Effective

Medical Physics Educational Activities

Models and Methods

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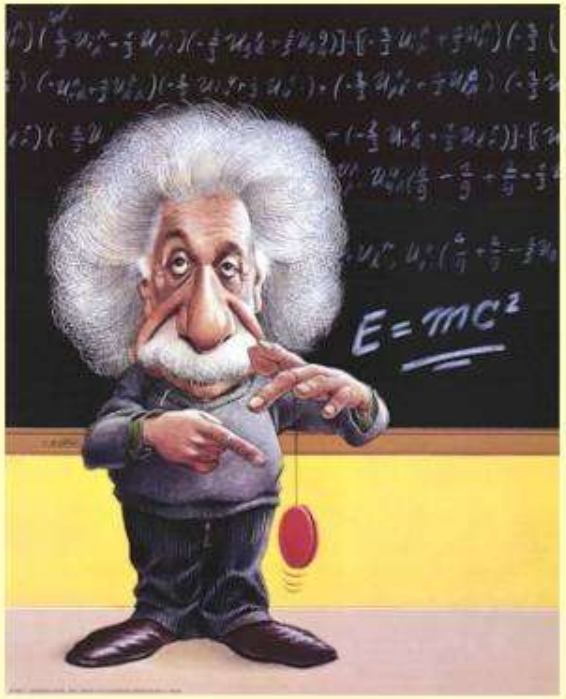
The Physicist as an Educator and Teacher

Our Objectives

Provide more EFFECTIVE learning activities.



Be EFFICIENT in our teaching

Challenges Opportunities

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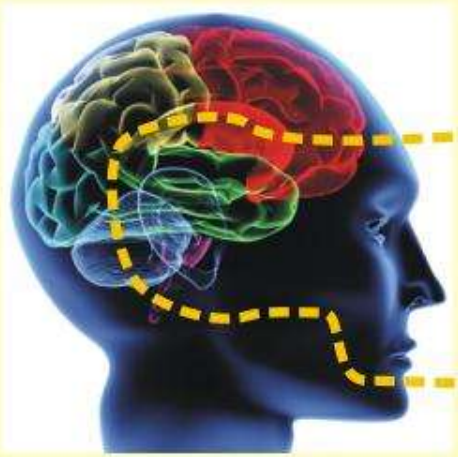
The Elements of
A Highly Effective Educational Session

The Brain

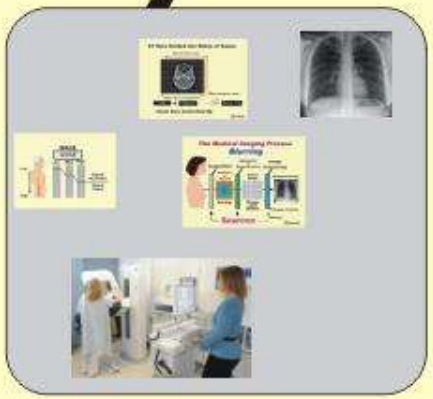


Connection

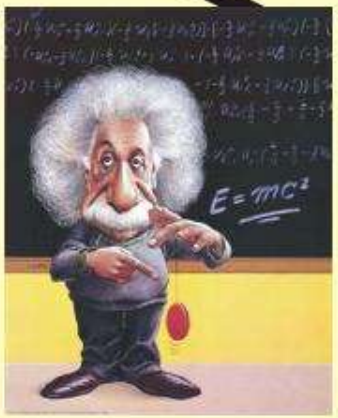
Observe

Interact

The Physical Universe
(Physics of Medical Imaging)



"Window"



Teacher /Guide

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Clinically Focused Physics Education

Classroom

Clinical Conference

Small Group

"Flying Solo"

Learning Facilitator
"Teacher"

Individual
and
Peer Interactive
Learning

Each type of learning activity has a unique value.

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January 23, 1896

The Spectrum of Learning Activities

For

Medical Physics

Effectiveness

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The Spectrum of Learning Activities

For

Medical Physics

Verbal ⟷ **Visual**

Effectiveness

Sprawls

The Spectrum of Learning Activities

For

Medical Physics

Passive ⟷ **Interactive**

Verbal ⟷ **Visual**

Effectiveness

Sprawls

The Spectrum of Learning Activities

For

Medical Physics

Easy ⟷ Effort

Passive ⟷ Interactive

Verbal ⟷ Visual

Effectiveness

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The Spectrum of Learning Activities

For

Medical Physics

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Easy ⟷ Effort

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Verbal ⟷ Visual

Effectiveness

Sprawls

The Spectrum of Learning Activities

For

Medical Physics

Tradition ⟷ Innivation

$ ⟷ $$$$

Easy ⟷ Effort

Passive ⟷ Interactive

Verbal ⟷ Visual

Effectiveness

Sprawls

The Spectrum of Learning Activities

For

Medical Physics

Tradition	Innivation
$	$$$$
Easy	Effort
Passive	Interactive
Verbal	Visual

Effectiveness

Sprawls

The Spectrum of Learning Activities

For

Medical Physics

Where do you fit in?

Effectiveness

Sprawls

The Spectrum of Learning Activities

For

Medical Physics










Effectiveness

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Large Classroom
Effective or Efficient ?

Large Classroom Effective or Efficient ?

Effective Medical Physics Education

is like a

Giant Puzzle

What do you bring to the table?

What do I bring to the table?

~~A Lecture~~

~~To Talk To You~~

~~Tell You What I Know~~

Share Experience
and
Some Resources

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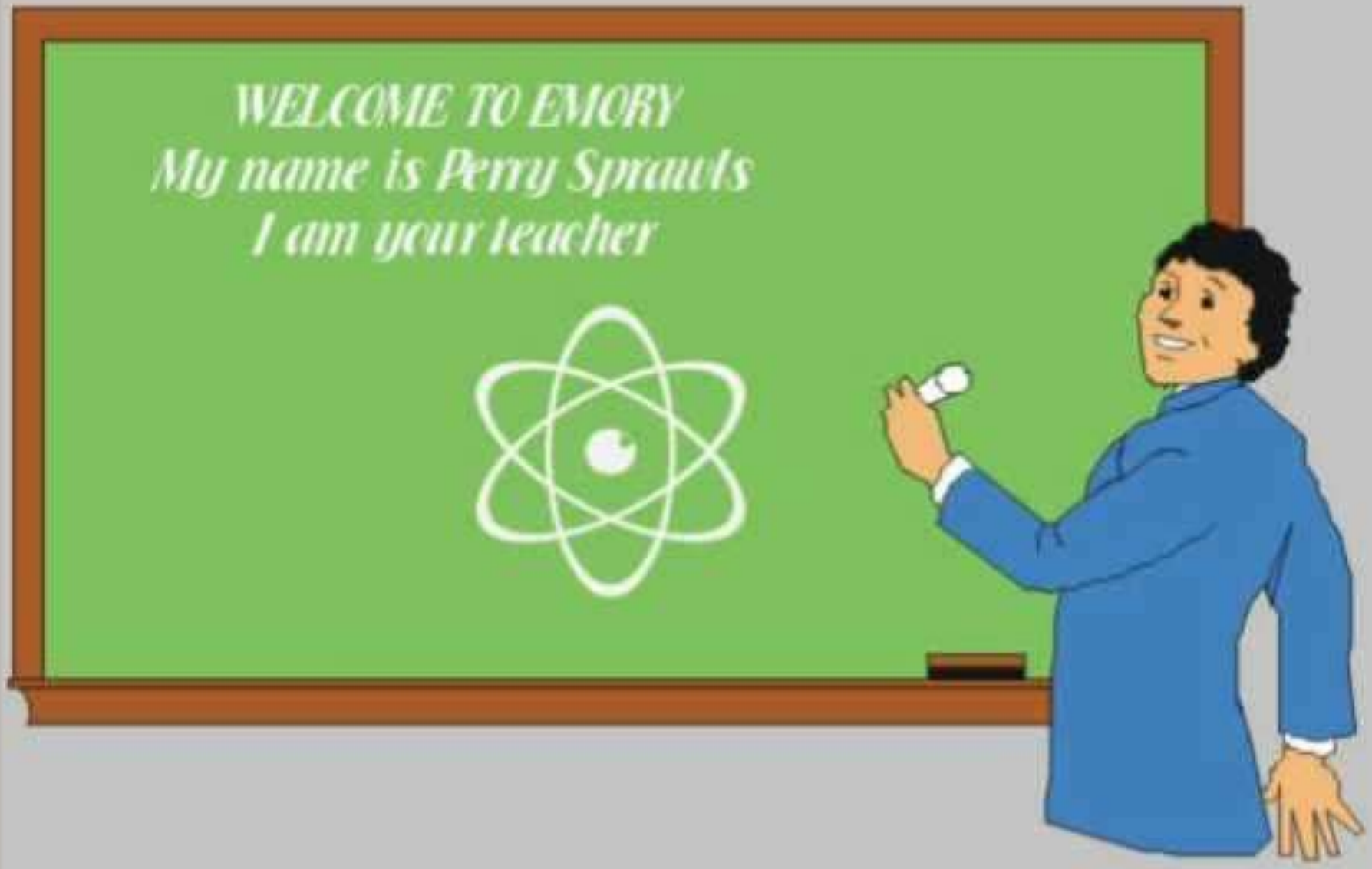
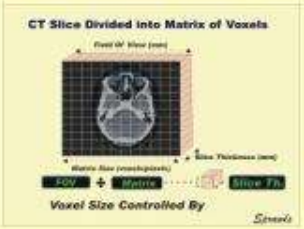
1960



The Traditional Classroom

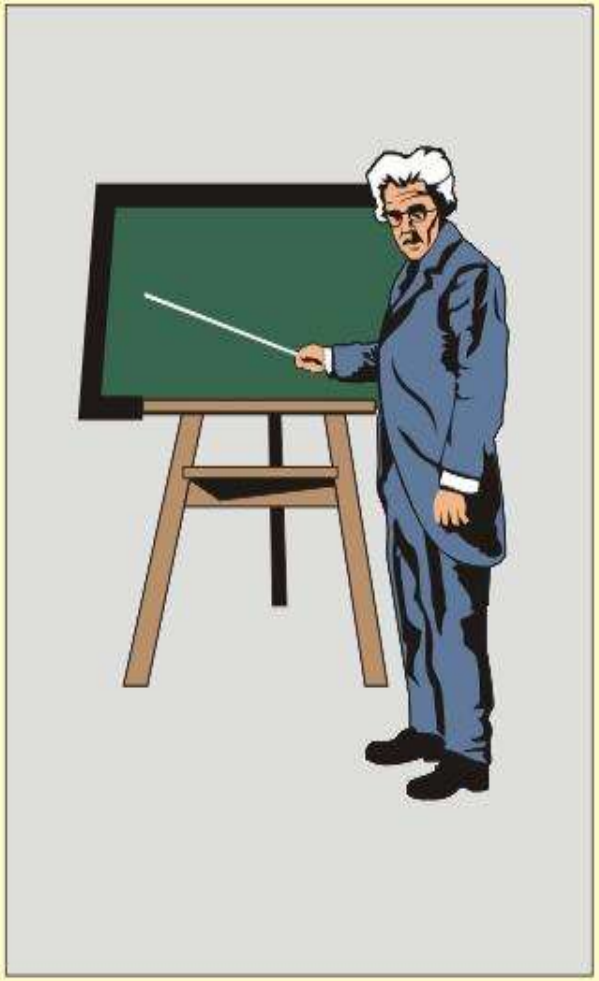
" A Box for Enclosing Students..."



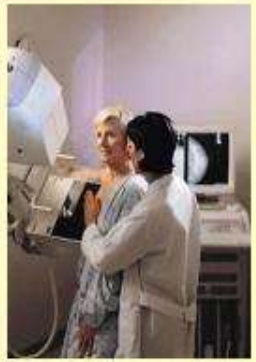
And hiding them from the world about which they should learning.

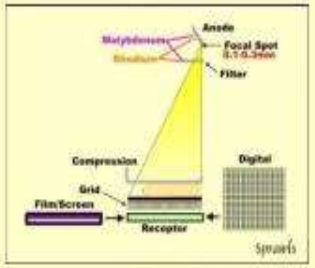
WINDOW
or
BARRIER

THE LEARNERS



PHYSICAL UNIVERSE





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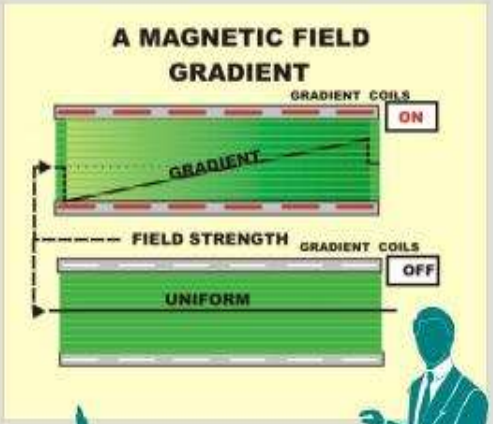
WINDOW or BARRIER

