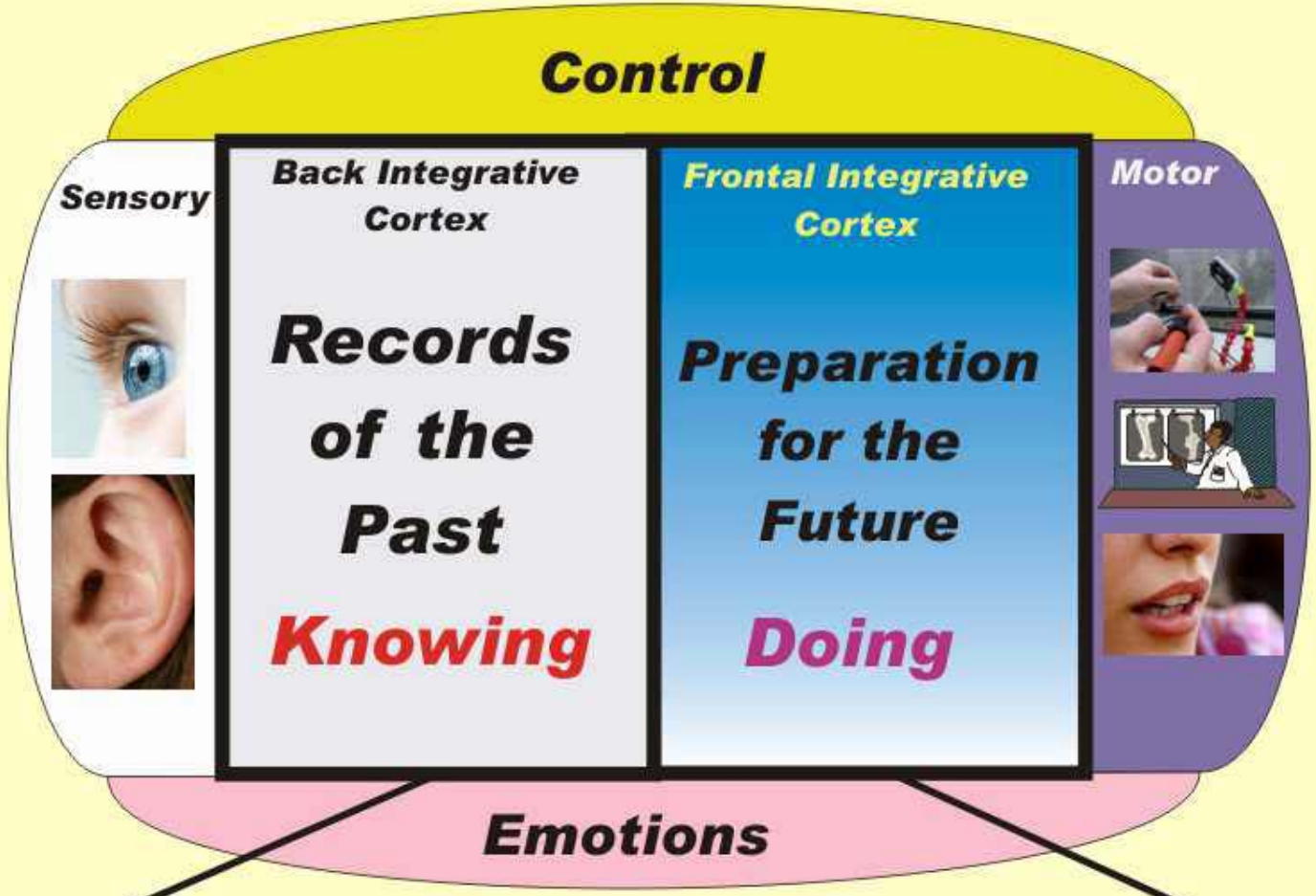
As P and pi remain constant, the luminous intensity is proportional to the inverse square of distance:

$$I \sim 1 / r^2$$

Verbal and Symbolic

Sprawls

Brain Functions for Learning Physics



Balanced Education

Sprawls

Robert Gagne (1916-2002)

Best known for his Nine Events of Instruction

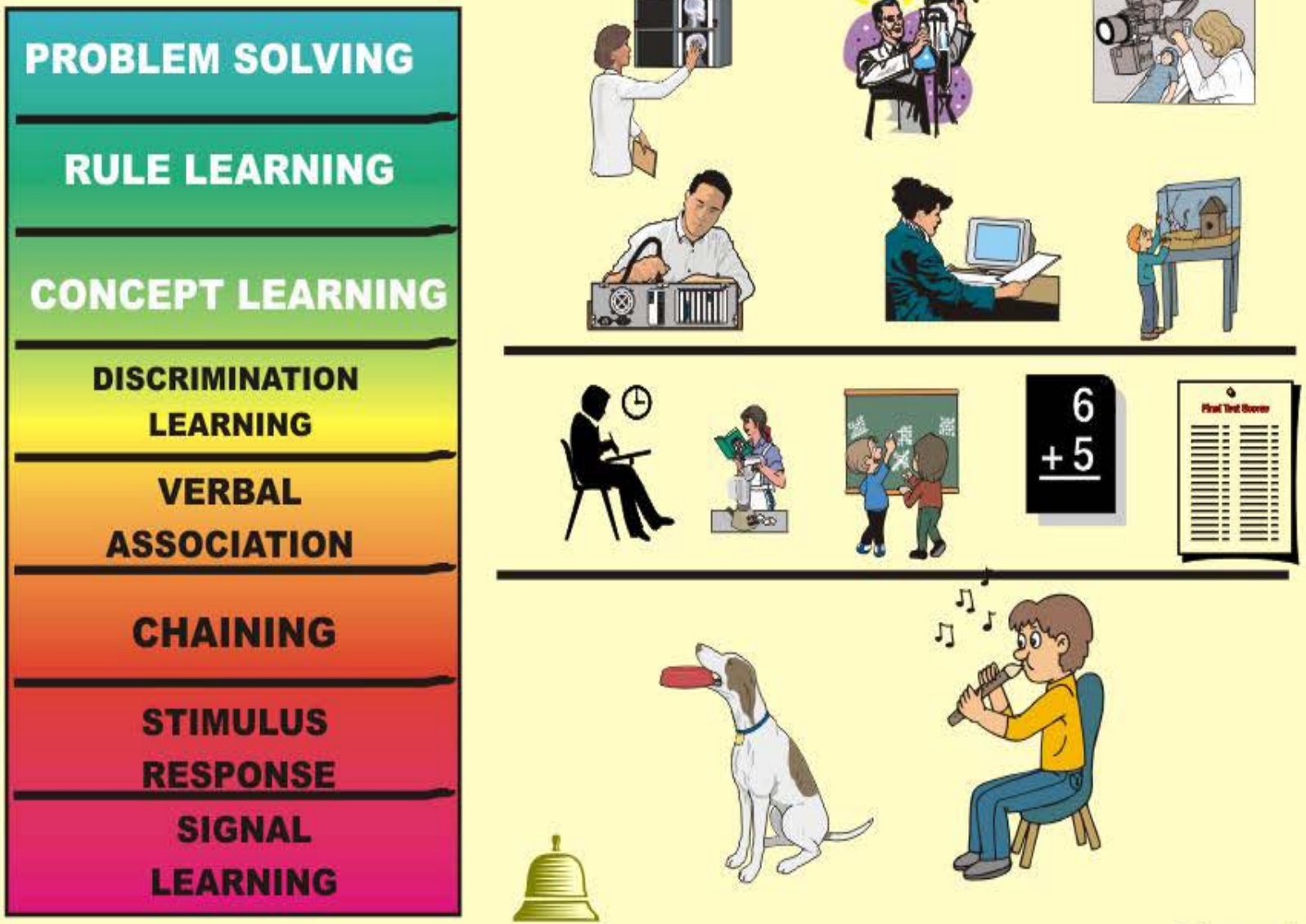
The Gagne assumption is that different types of learning exist, and that different instructional conditions are most likely to bring about these different types of learning

Gagné was also well-known for his sophisticated stimulus-response theory of eight kinds of learning which differ in the quality and quantity of stimulus-response bonds involved. From the simplest to the most complex, these are:

signal learning (Pavlovian conditioning)
stimulus-response learning (operant conditioning)
chaining (complex operant conditioning)
verbal association
discrimination learning
concept learning
rule learning
and problem solving.