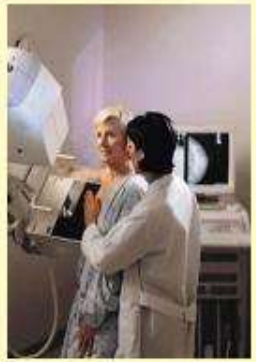
THE LEARNERS

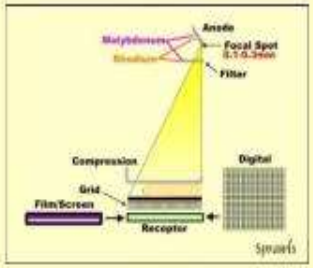
Visuals



Physicists

PHYSICAL UNIVERSE





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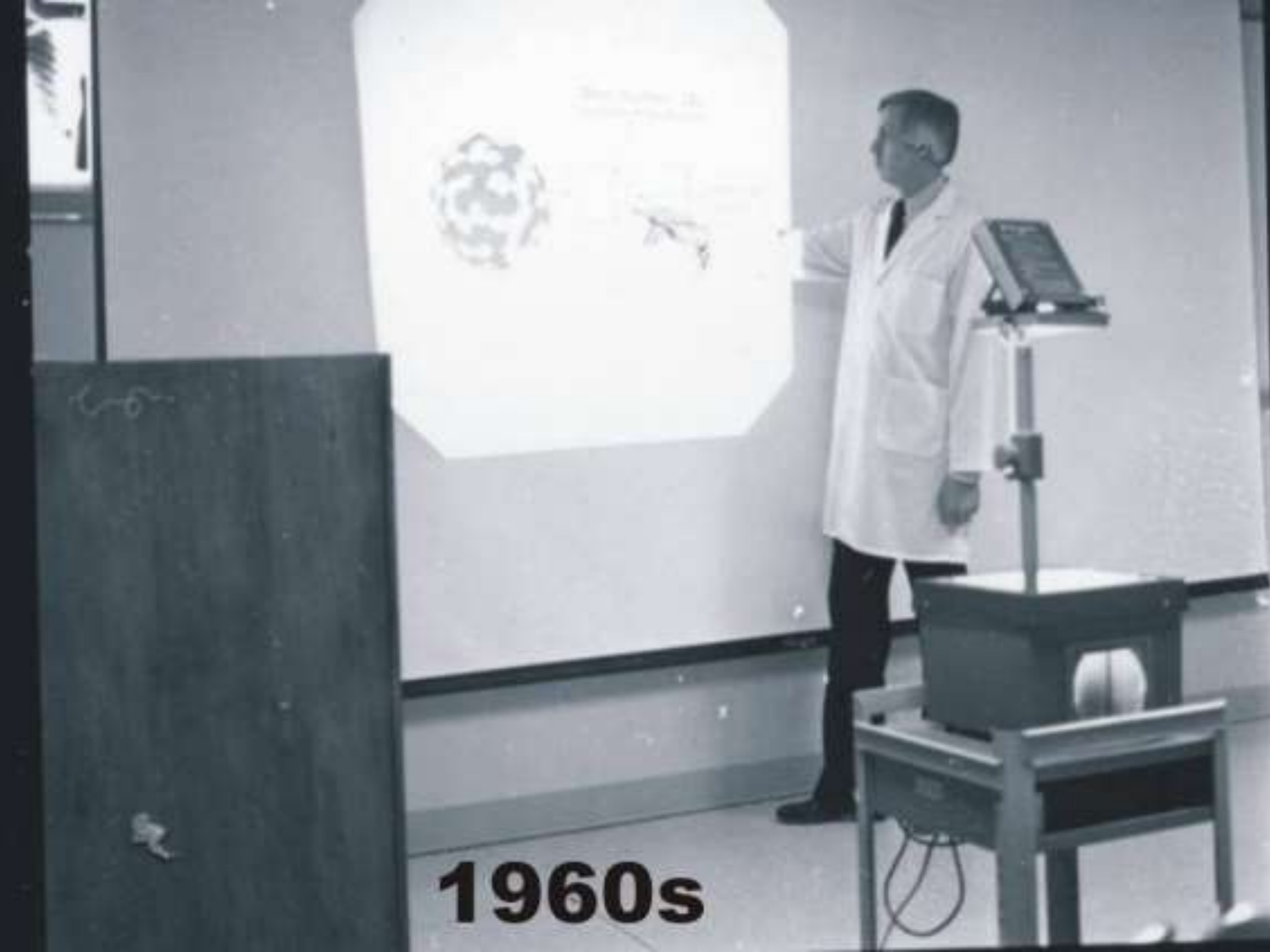
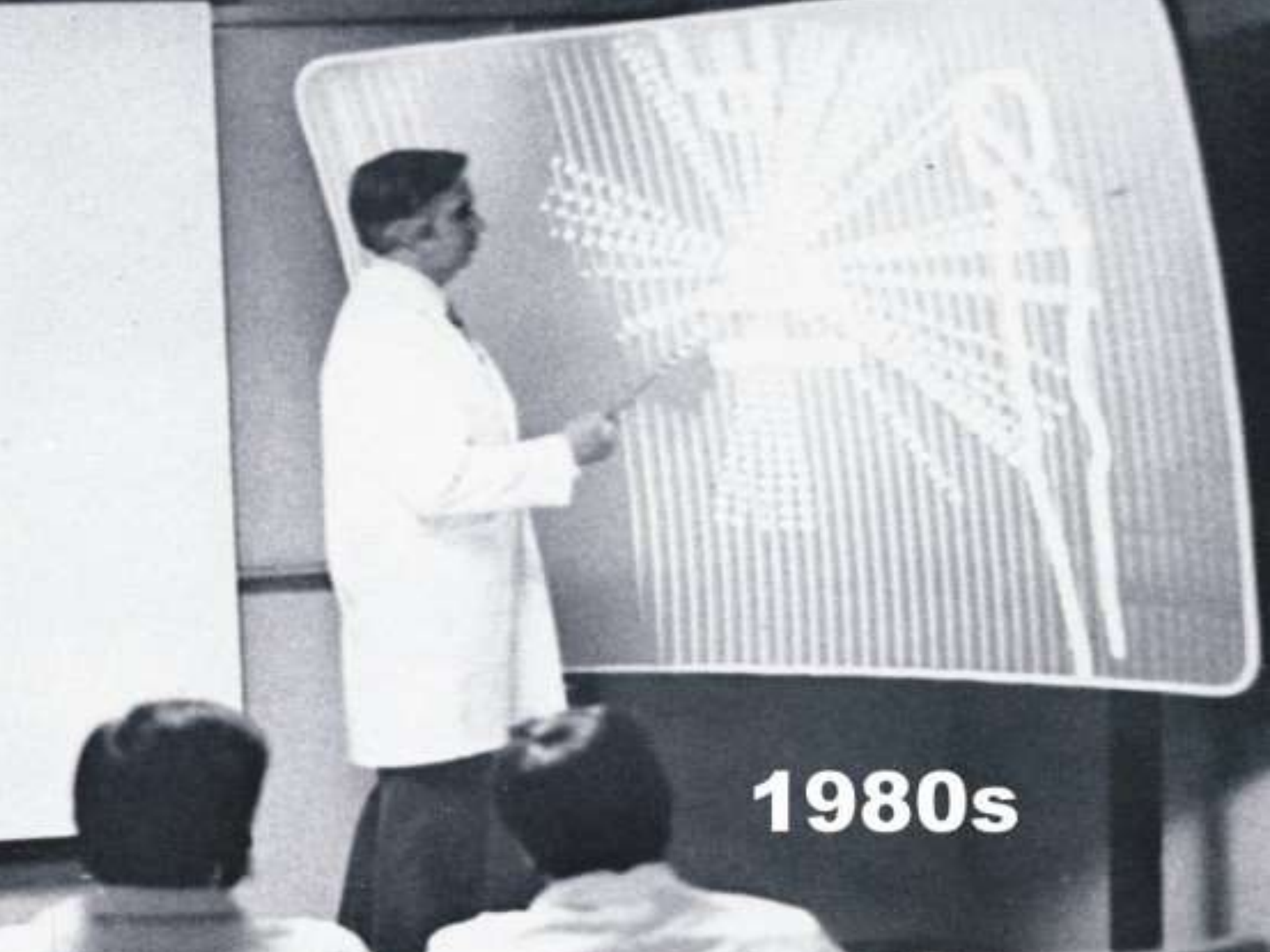

1960s


1980s

The Sprawls Resources

Sharing the Emory Experience with the World

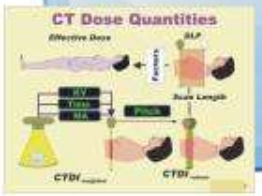
With Emphasis on the Developing Countries

Emory

www.sprawls.org/resources

Open Access

Educational Resources



Visuals **Books** **Modules**

Global Impact

Enhancing Radiology Education in Every Country of the World

The Collaborative Teaching Model

Sprawls Online Resources

Modules Books Visuals

Enhance the performance of physics faculty

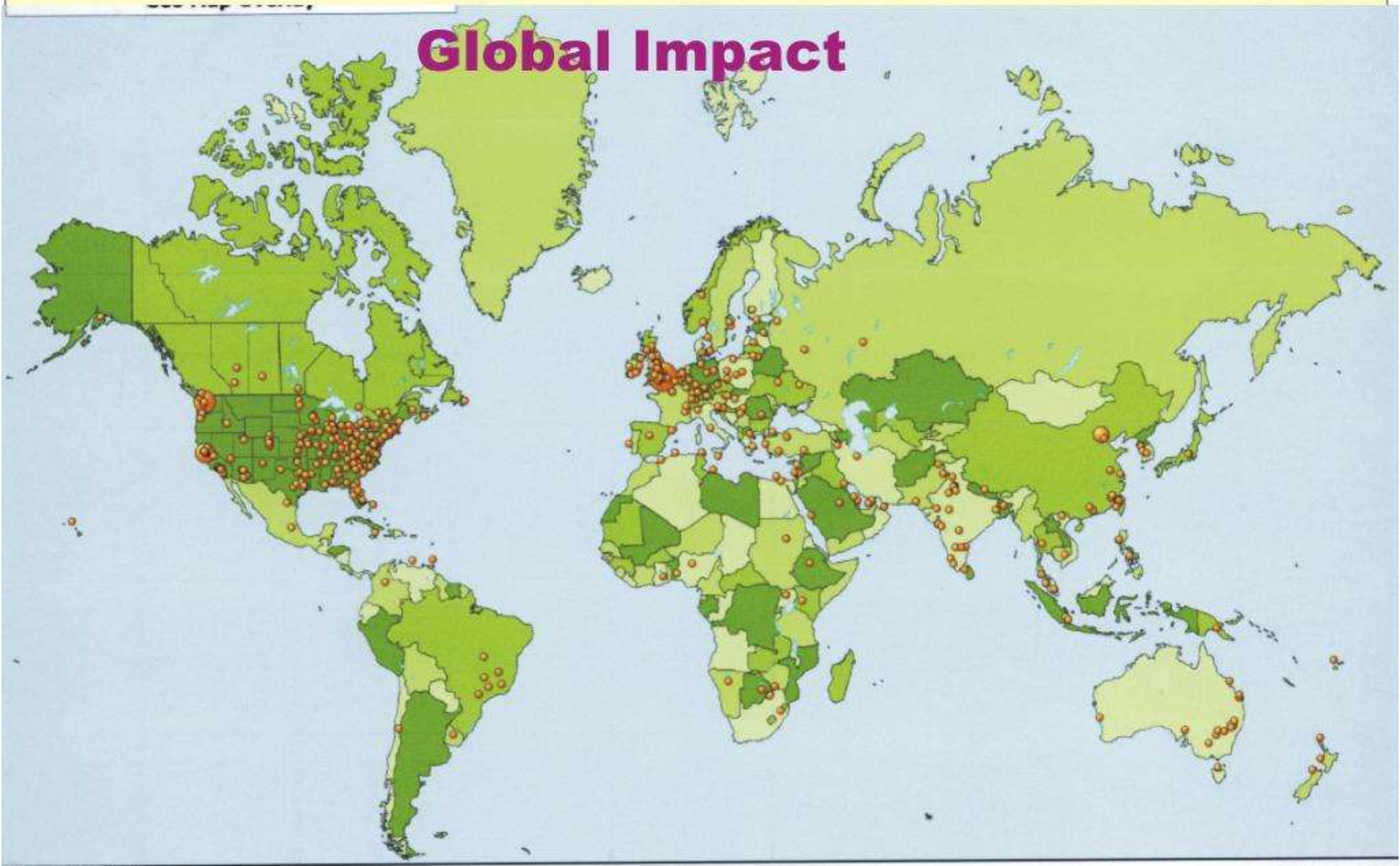
Residents & Radiologists

Local Universities

Sprawls

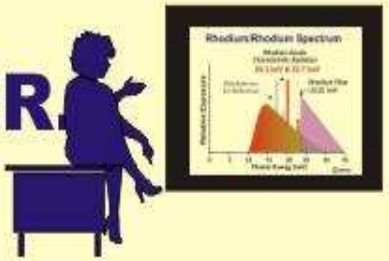
The Sprawls Resources

Users, April 2013



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

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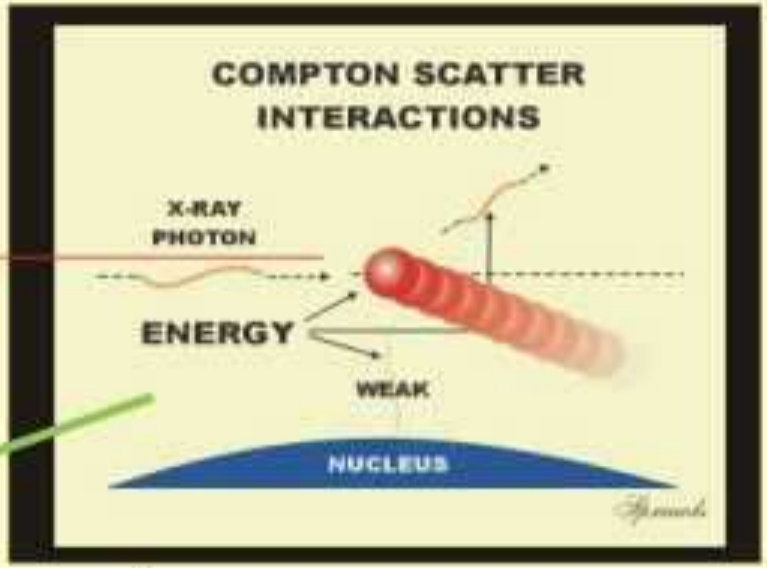
Technology Enhanced Learning



Learning Guide

Learner

Visuals for Classroom

Notes
and
Text

Online
Resources

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The Barrier

Physics Education

Clinical Imaging

Efficiency

Location, Resources, Human Effort, Cost

Limited Experience

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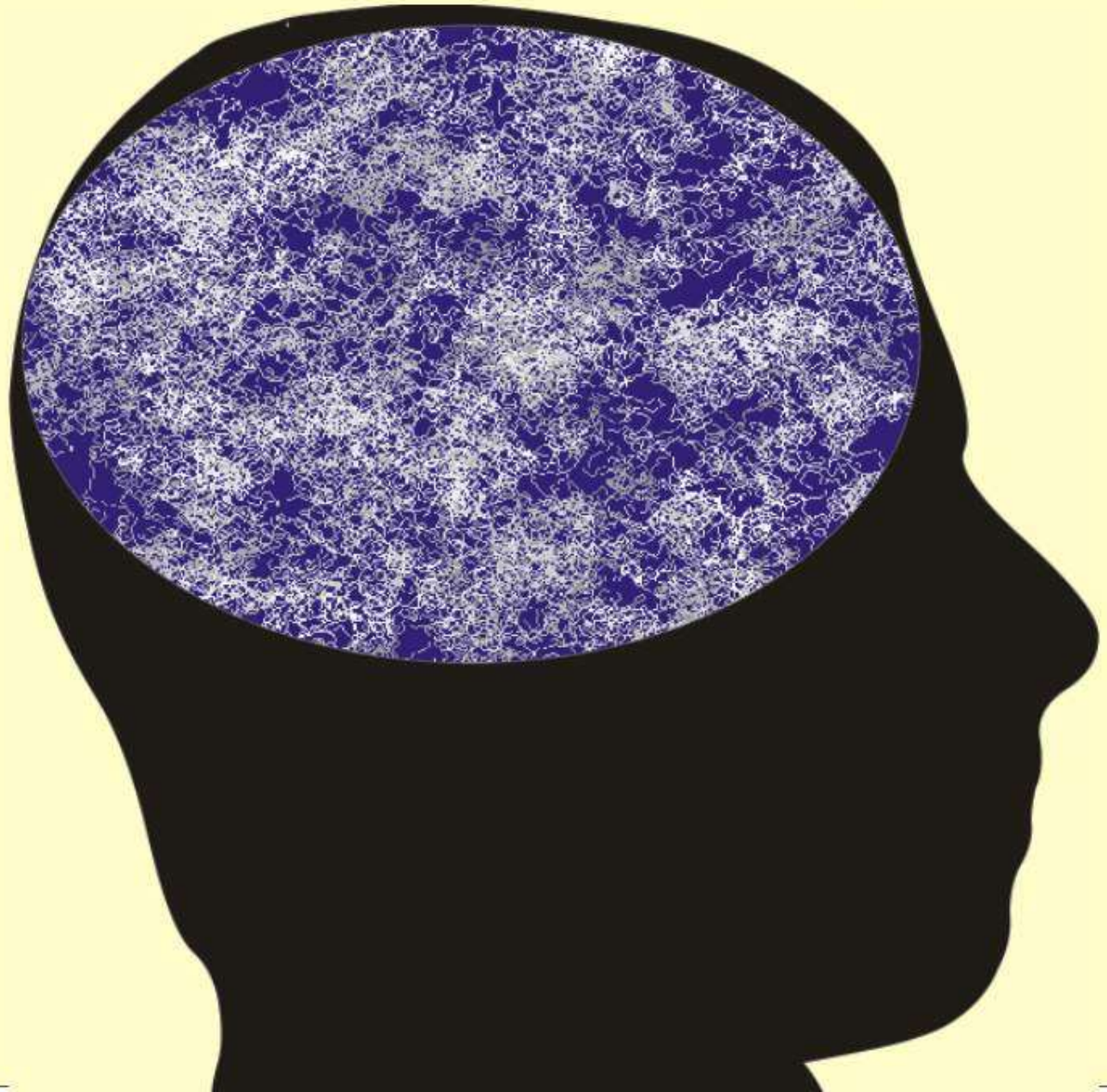
Your Mind



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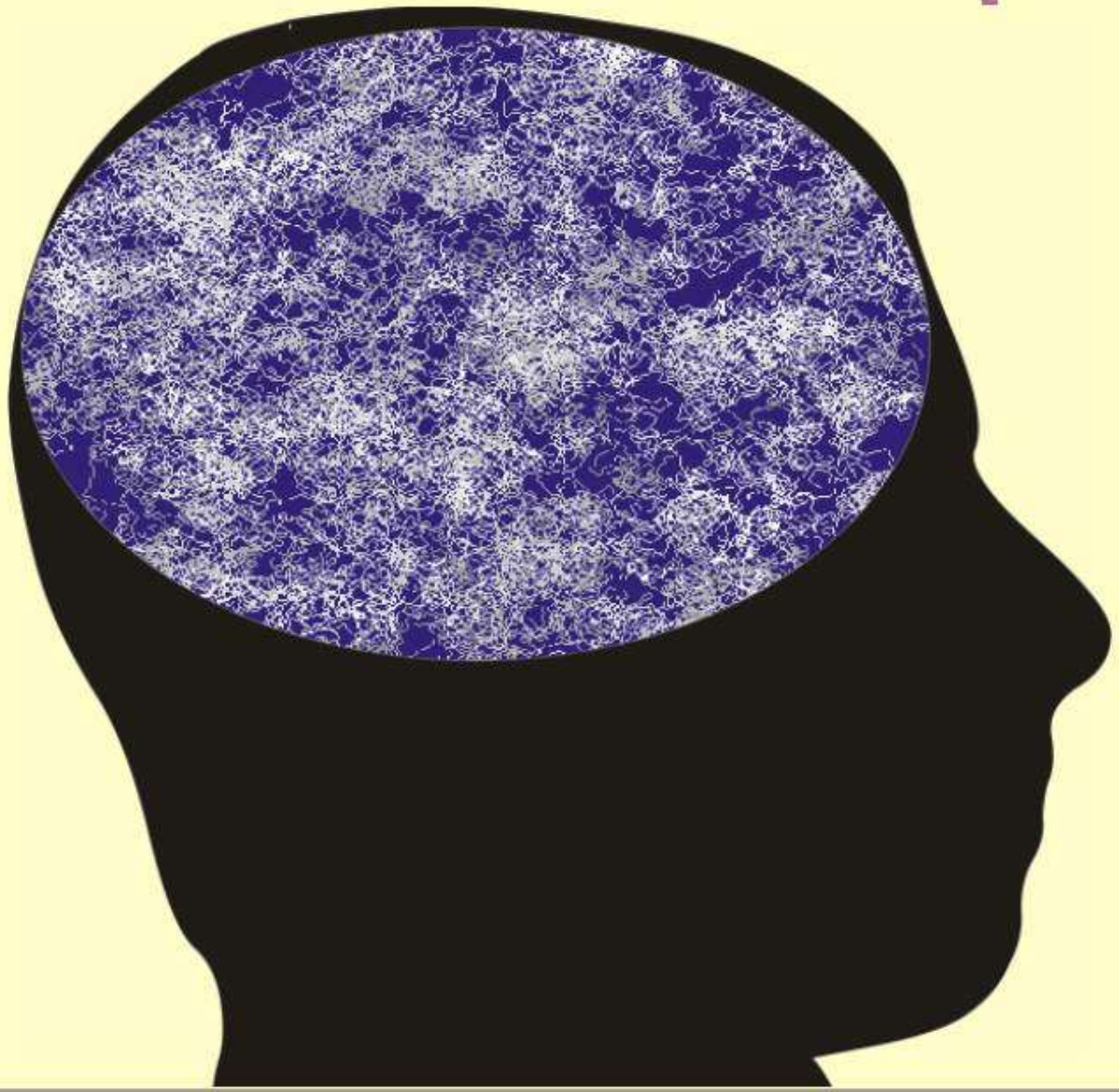
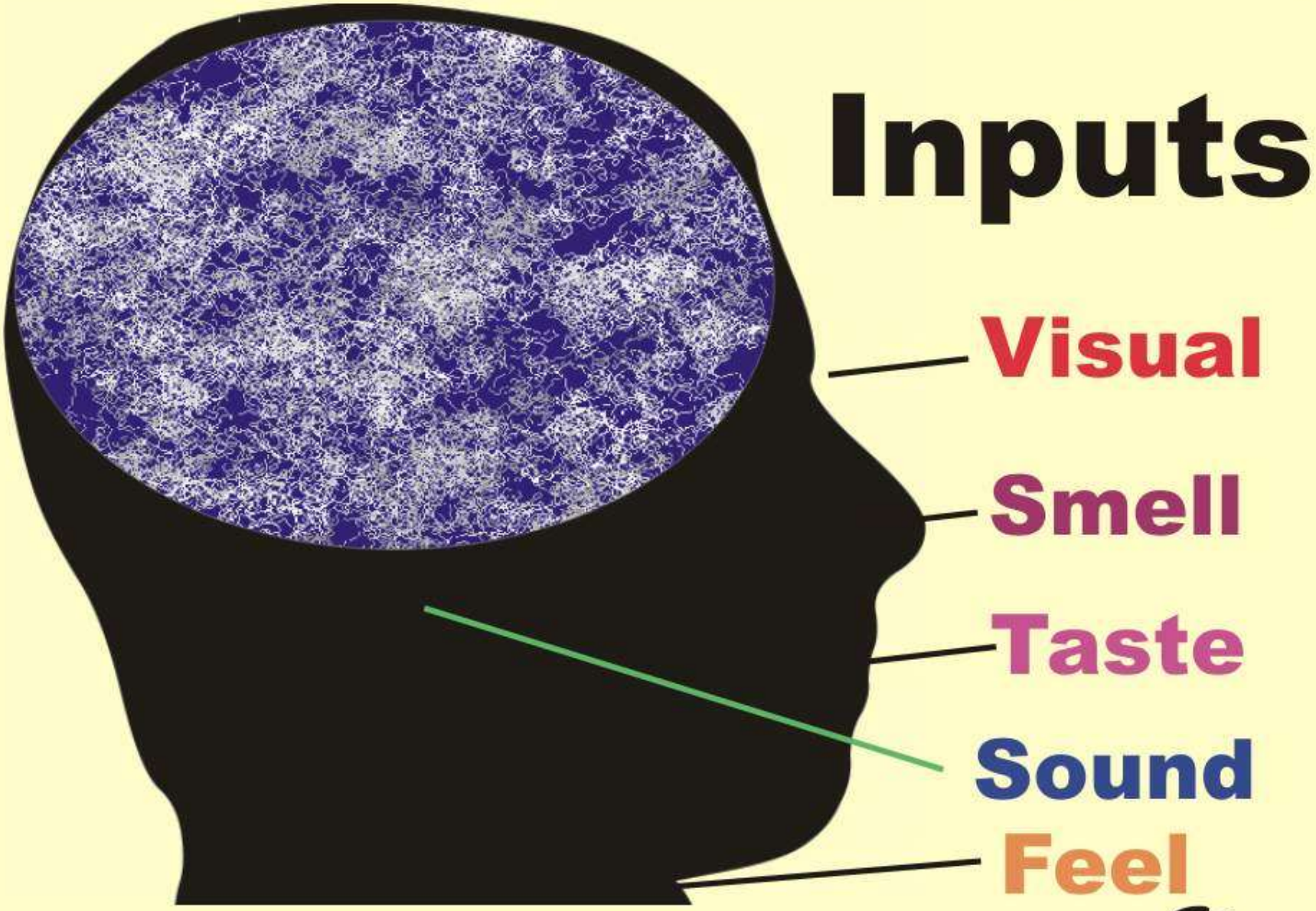
Your Mind

Network of A Lifetime of Experiences



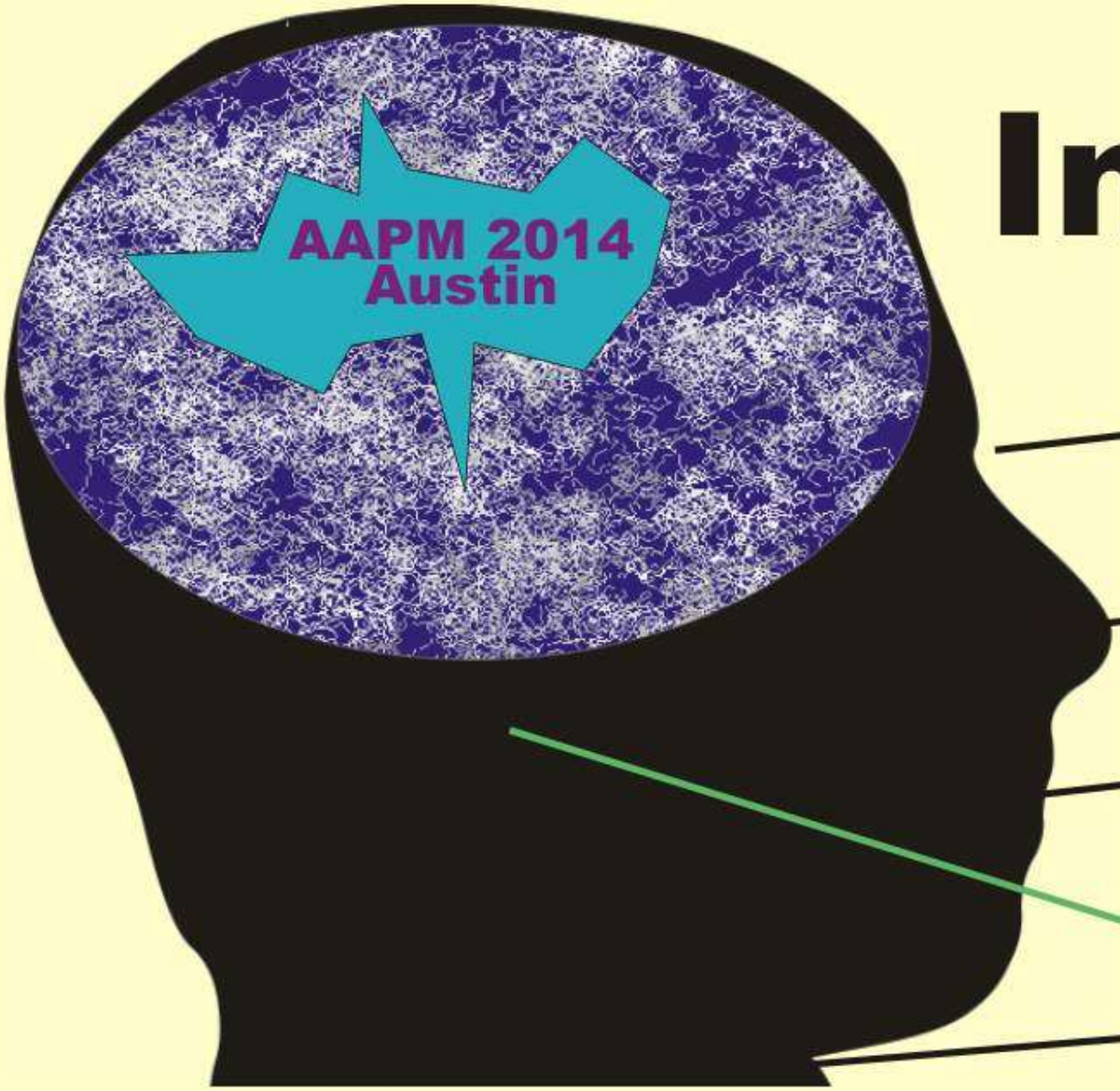
Sprawls

Network of Sensory Experiences



Sprawls

Network of Sensory Experiences



Inputs

- Visual
- Smell
- Taste
- Sound
- Feel

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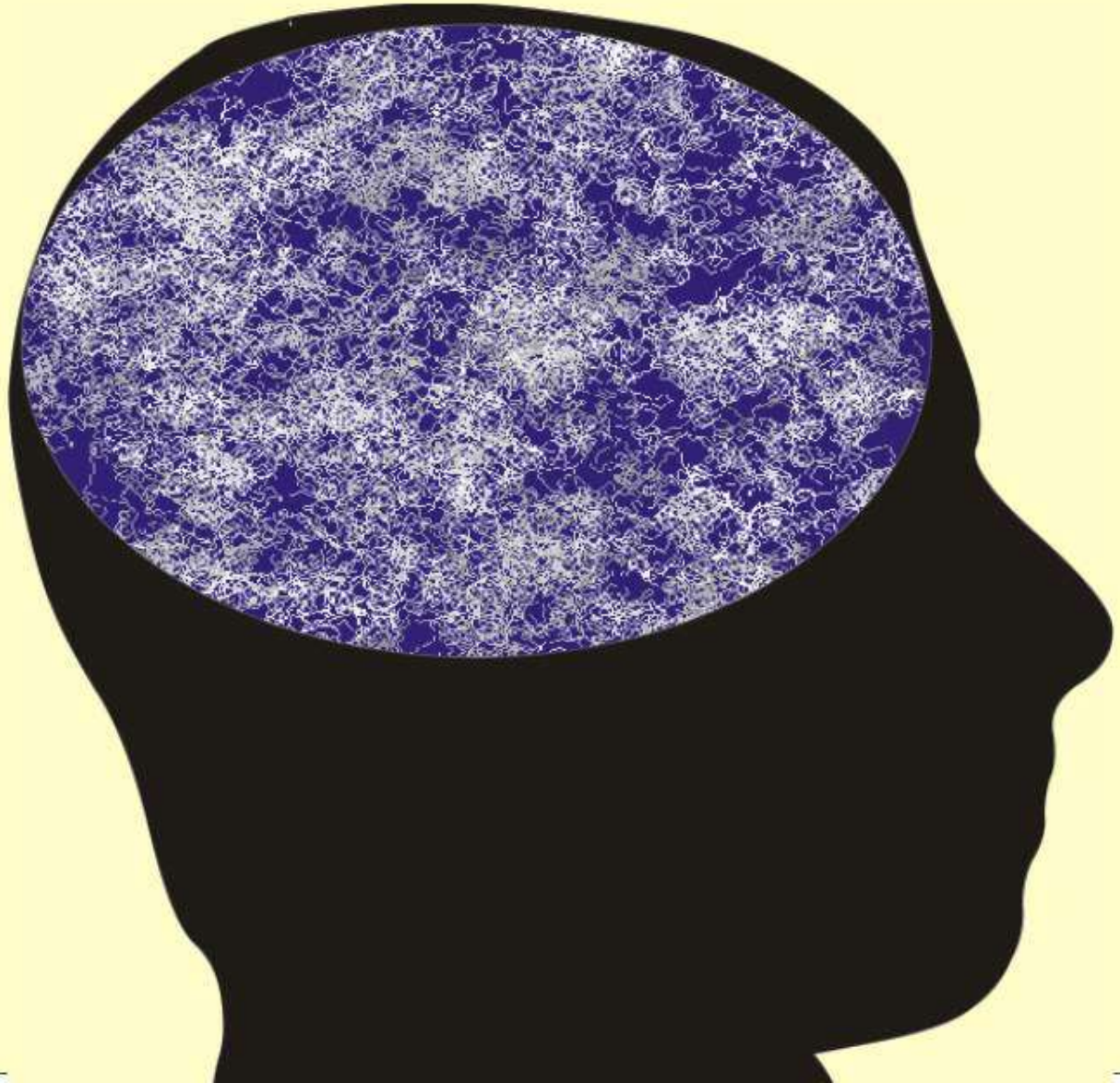
Exploring Your Mind

What Can You See?