Sprawls

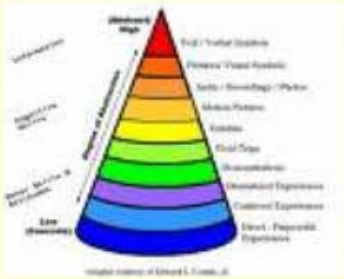
Gagne's Hierarchy of Learning



Edgar Dale (1900-1985)

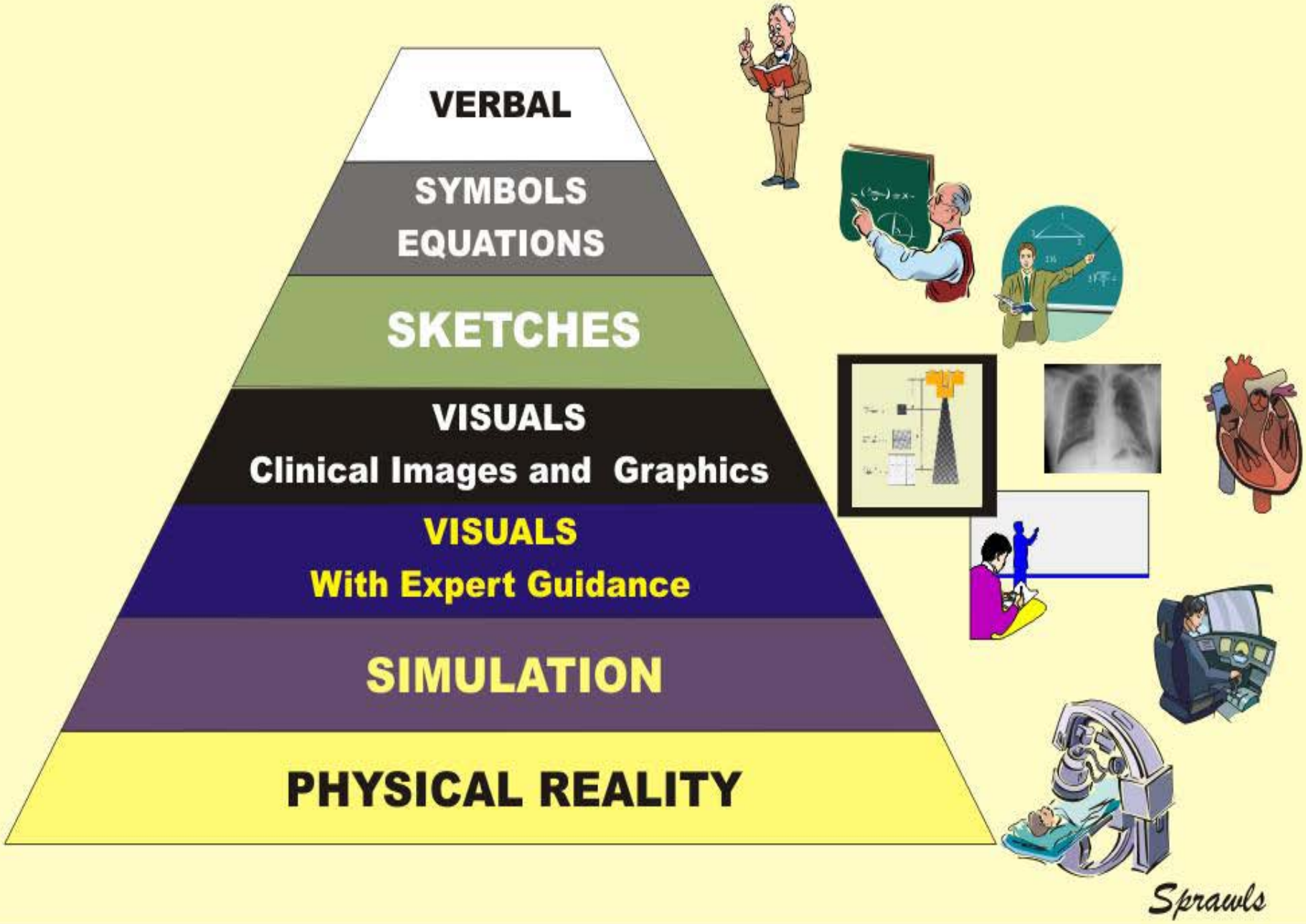
Educationalist who developed the famous

Cone of Experience theory

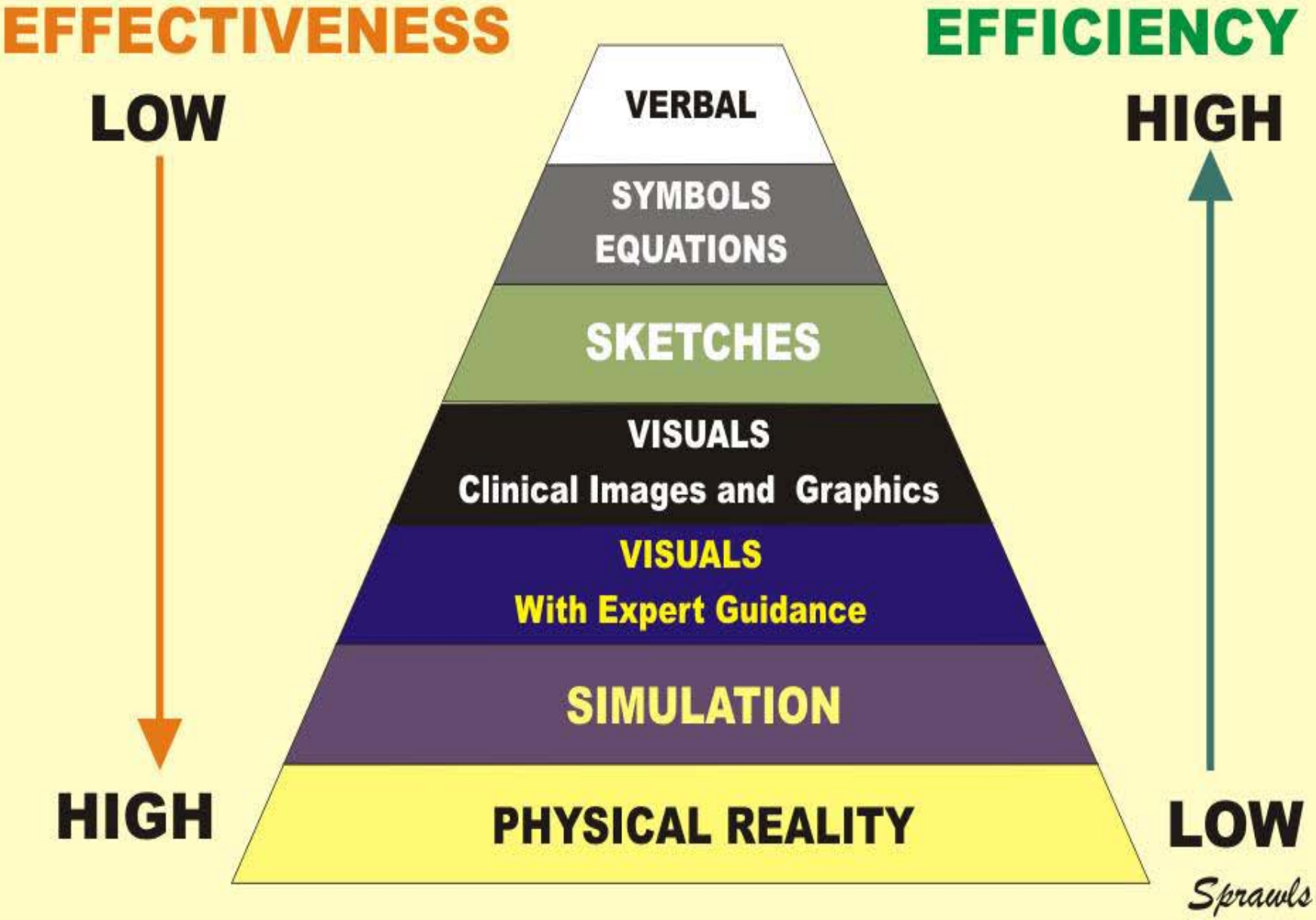


Sprawls

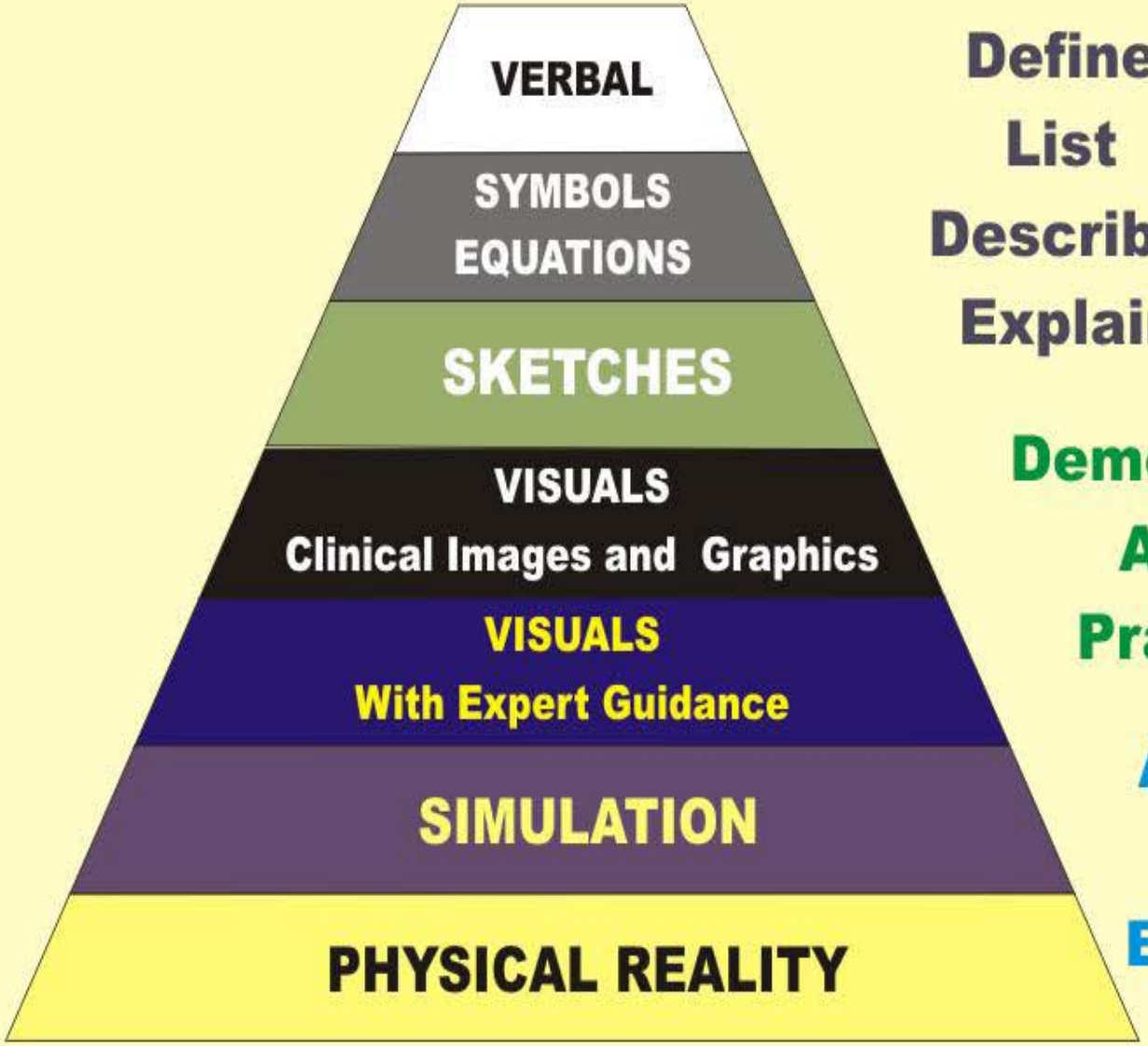
Cone of Experience for Medical Imaging Education