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Network of Sensory Experiences

Inputs

- Visual
- Smell
- Taste
- Sound
- Feel

Sprawls

Chocolate Cake

Ingredients

- Baking spray, for spraying custard cups
- 1 stick butter
- 2 ounces bittersweet chocolate
- 2 ounces semisweet chocolate
- 1 1/4 cups powdered sugar
- 2 whole eggs
- 3 egg yolks
- 1 teaspoon vanilla
- 1/2 cup all-purpose flour
- Vanilla ice cream, for serving

Directions

Preheat the oven to 425 degrees F. Spray four custard cups with baking spray and place on a baking sheet.

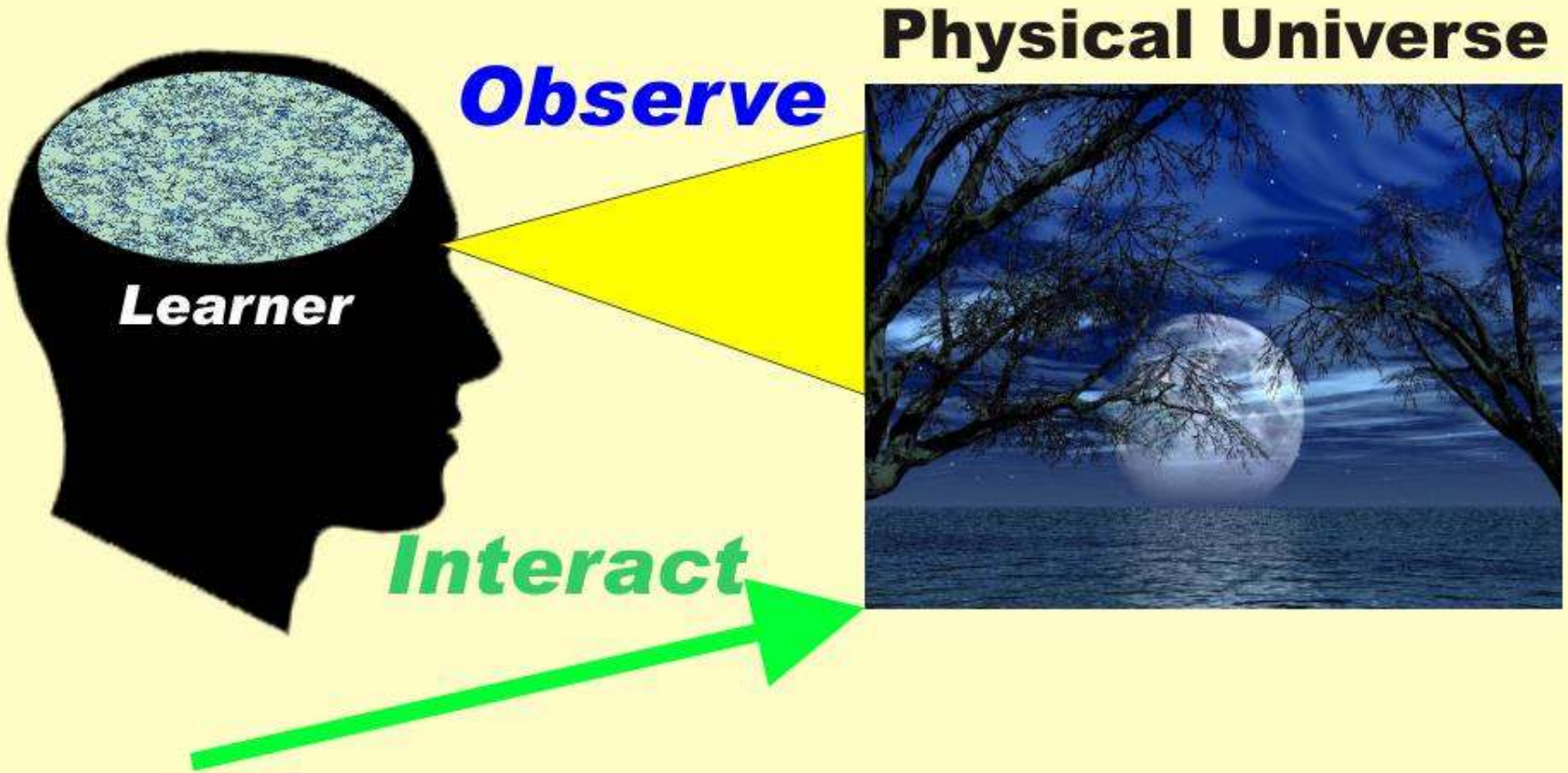
Microwave the butter, bittersweet chocolate and semisweet chocolate in a large bowl on high until the butter is melted, about 1 minute. Whisk until the chocolate is also melted. Stir in the sugar until well blended. Whisk in the eggs and egg yolks, then add the vanilla. Stir in the flour. Divide the mixture among the custard cups.

Bake until the sides are firm and the centers are soft, about 13 minutes. Let stand 1 minute. Invert on individual plates while warm and serve with vanilla ice cream.

CATEGORIES: Chocolate, Dessert, Cake | View All

Learning is a Natural Human Process

We Learn by Experience



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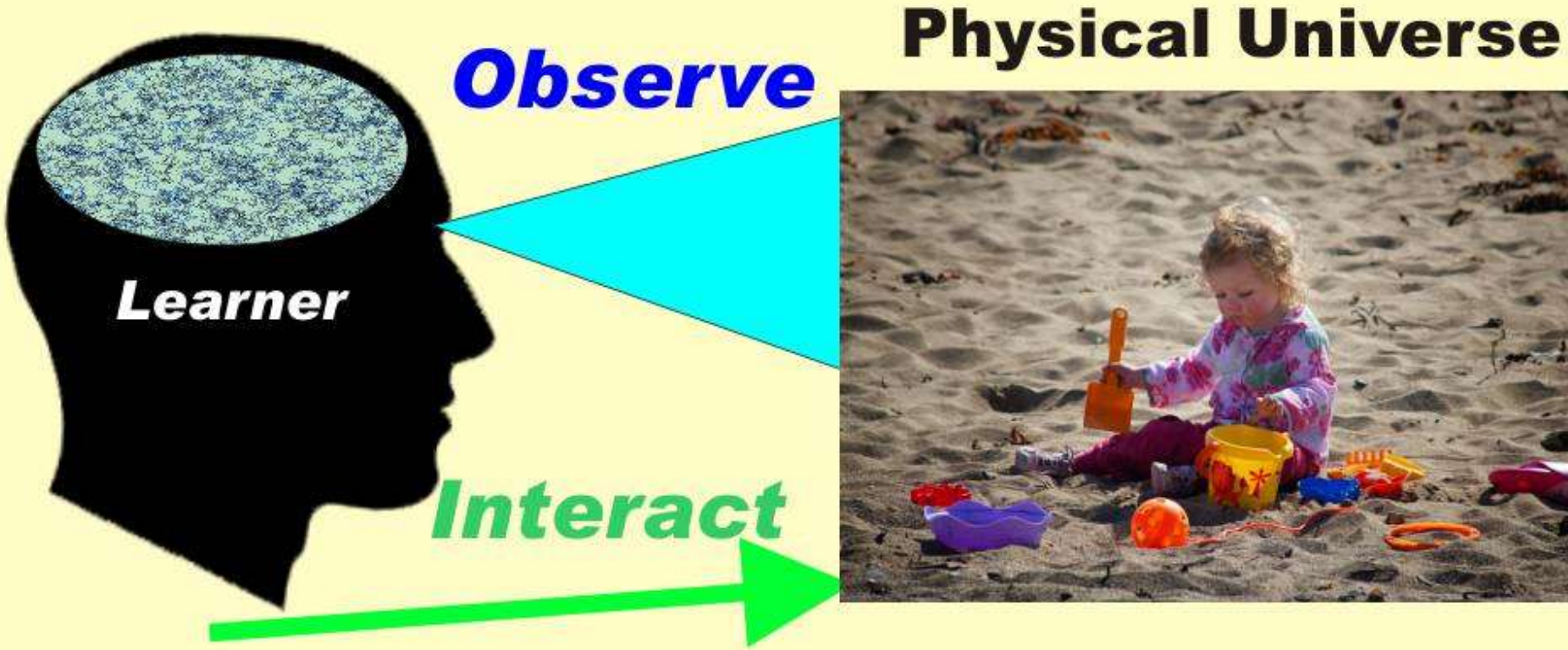
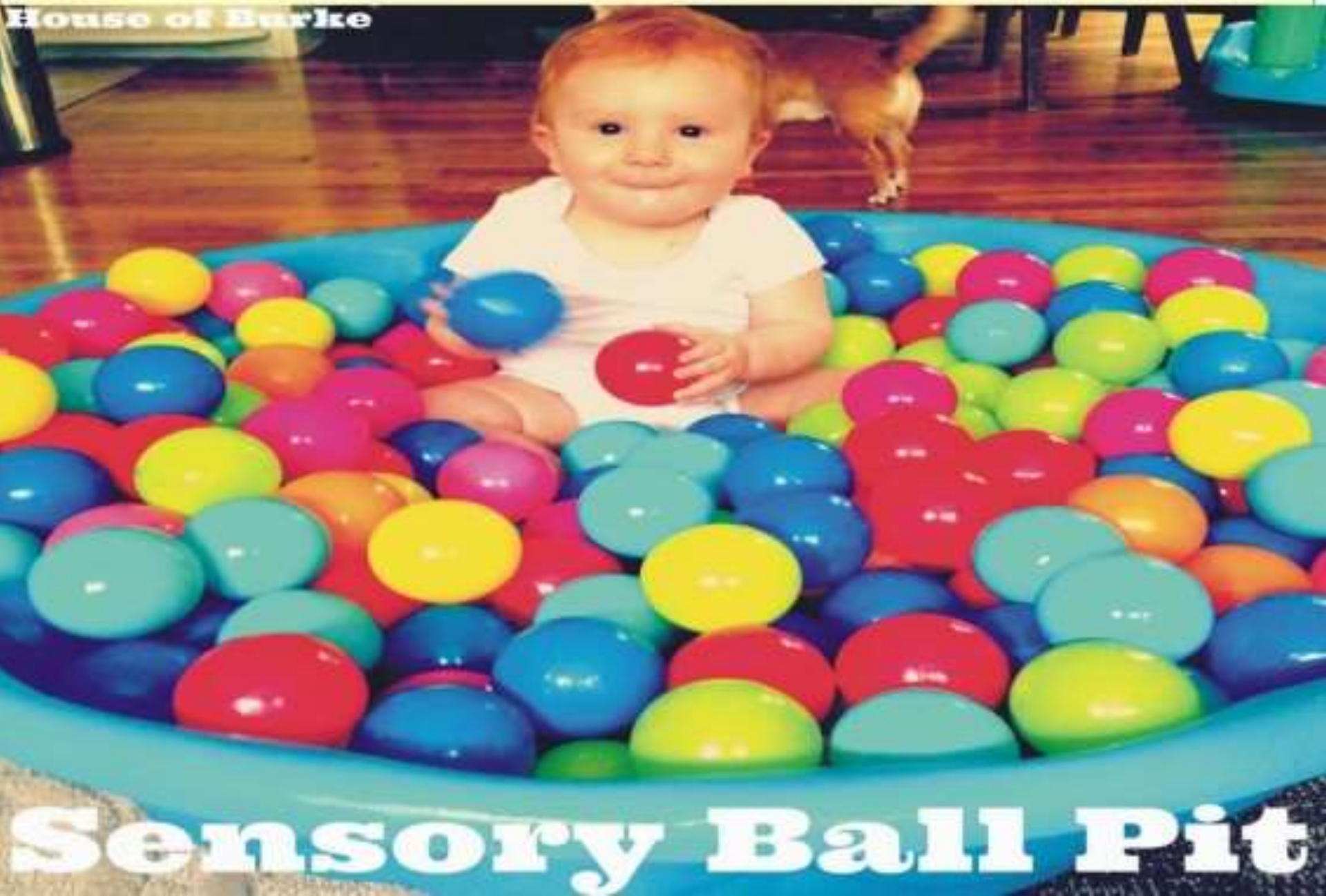


Our Early Physics Learning Activities

Sprouts

One of Our First Physics Lessons



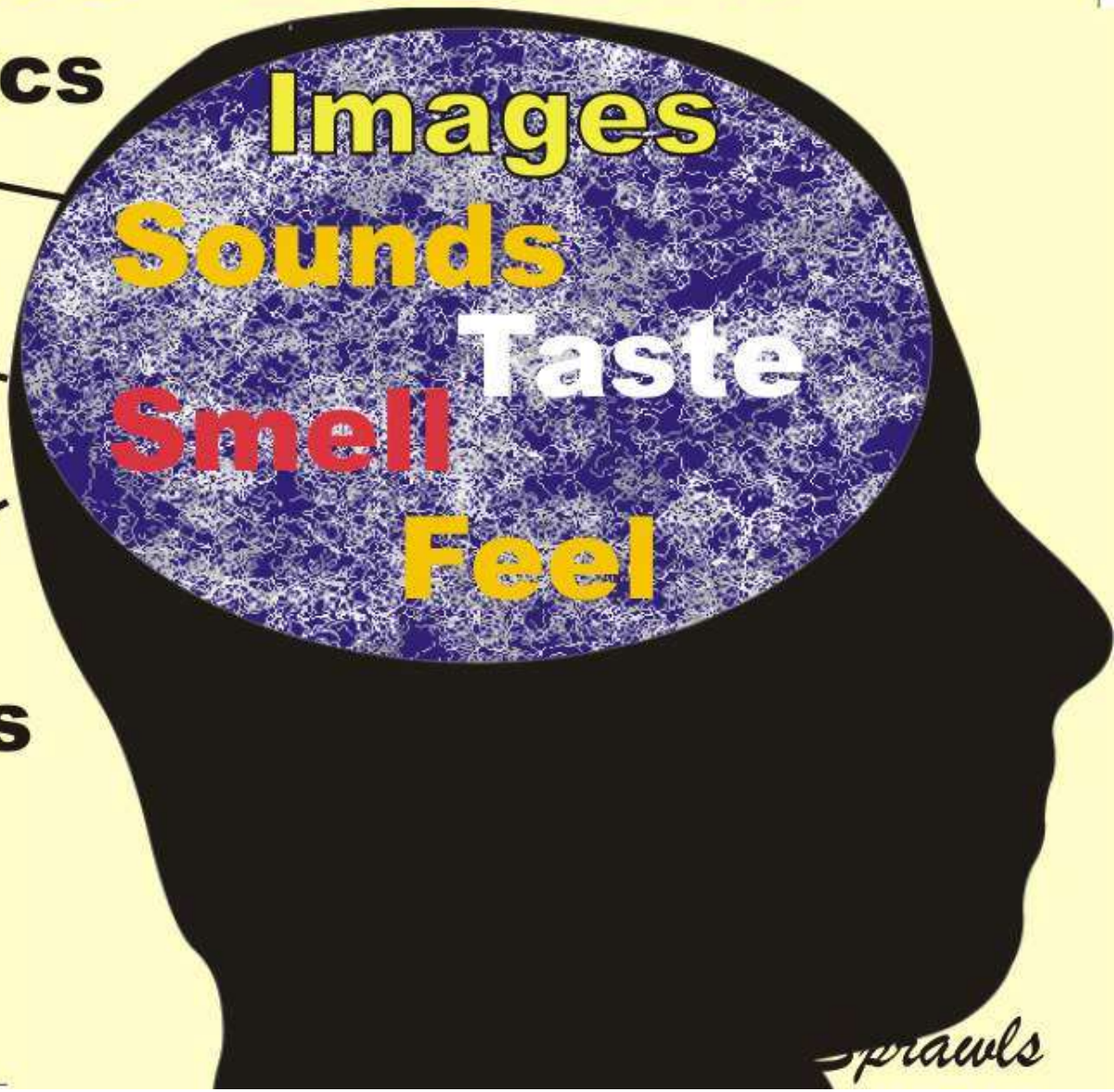
Knowledge Structure Formation

Atributes Elements

Characteristics

Names

Relationships



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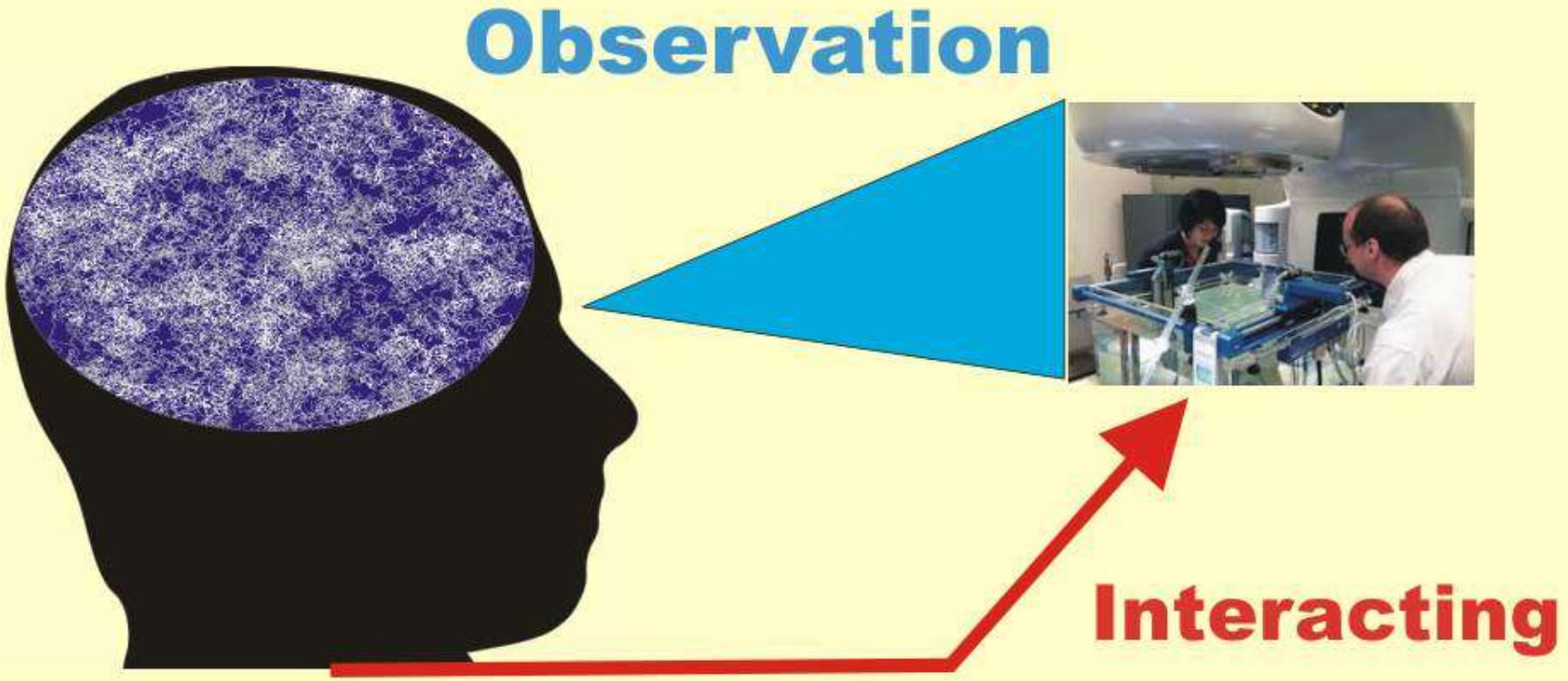
Learning By Direct



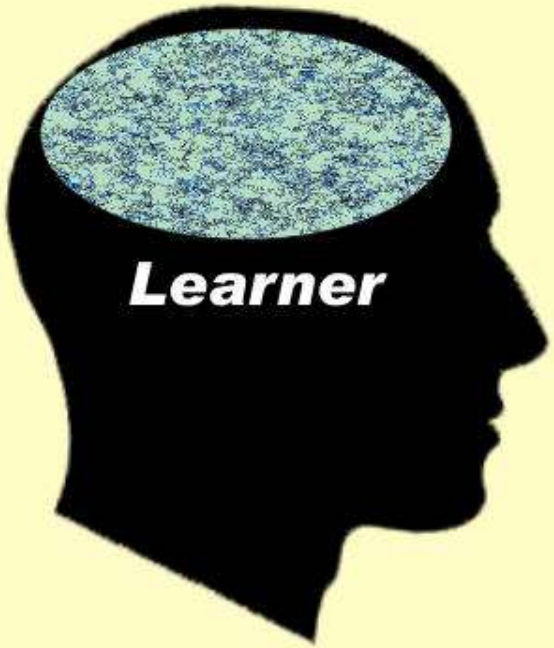
A Natural Human Function

Sprawls

Teaching

is helping someone

Building a Knowledge Structure in the Brain



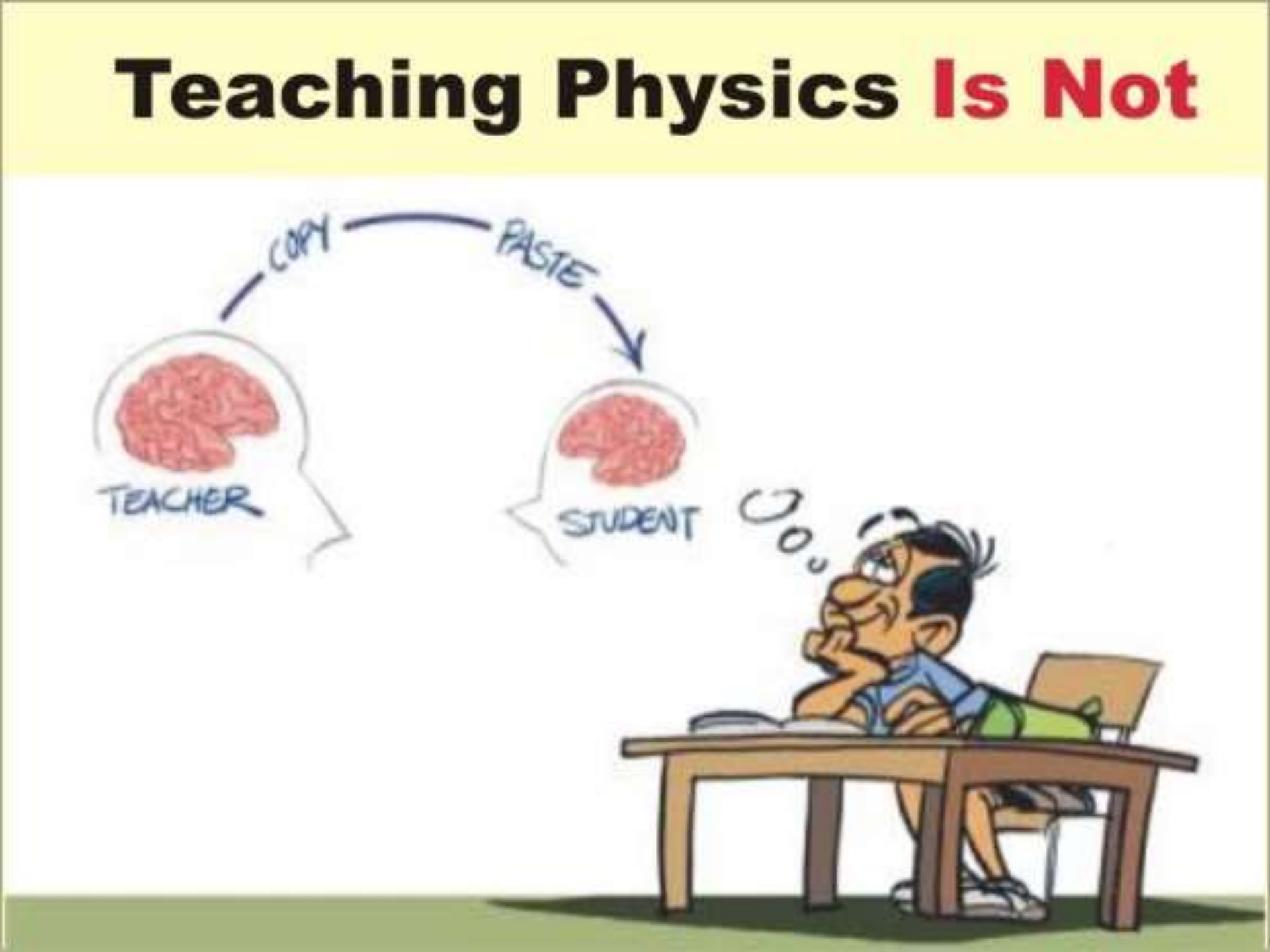
Physical Universe

A mental representation of physical reality

Connect Organize Guide

Sprawls

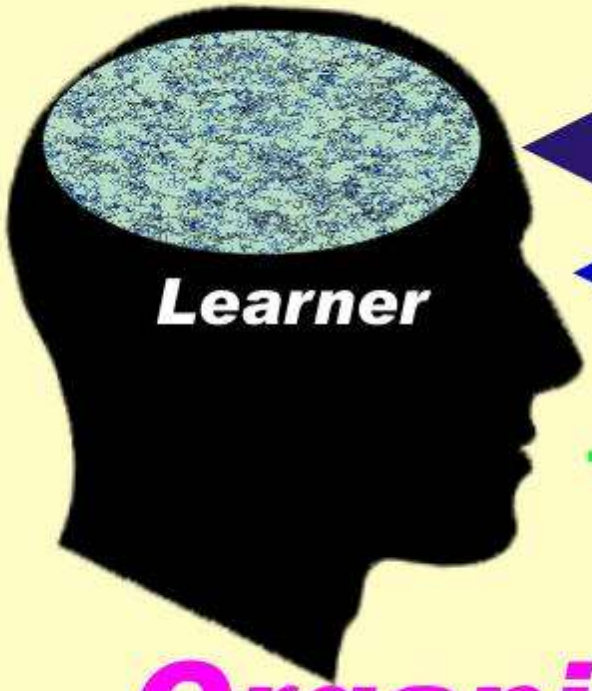
Teaching Physics Is Not



The Role of Formal Education

Connect

Physical Universe



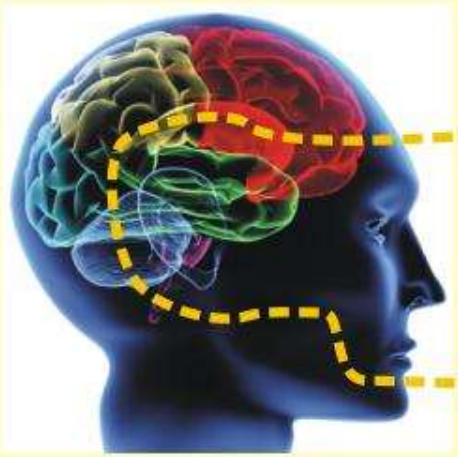
Observe

Interact

Organize and Guide

The Elements of
A Highly Effective Educational Session

The Brain

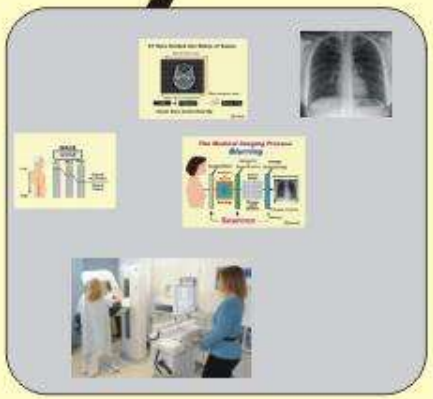


Connection

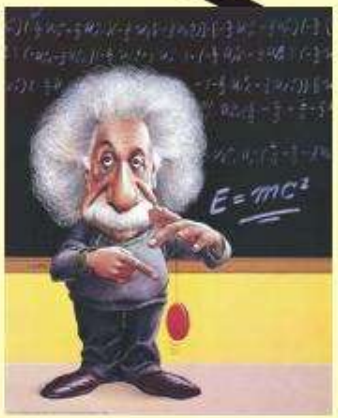
Observe

Interact

The Physical Universe
(Physics of Medical Imaging)



"Window"



Teacher /Guide

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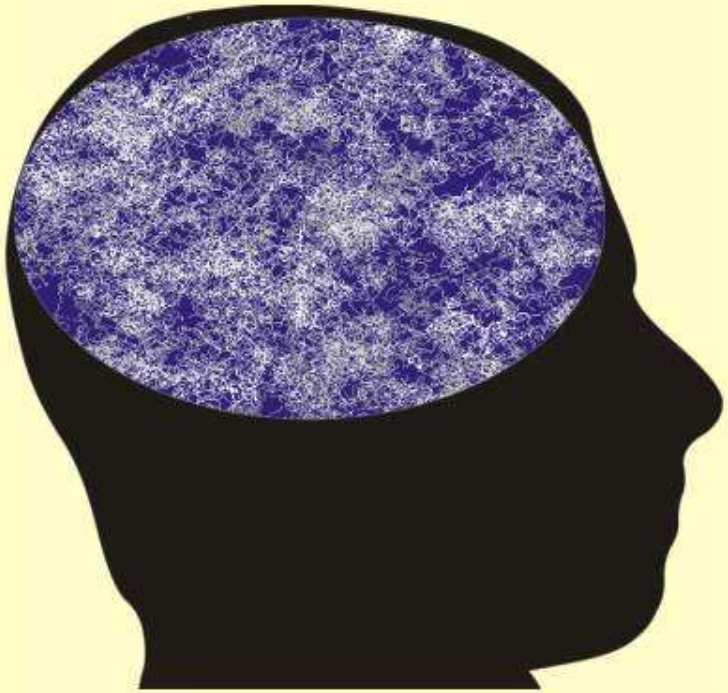
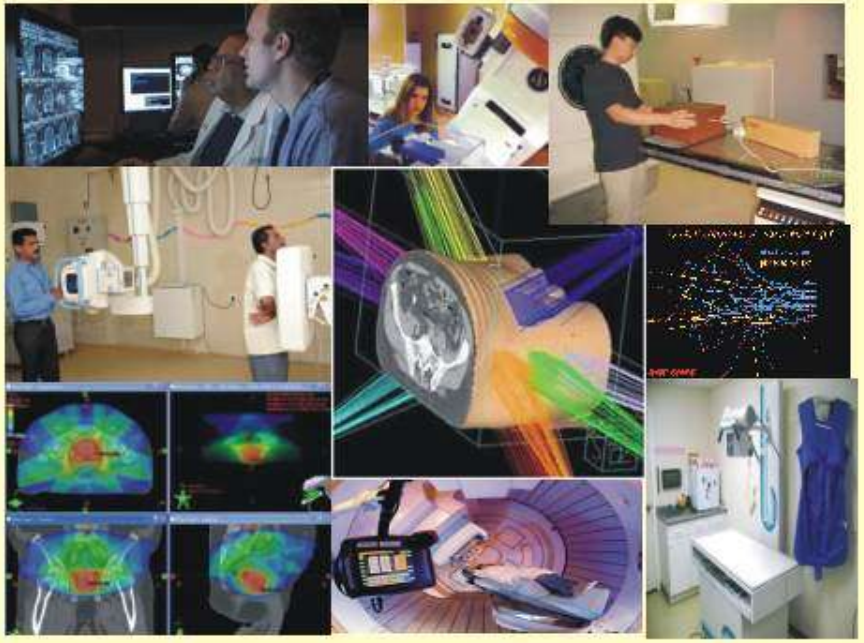
What do they need?