Cone of Experience for Medical Imaging Education



Cone of Experience for Medical Imaging Education



LEARNING OUTCOMES

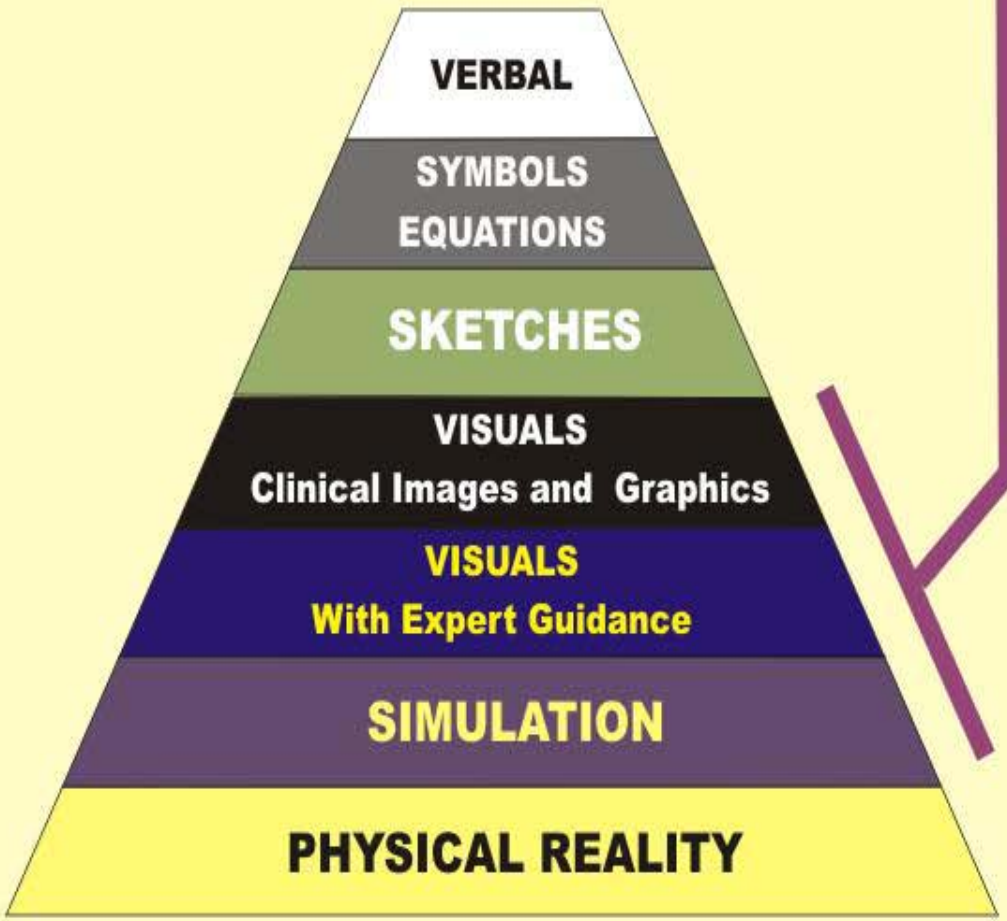
Define
List
Describe
Explain

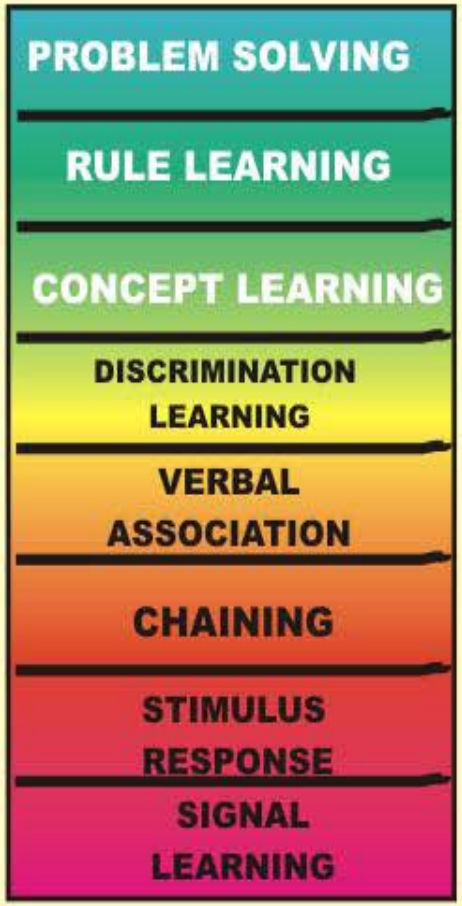
Demonstrate
Apply
Practice

Analyze
Create
Evaluate

Sprawls

Effective Learning



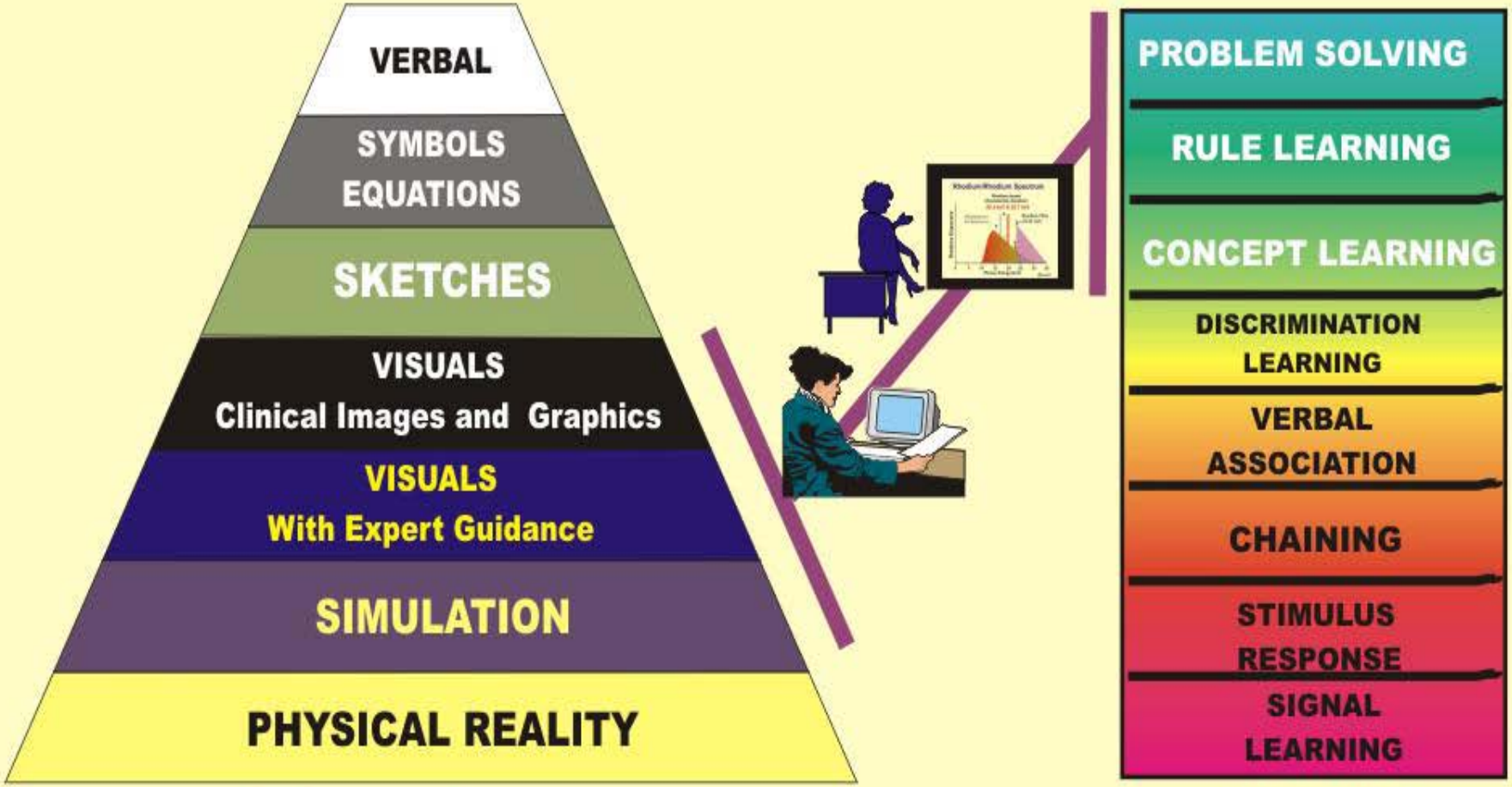


Experience — **Learning** — **Level**

Sprawls

Technology Enhanced

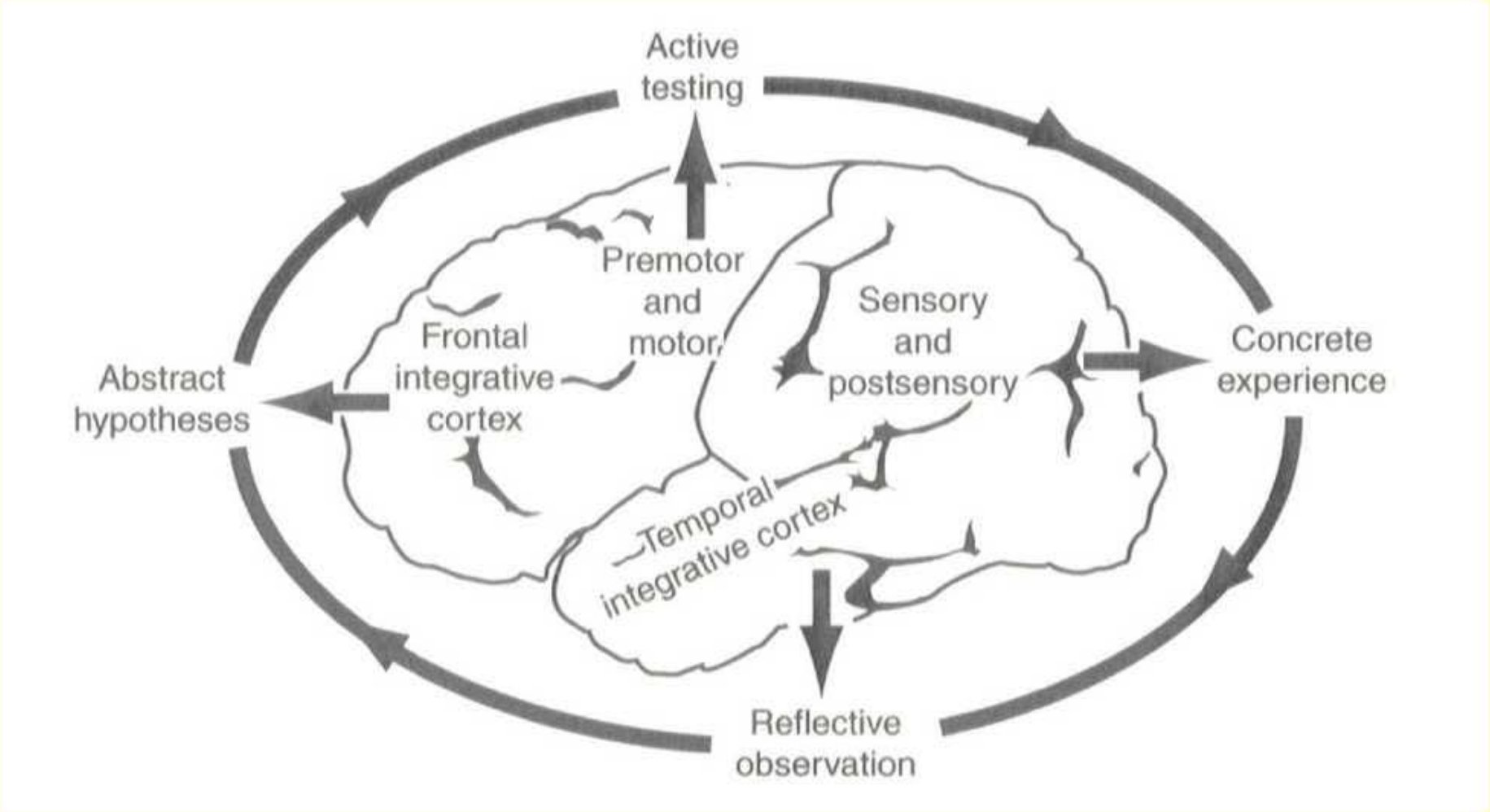
Learning and Teaching



Experience — **Learning** — **Level**

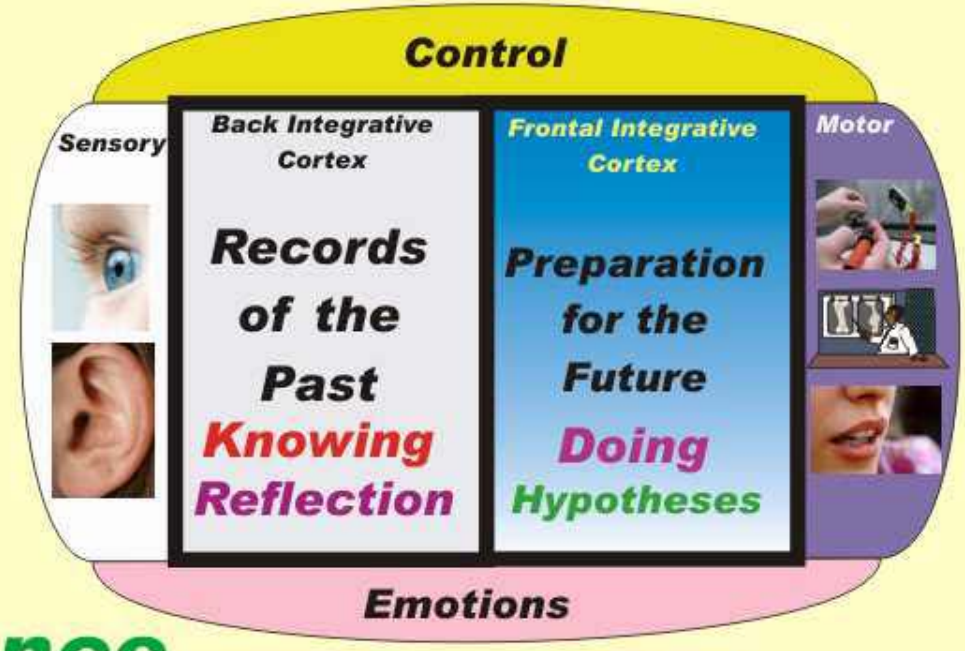
Sprawls

Zull's Model of Brain Function



Brain Functions for Learning Physics

Active Experimentation and Testing



Sense and Experience Observe

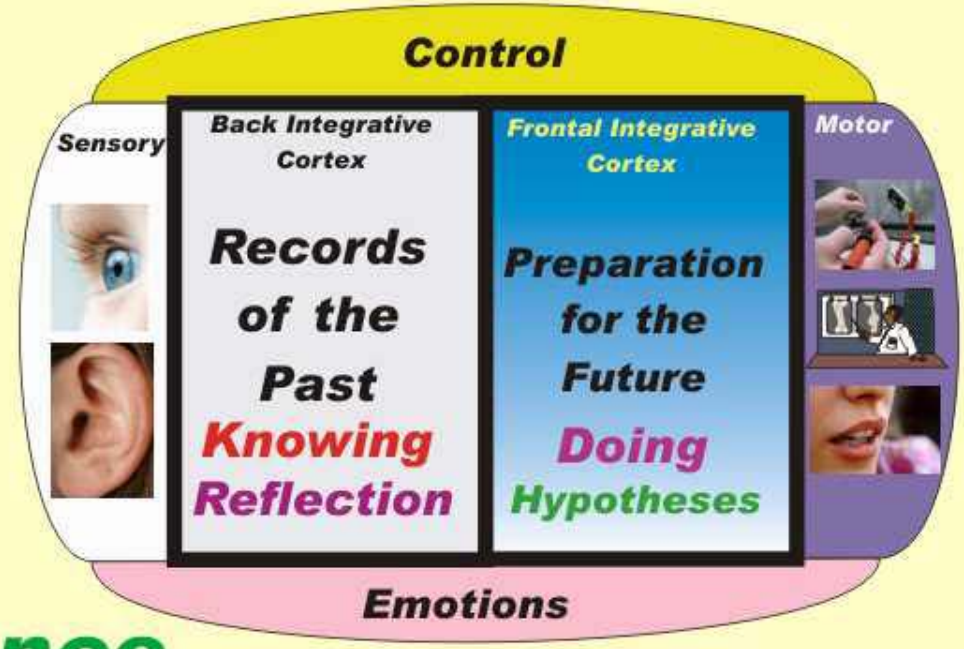