Learner



Medical Physics Universe

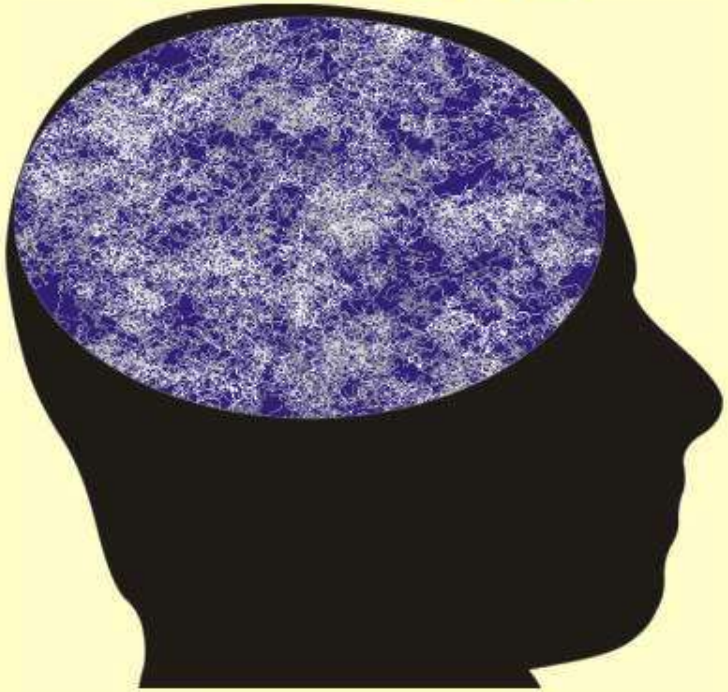


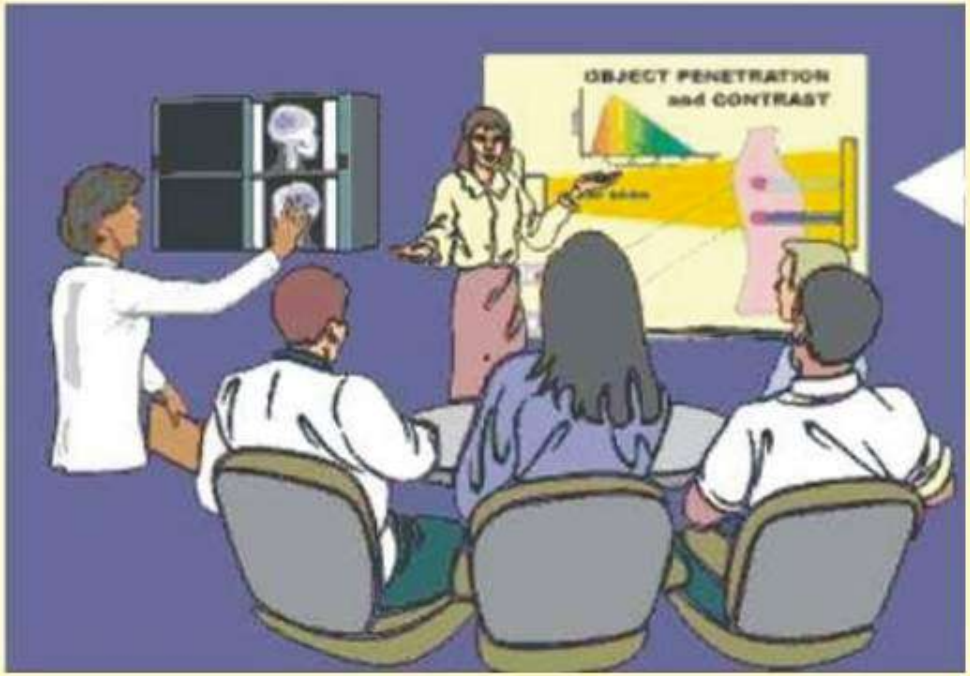
"Know" or to "Do"

Sprawls

What do you need?

You As An Educator





Provide a highly-effective learning experience

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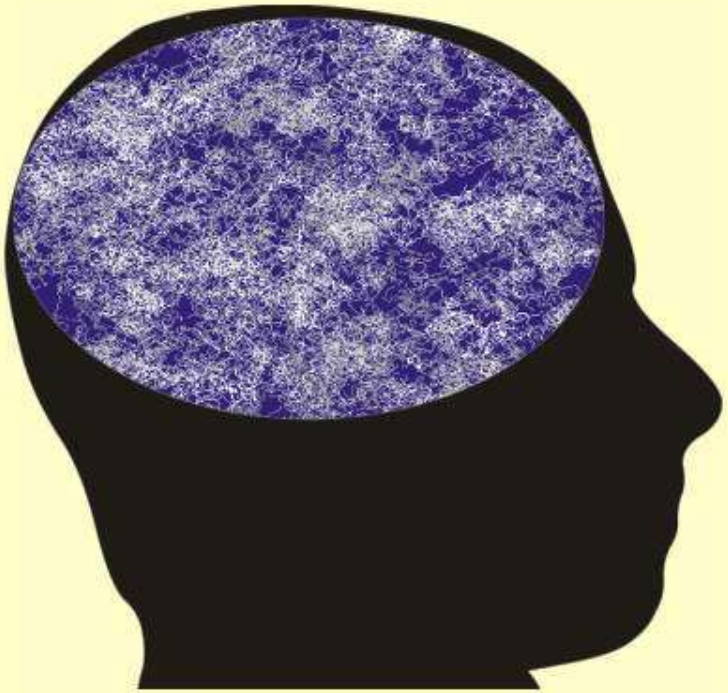
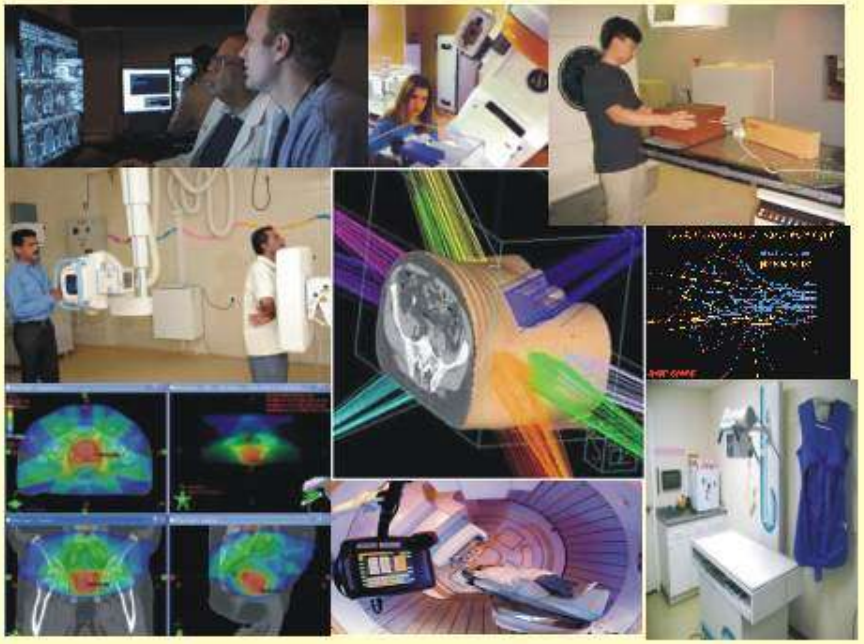
Here is our challenge!

Learner



Medical Physics Universe



How are you going to do it?

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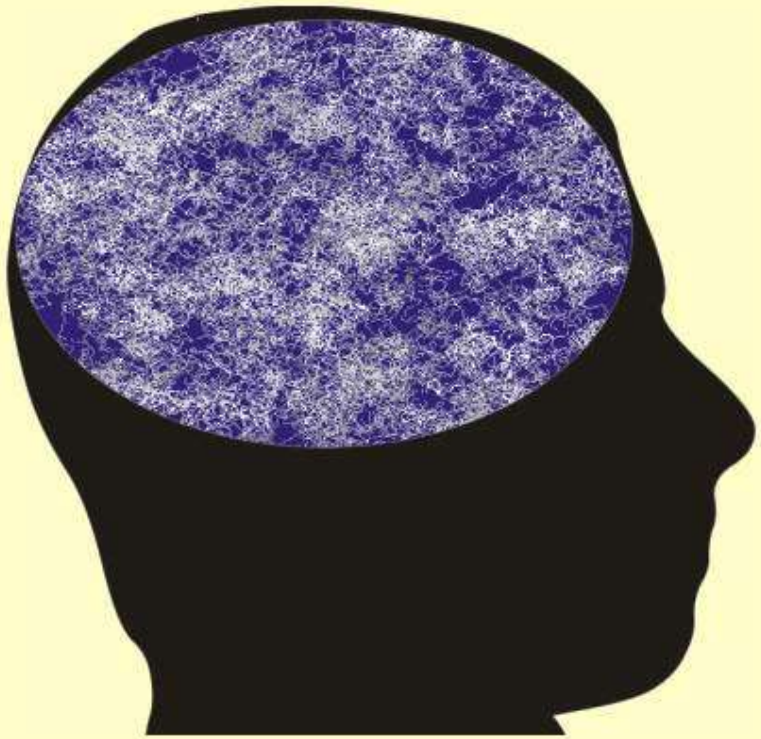
Learning Medical Physics

is



Building a Knowledge Structure in the Mind

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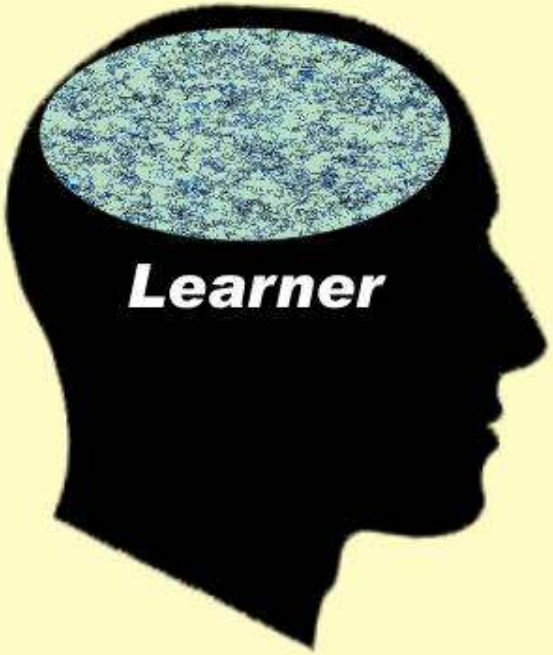
Learning Physics
is
Building a Knowledge Structure
in the Brain



Physical Universe

A mental representation of physical reality

Sprawls

Knowledge Structure of Medical Physics

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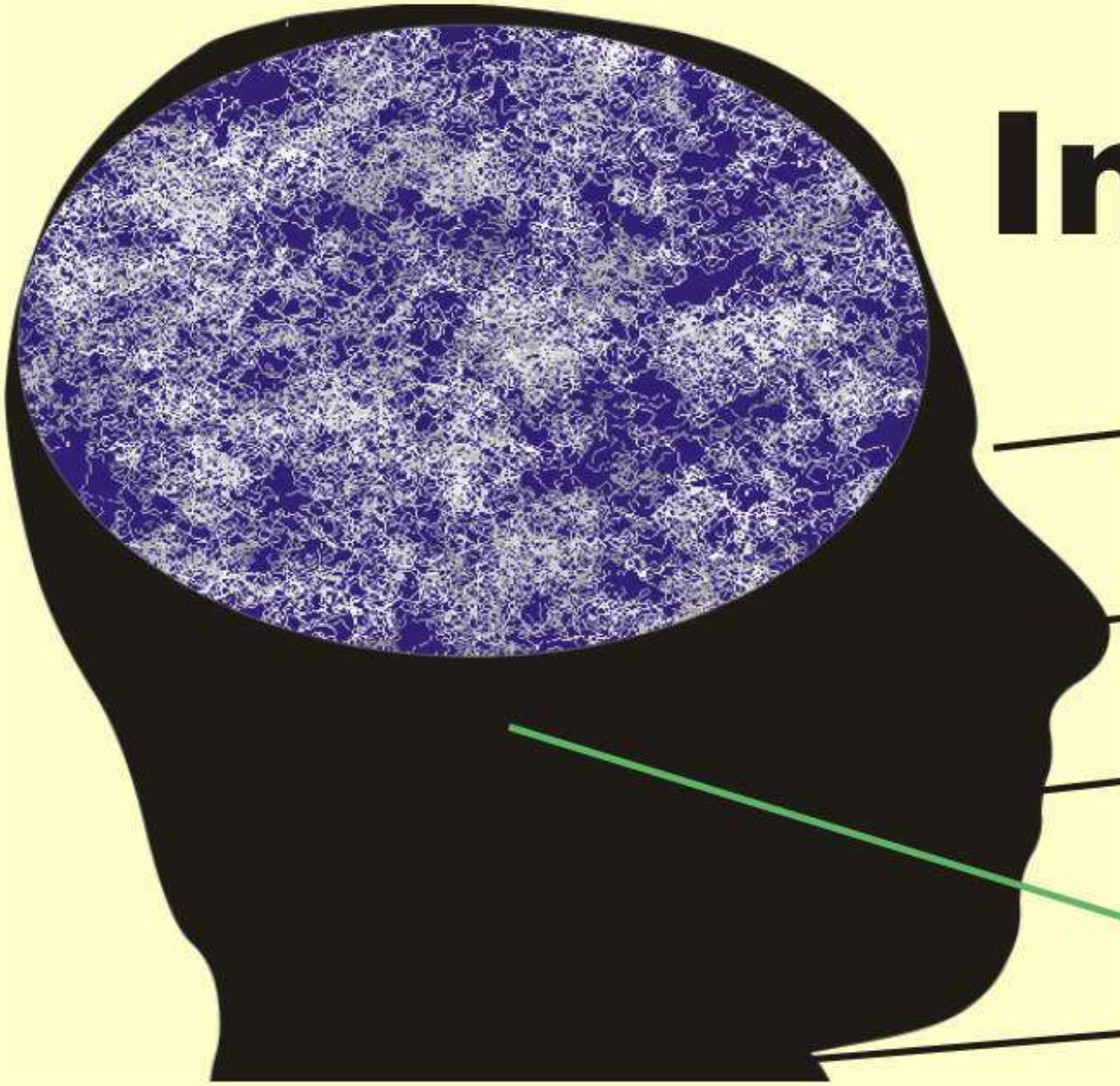
Network of Sensory Experiences