Interact and Affect

Physical Universe

Sprawls

Brain Functions for Learning Physics

Active Experimentation and Testing



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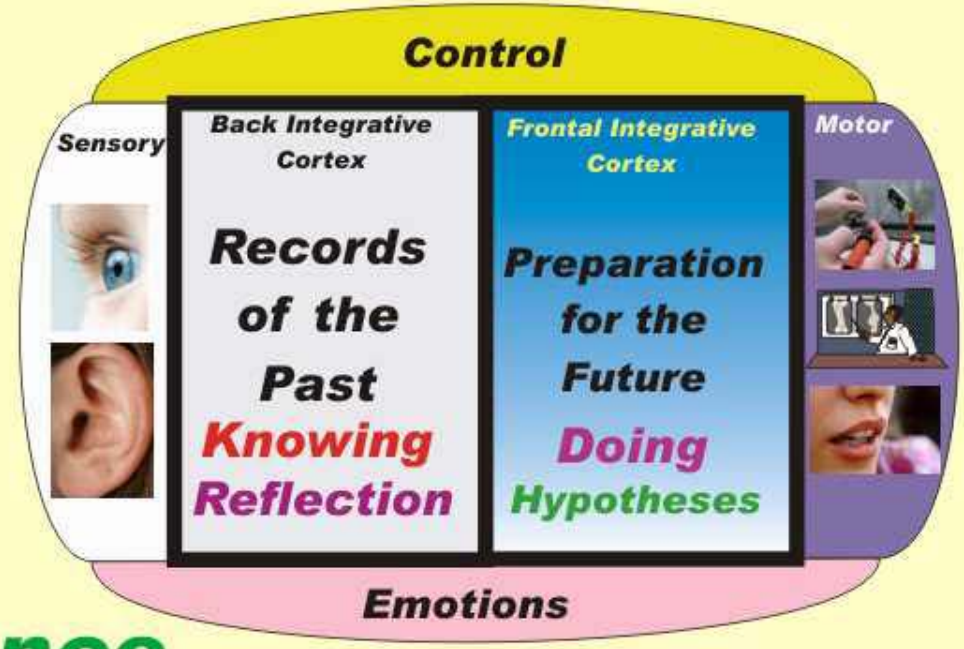

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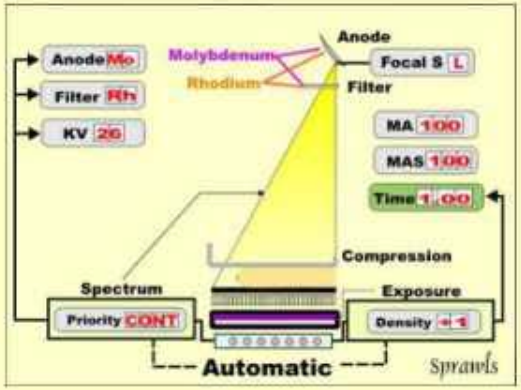
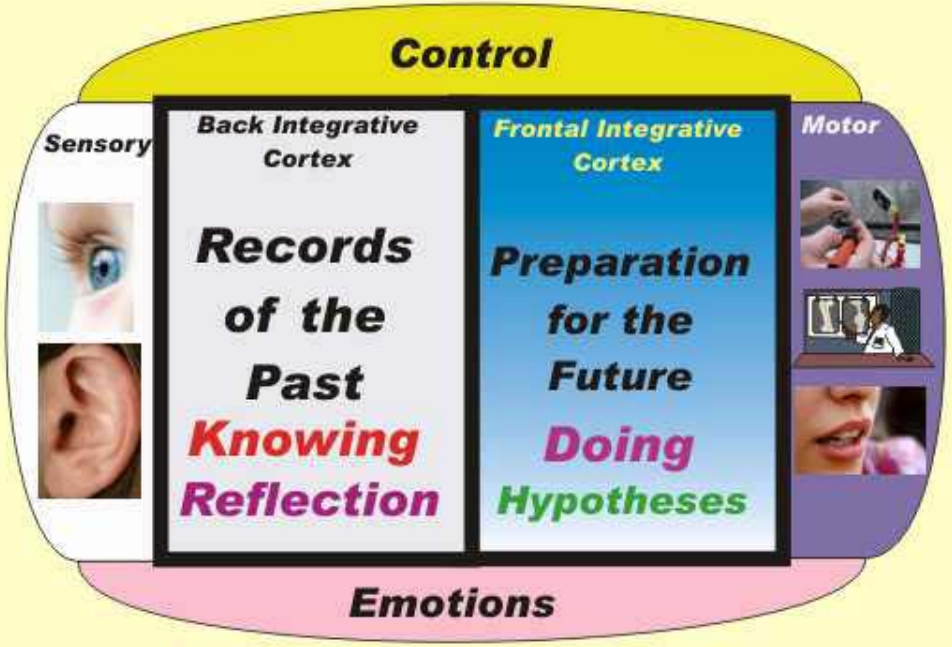