Inputs

Visual

Smell

Taste

Sound

Feel

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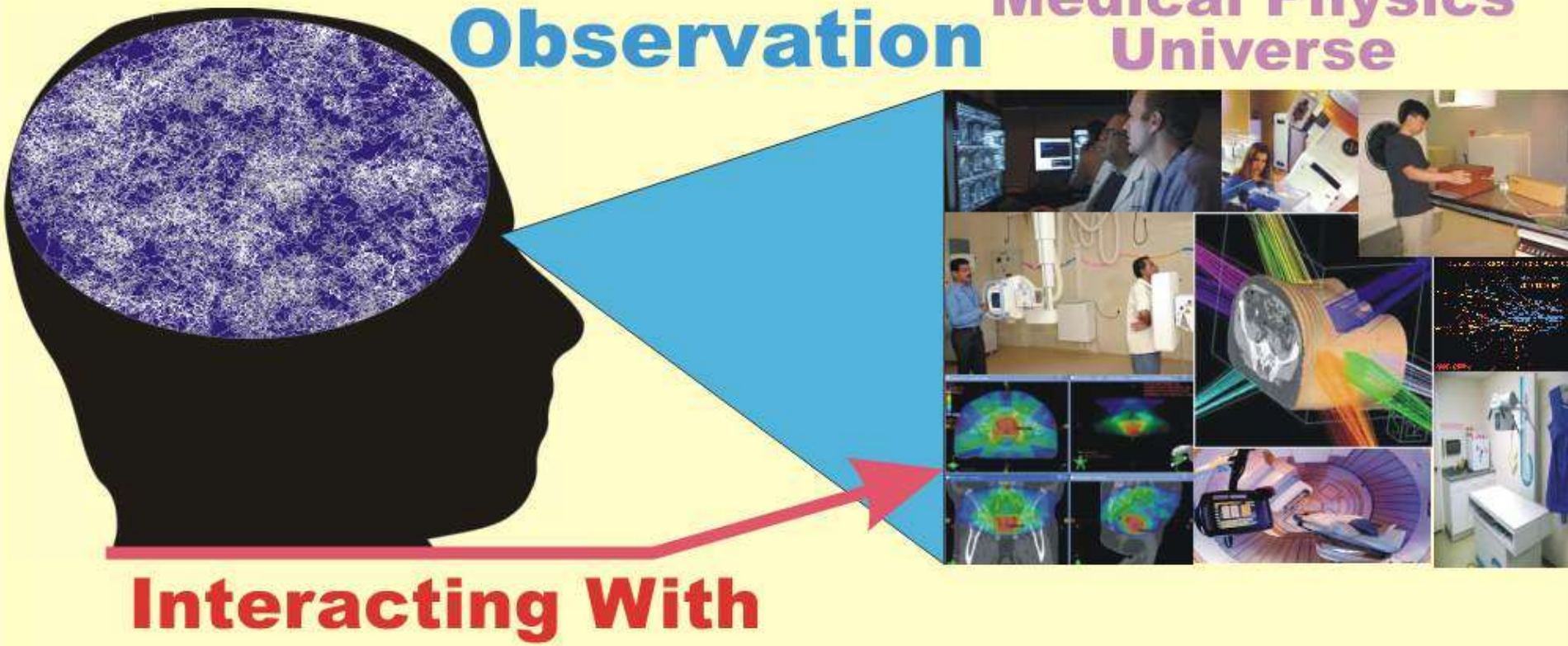
Learning Medical Physics Requires



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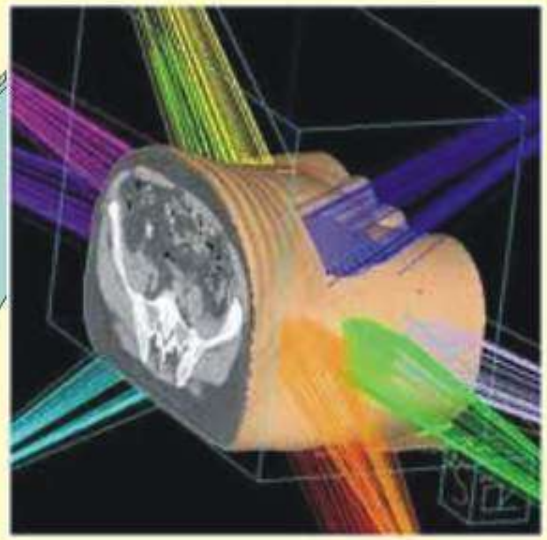
The Most EFFECTIVE way to
Build Physics Knowledge Structures

Visuals



Technology

Audio

Human

(Teacher)

Guiding The Process

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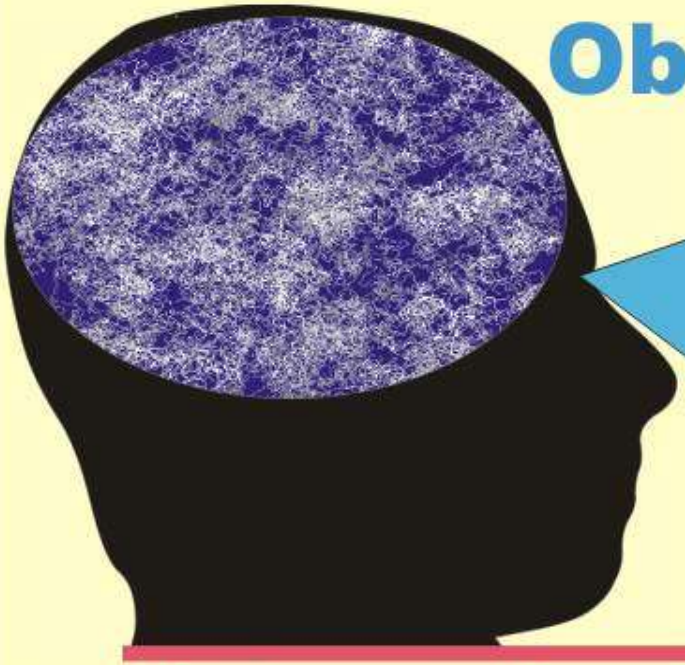
Teaching Medical Physics

Medical Physics Universe

Observation



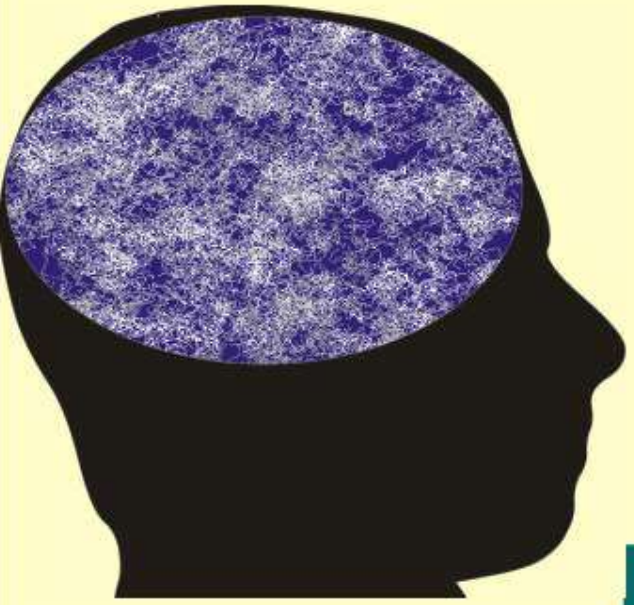
Interacting With

Is

Connecting and Guiding

Sprawls

Teaching Medical Physics



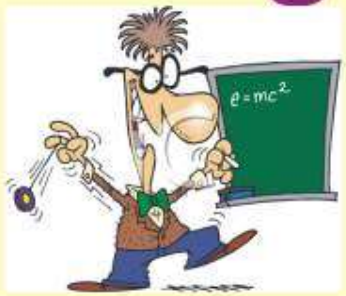
"Window"

Medical Physics Universe

Provide Window

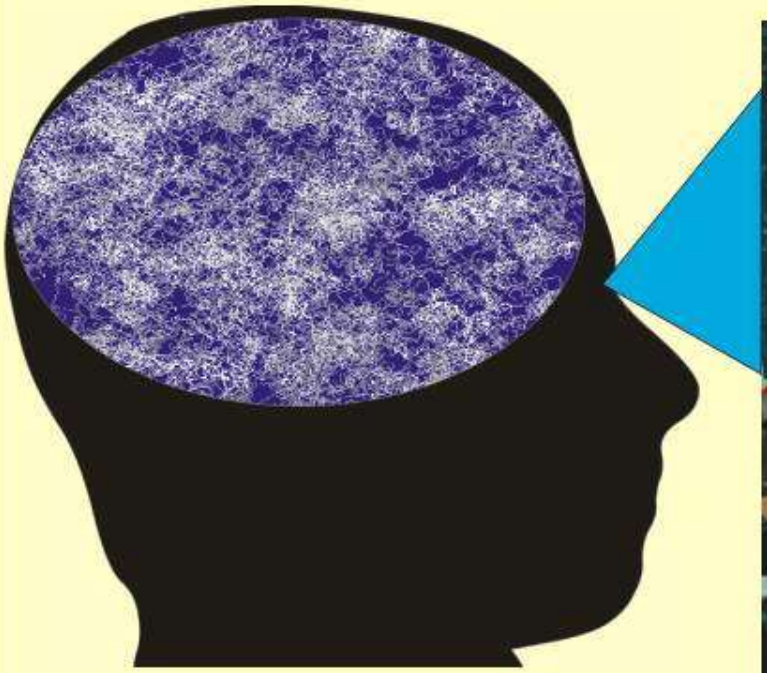
Guide the Learning Process

Teacher must



Sprawls

A Traditional "Window" to the Physical Universe



Sprawls

The Physical Universe

The inverse square law is.....

Twice the Distance

Photon Concentration (Exposure) decreased to 1/4th

X-ray beam now covers four times the area

The Inverse Square Law

$$\frac{I_1}{(I_2)} = \frac{(d_2)^2}{(d_1)^2}$$

I_1 is the initial intensity of radiation, d_1 is the initial distance, and d_2 is the final distance, and I_2 is the final intensity.

Verbal

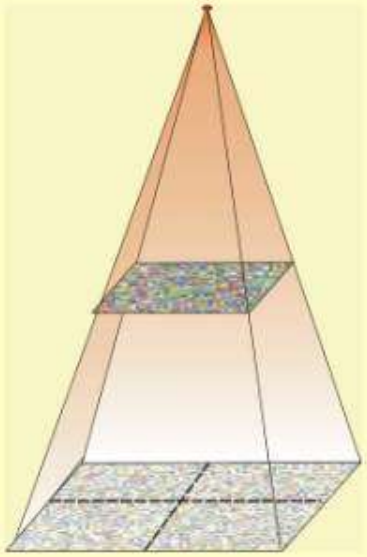
Sensory

Mathematical

Sprawls

Medical Physics Knowledge Structures

Sensory



Linguistic

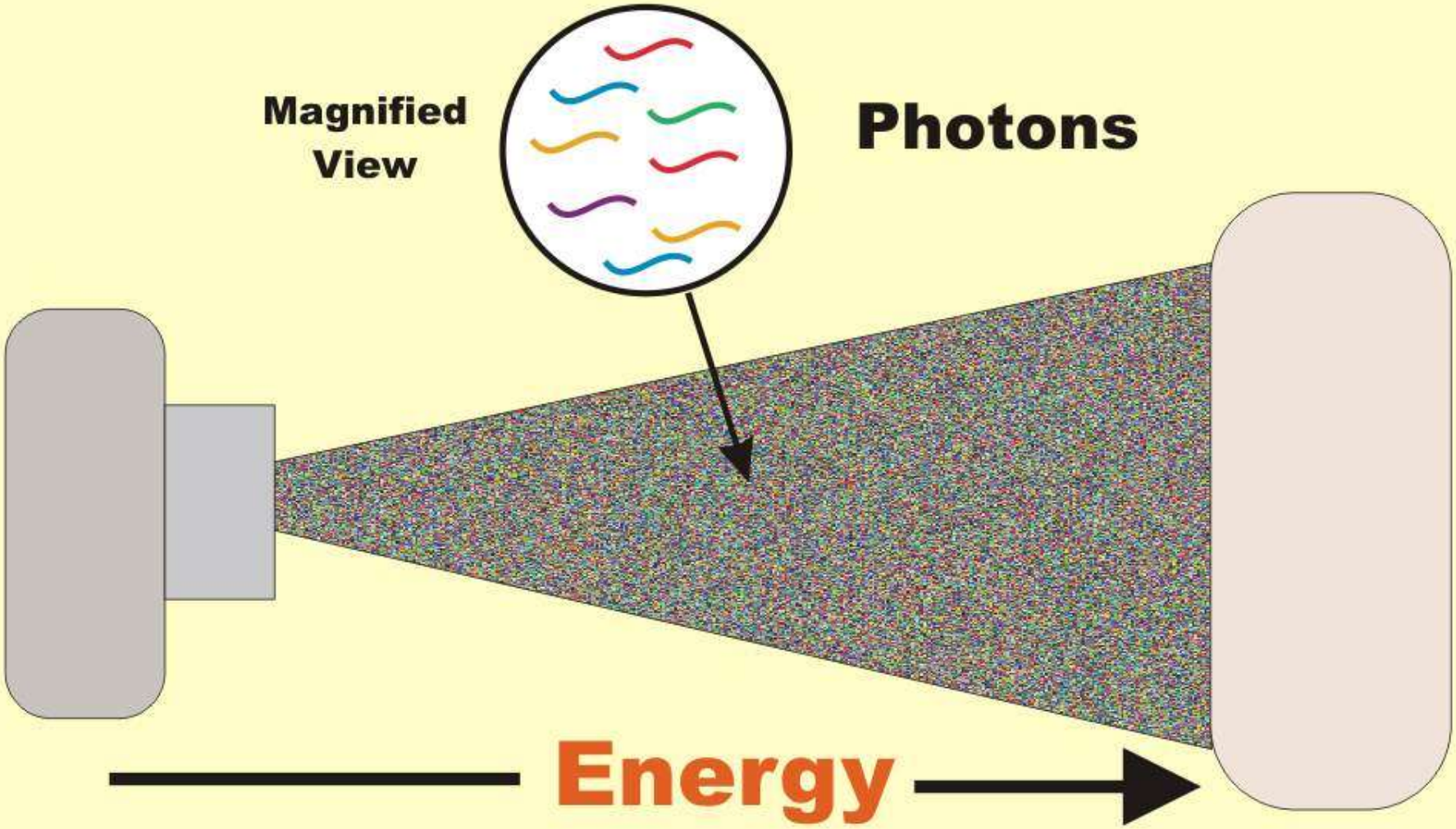
The inverse-square law states that the exposure decreases inversely to the square of the distance from the source.