Physical Universe

Sprawls

The Learning Environment



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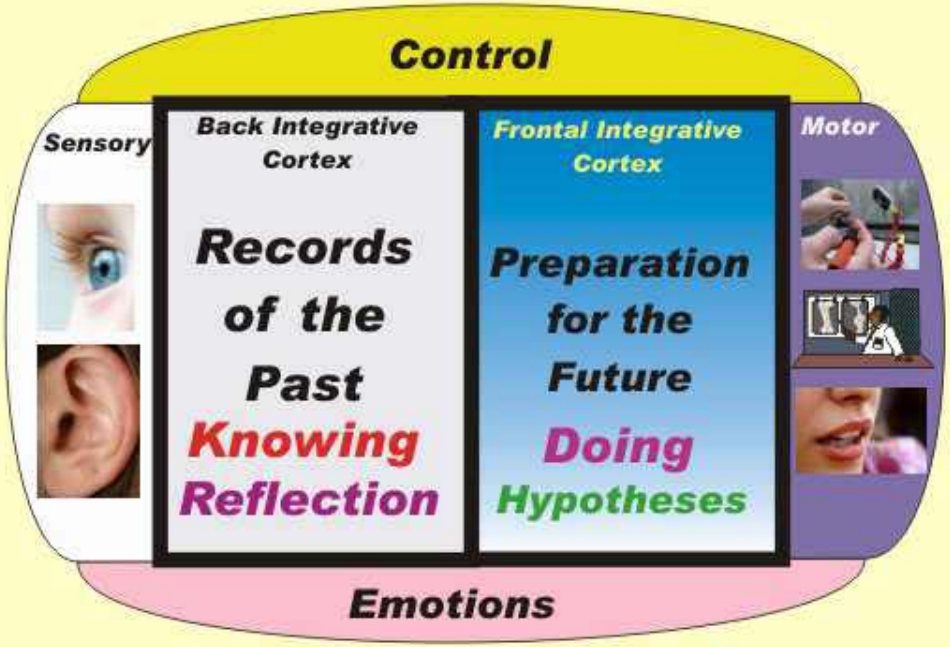
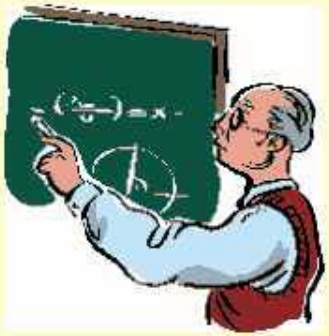
Challenging Learning Environments





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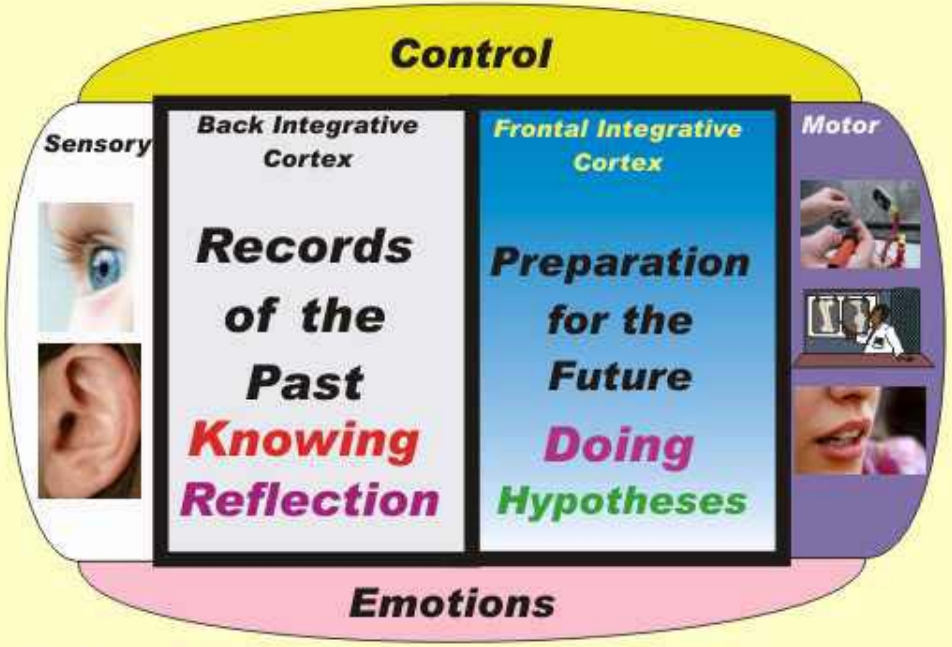
Rich Learning Environments



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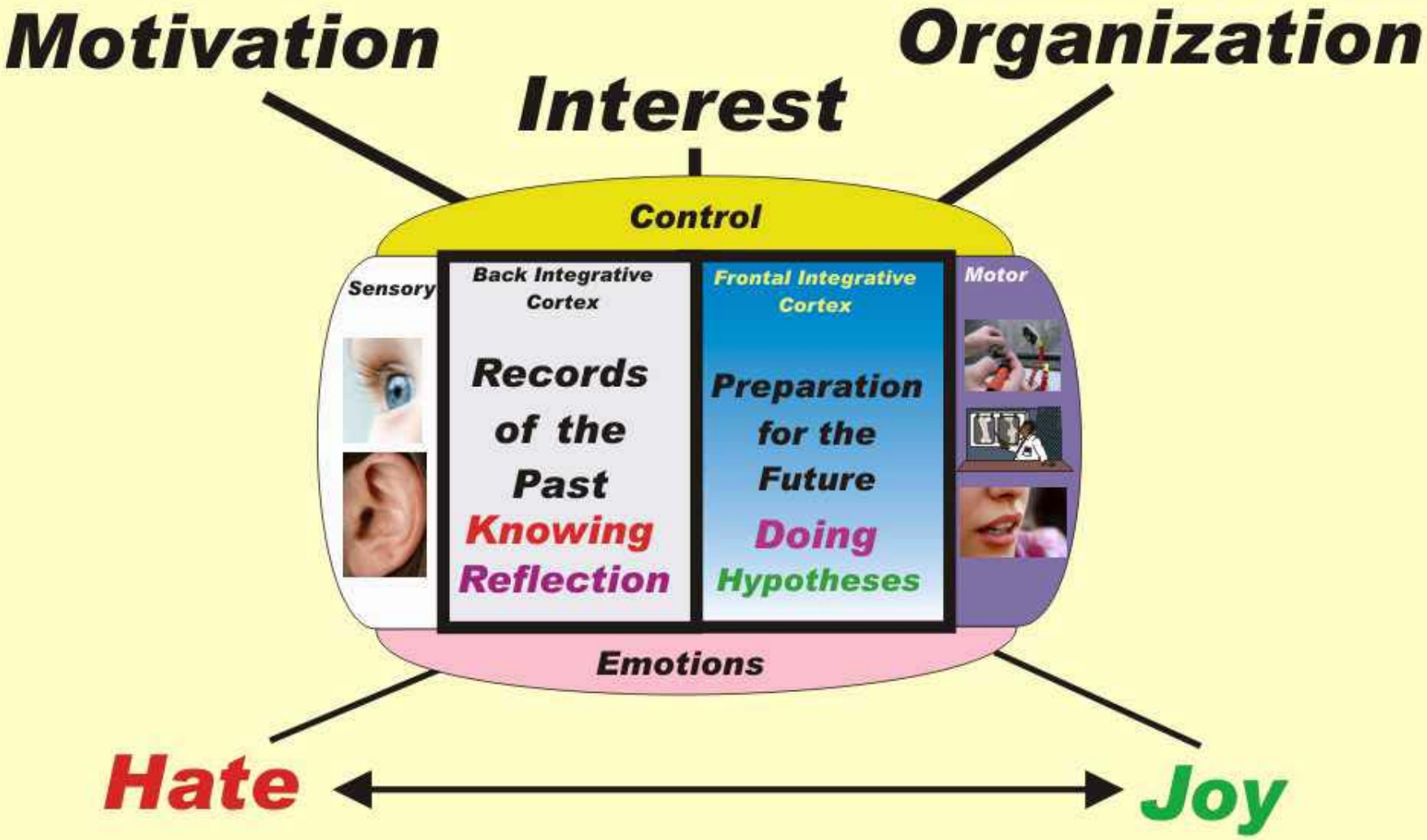
Brain Functions for Learning Physics



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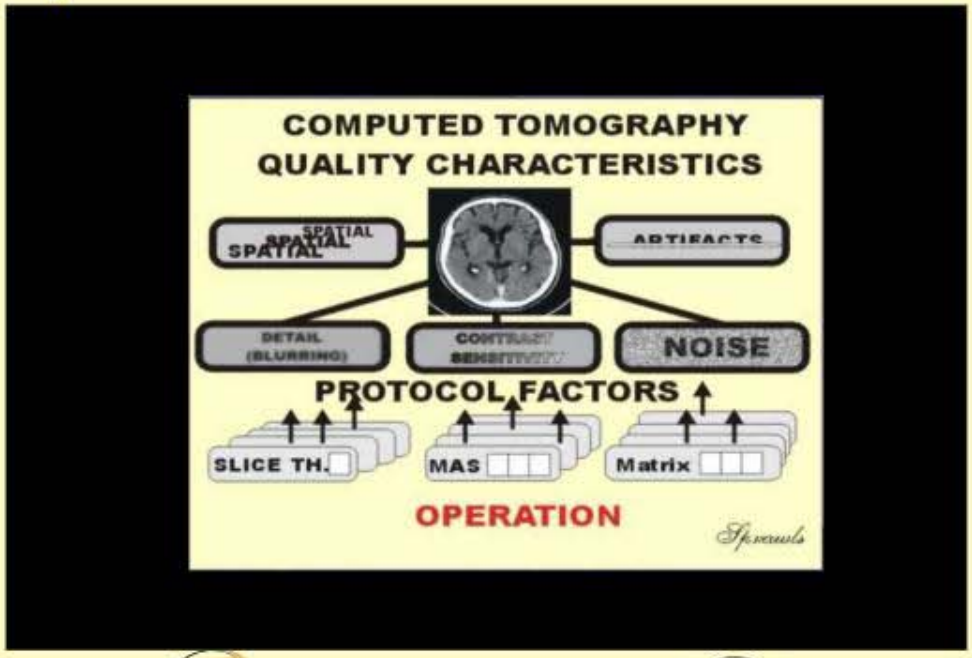
Interactive Group Learning Activity

(Classroom, Conference, Small Group)

Representation of Reality



Guide

(Teacher)

Engage

Motivate

Provide Structure and Organization

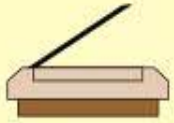
Learners

Sprawls

Why:

1. **Is Medical Imaging Physics Education Changing?**
2. **Do we have Evolving Models?**

Sprawls



Digital Technology

Tools for:

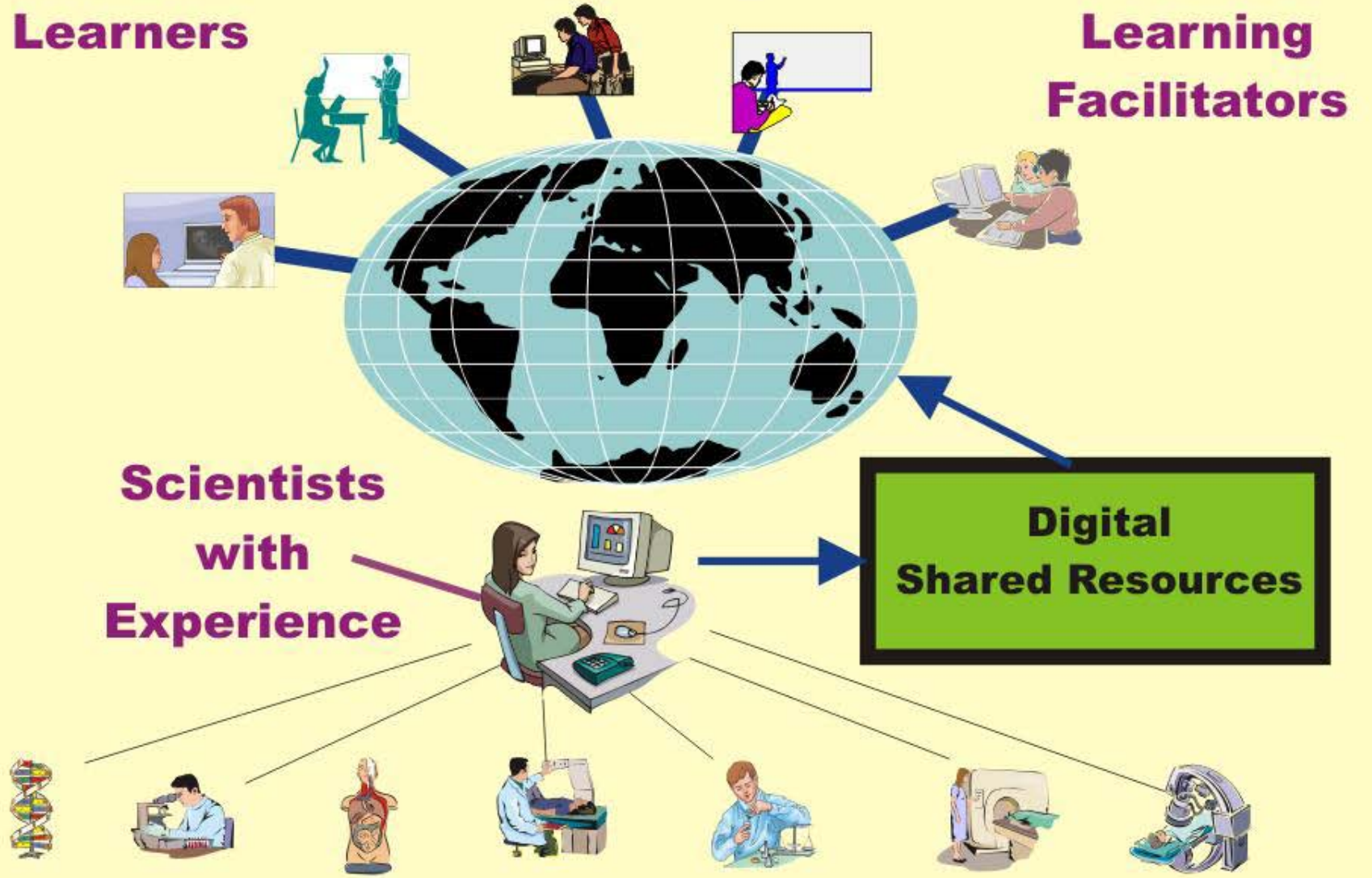
Developing High Quality Educational Resources

Organizing and Managing Resources

Distributing and Sharing Resources

Sprawls

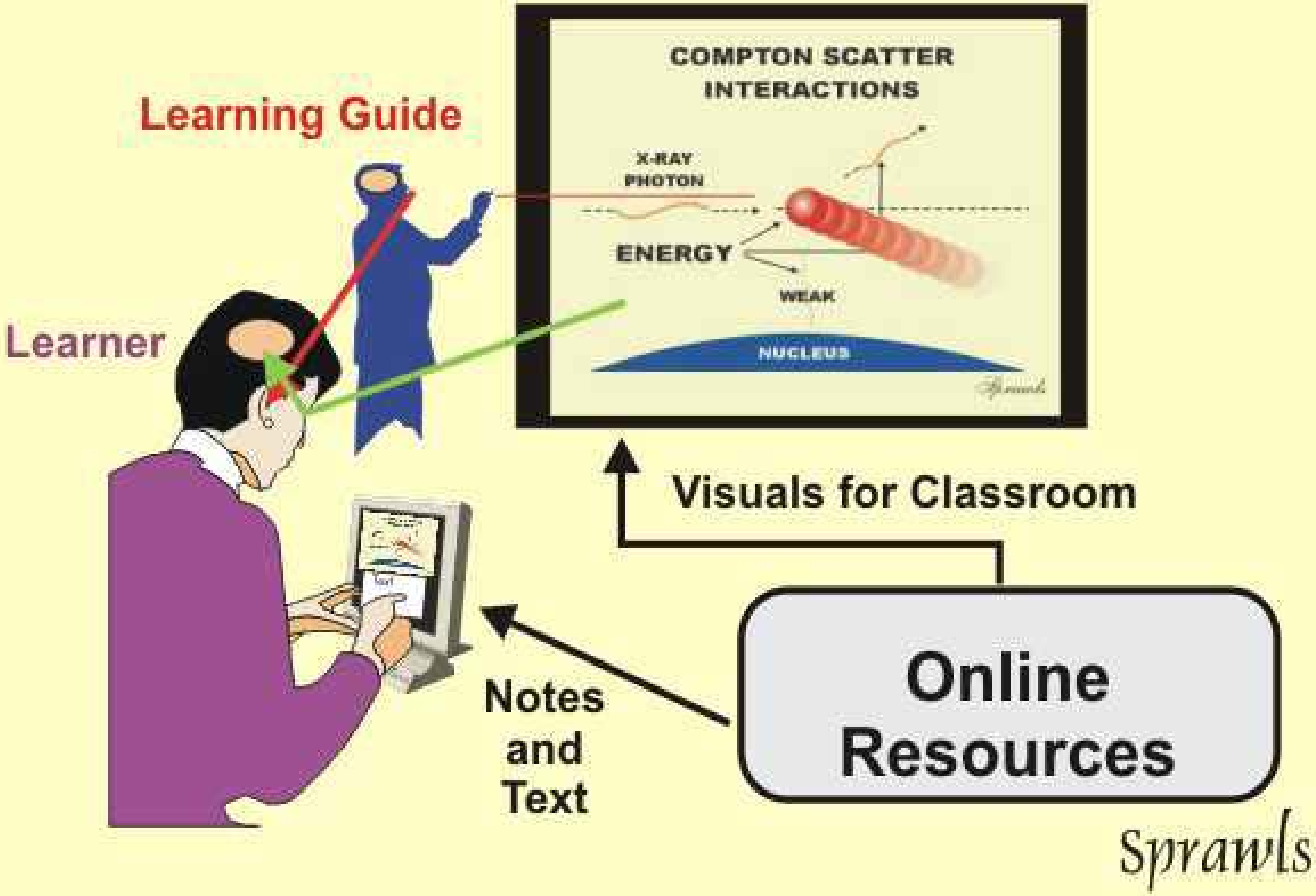
Enriched Learning Environments

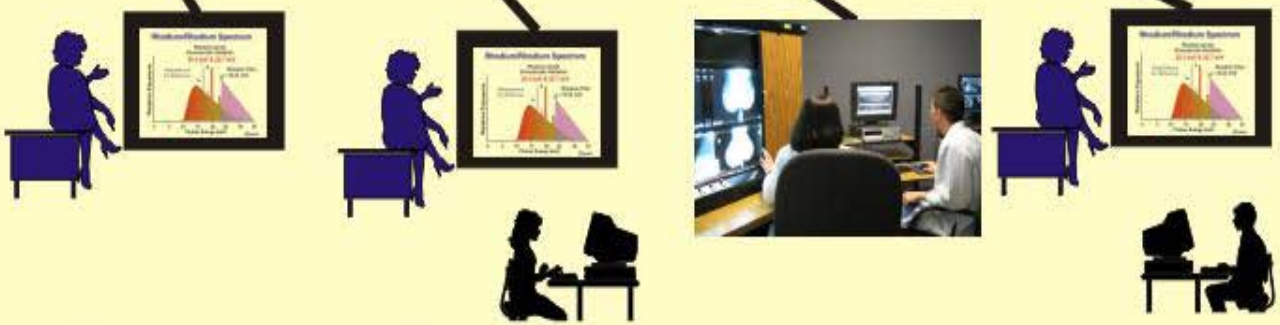


The Physical Universe

Sprawls

Technology Enhanced Learning





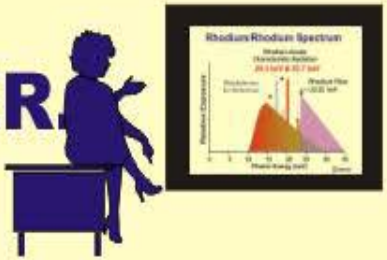
In Partnership with Other Medical Physics Teachers

to be More Effective and Efficient in Providing

Medical Imaging Education

The Values We Hold

The PHYSICIST is the TEACHER.



TECHNOLOGY is the TOOL that can be used for effective and efficient teaching.

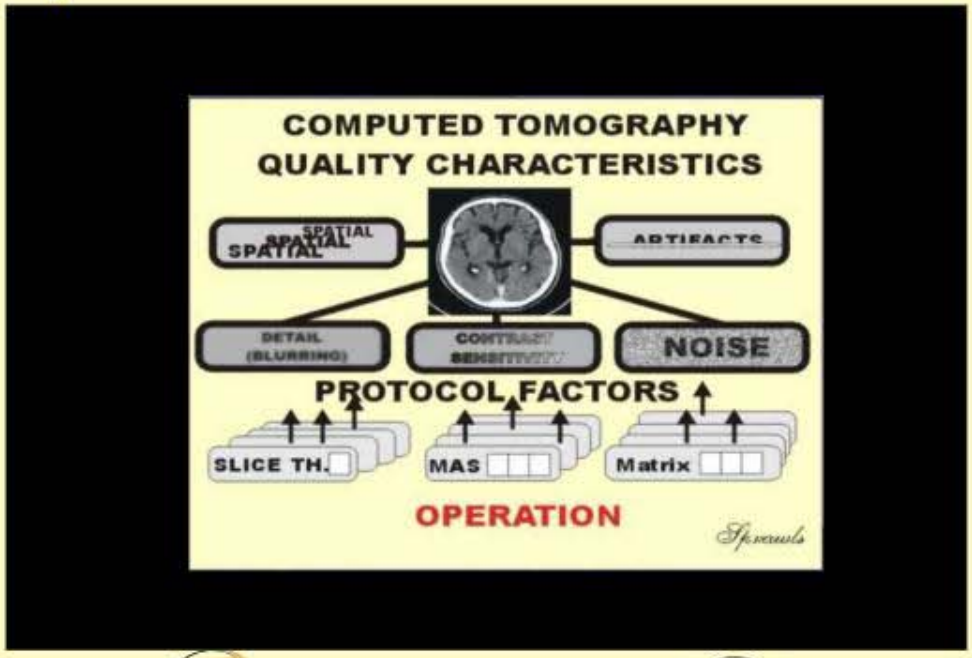
Technology should be used to enhance human performance of both learners (residents, students, etc.) And teachers

Sprawls

Interactive Group Learning Activity

(Classroom, Conference, Small Group)

Representation of Reality



Guide

(Teacher)

Engage

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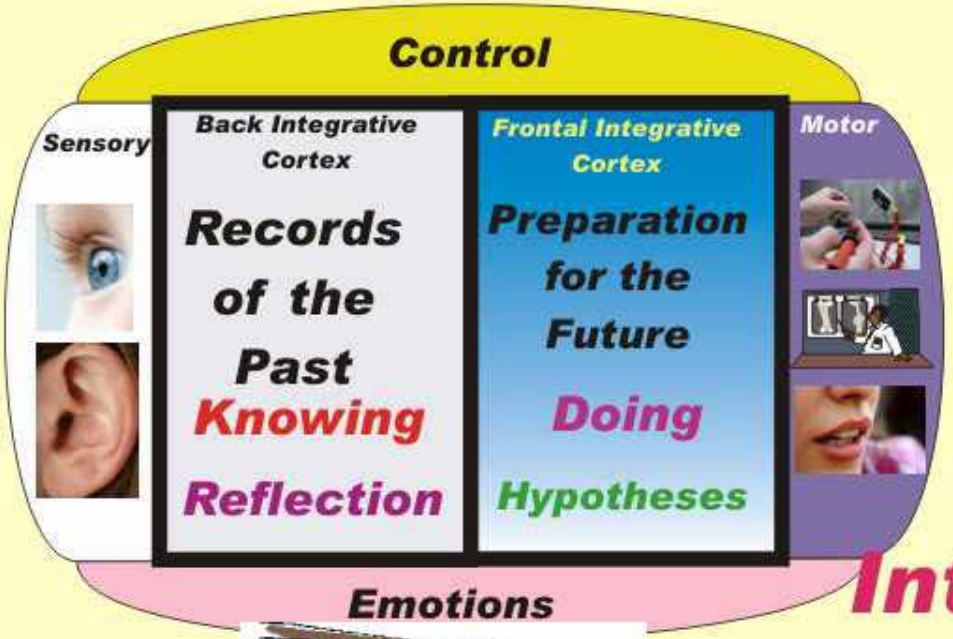
Sprawls

Brain Functions for Learning About

Learning Physics



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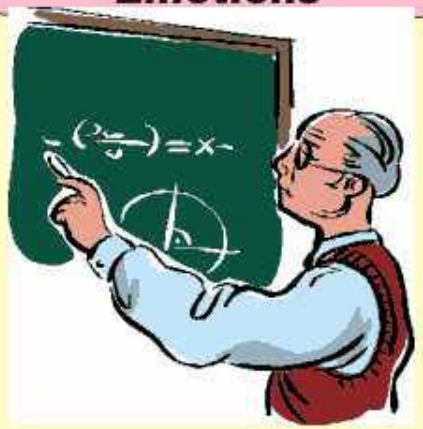


Our Teaching

Sprawls

Developing Rich Learning Experiences for Medical Physics Education

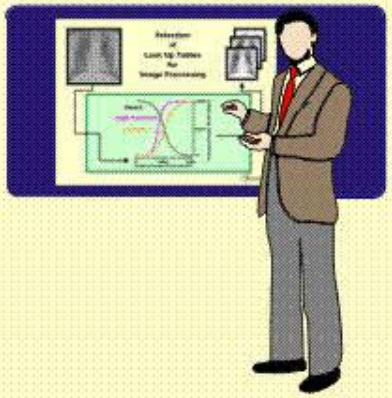
Perry Sprawls, Ph.D.

Emory University

and

Sprawls Educational Foundation

Xhttp://www.sprawls.org



This Course Web Site

http://www.sprawls.org/learning