Quantative

$$E_2 = E_1/(d_2/d_1)^2$$

Sprawls

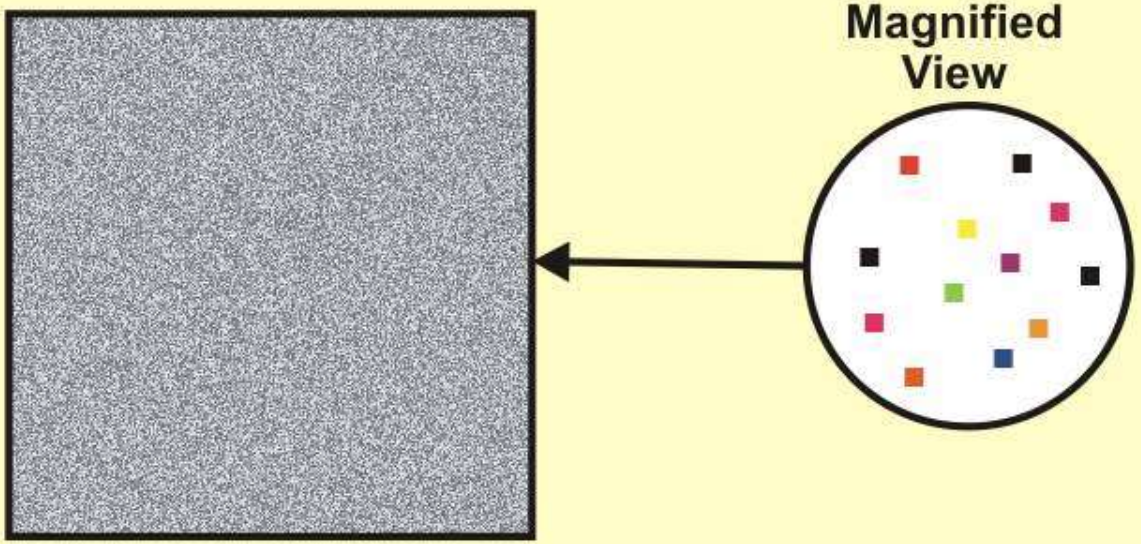
The X-ray Beam



Sprawls

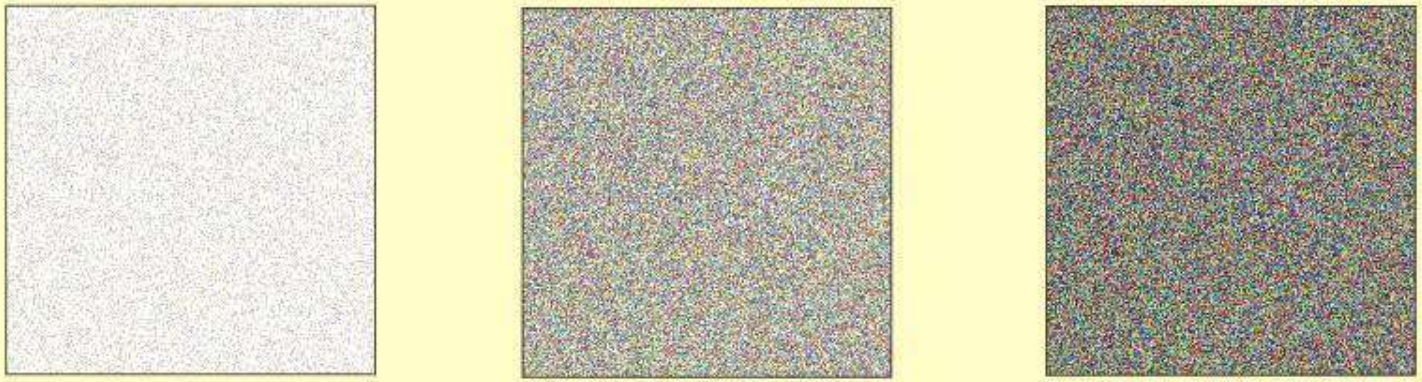
Image Of An X-ray Beam

A Random Distribution of Photons



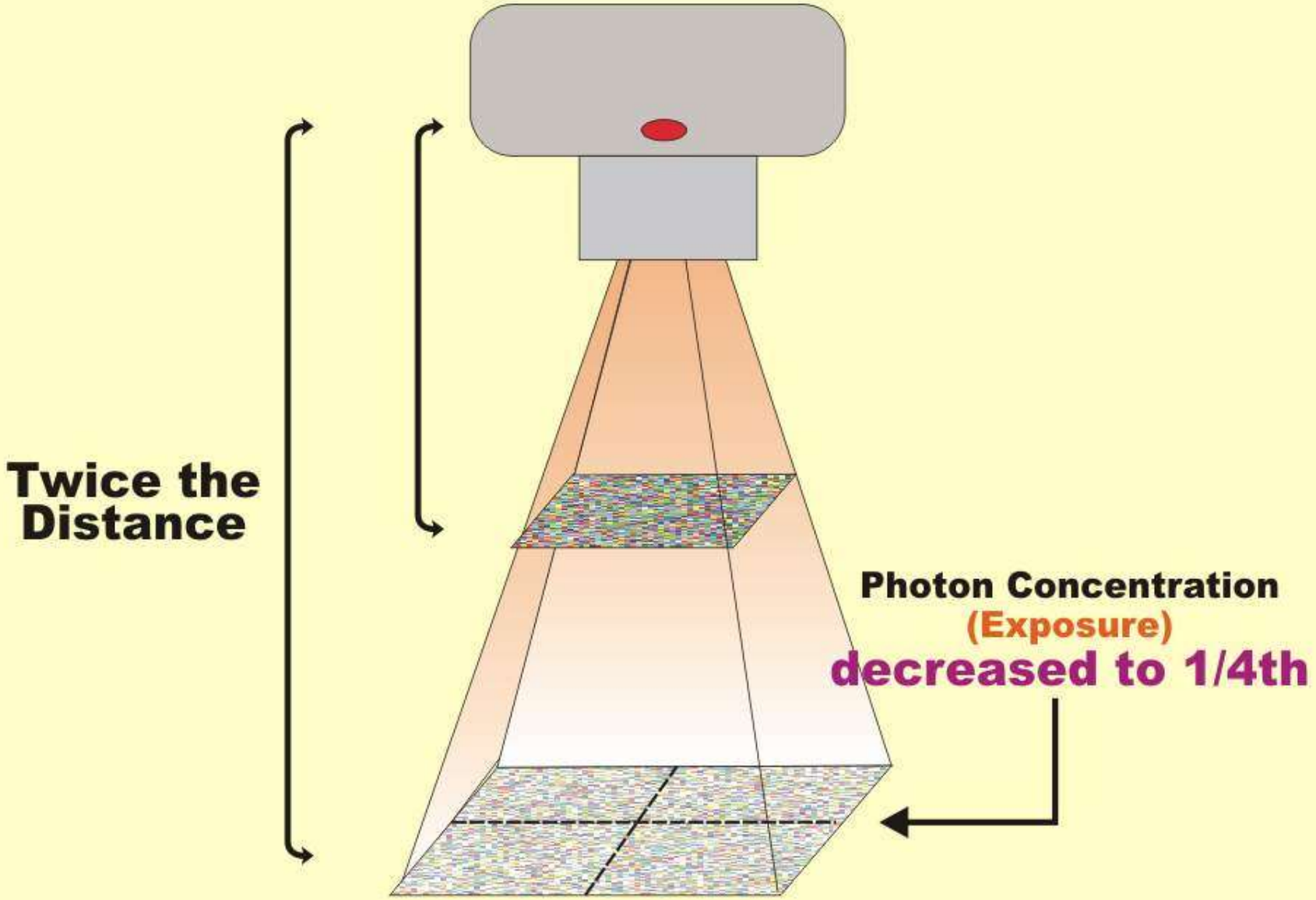
This is visible in an x-ray image as noise (quantum noise).

High **Medium** **Low**



— Photon Concentration (Exposure)→

Sprawls

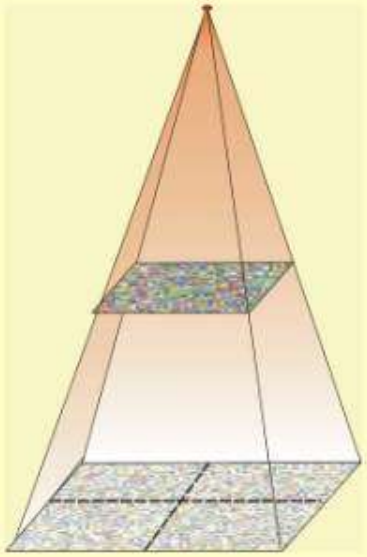


X-ray beam now covers four times the area

Sprawls

Medical Physics Knowledge Structures

Sensory



Linguistic

The inverse-square law states that the exposure decreases inversely to the square of the distance from the source.

Quantative

$$E_2 = E_1/(d_2/d_1)^2$$

Sprawls

Who needs a knowledge of Physics applied to clinical imaging?

Radiologists, Residents and Fellows

Technologists

Medical Physicists

Each provides unique challenges and opportunities.

Sprawls

Physics Learning Objectives for Radiologists

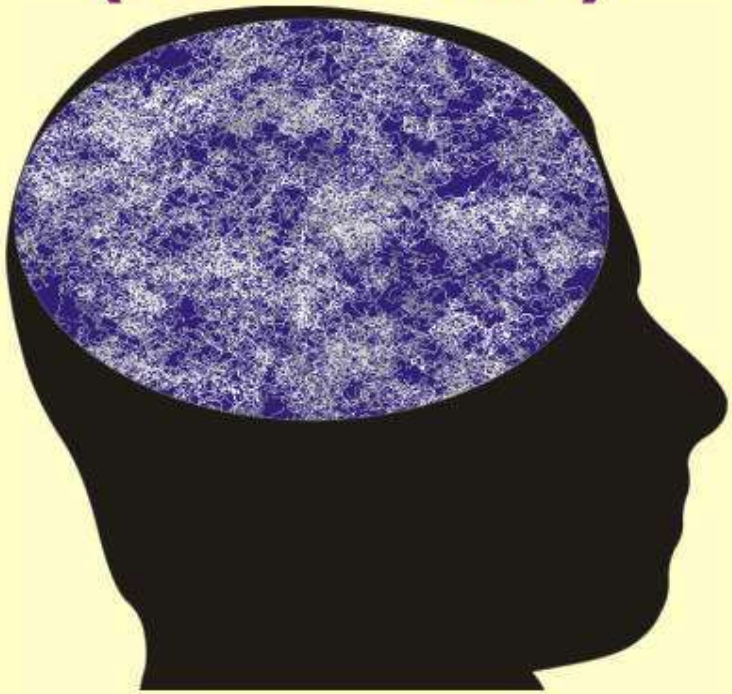
Image Physical Characteristics

- **Identify**
- **Relationship to Visibility** → **Anatomy and Pathology**
- **Evaluate**
- **Control and Optimize** → **Risk**

Sprawls

What do they need?

Learner (Resident)

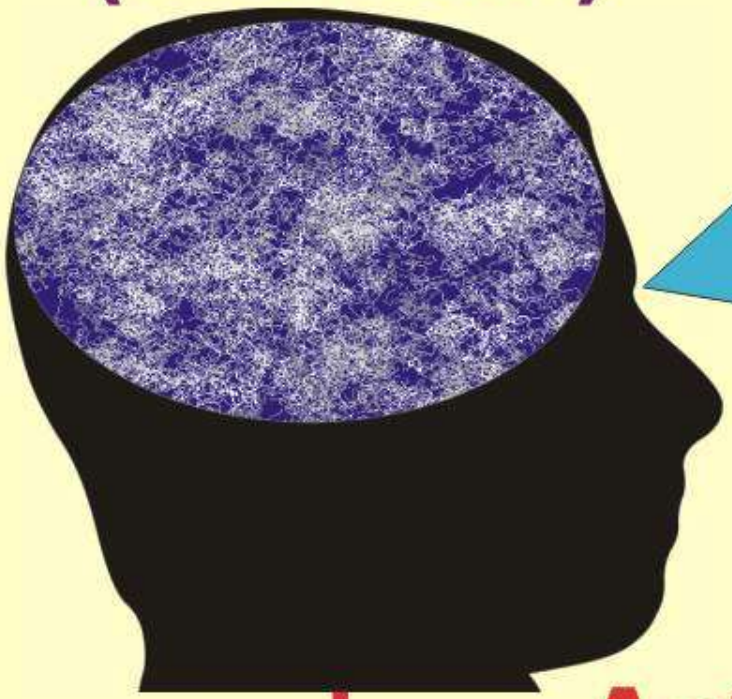


Optimize CT image quality and manage dose.

Sprawls

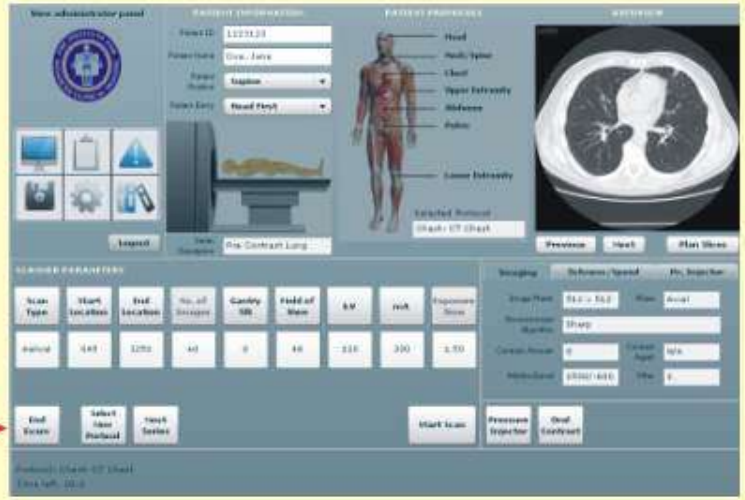
What do they need to DO?

Learner (Resident)



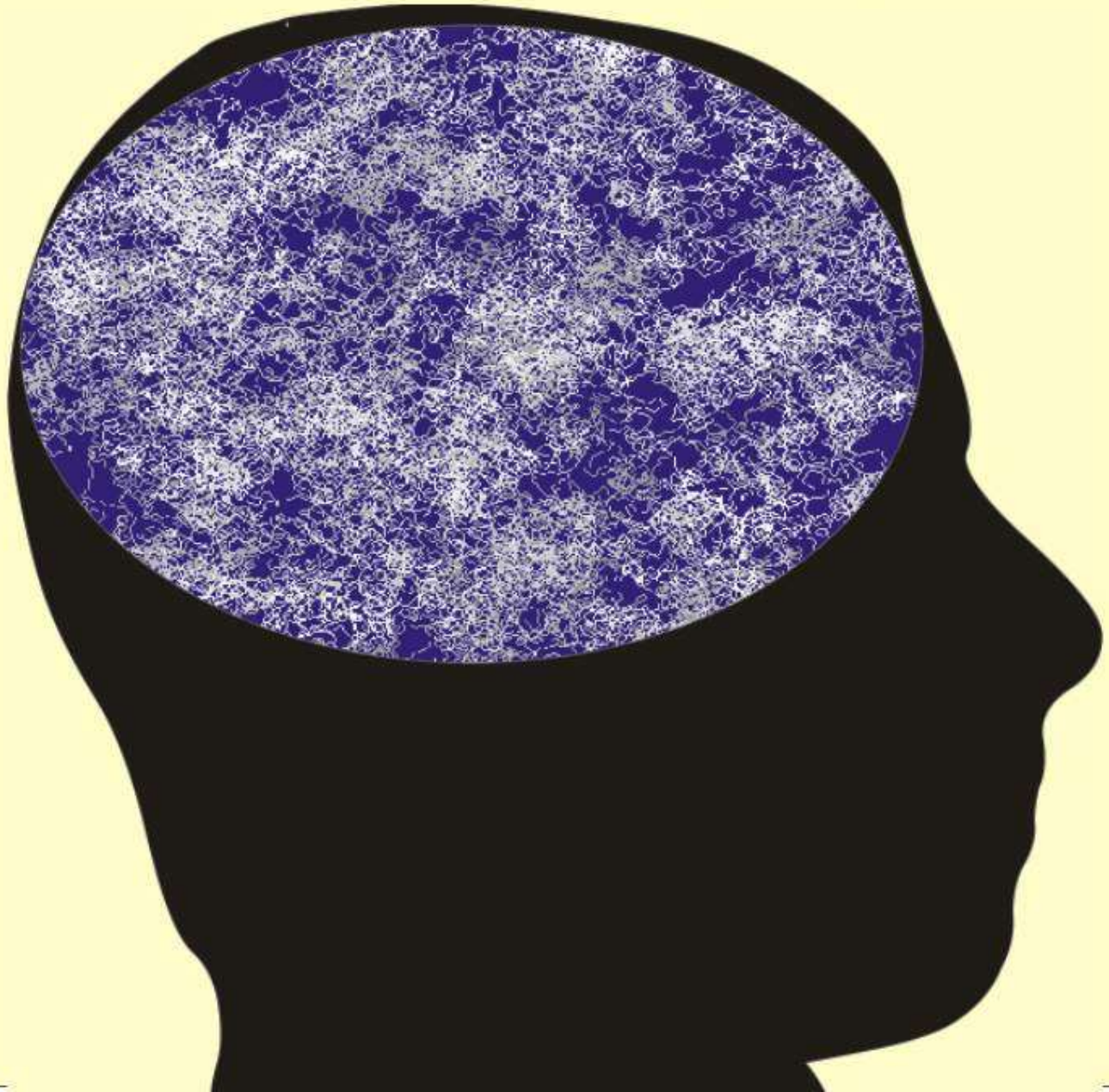
View

Action



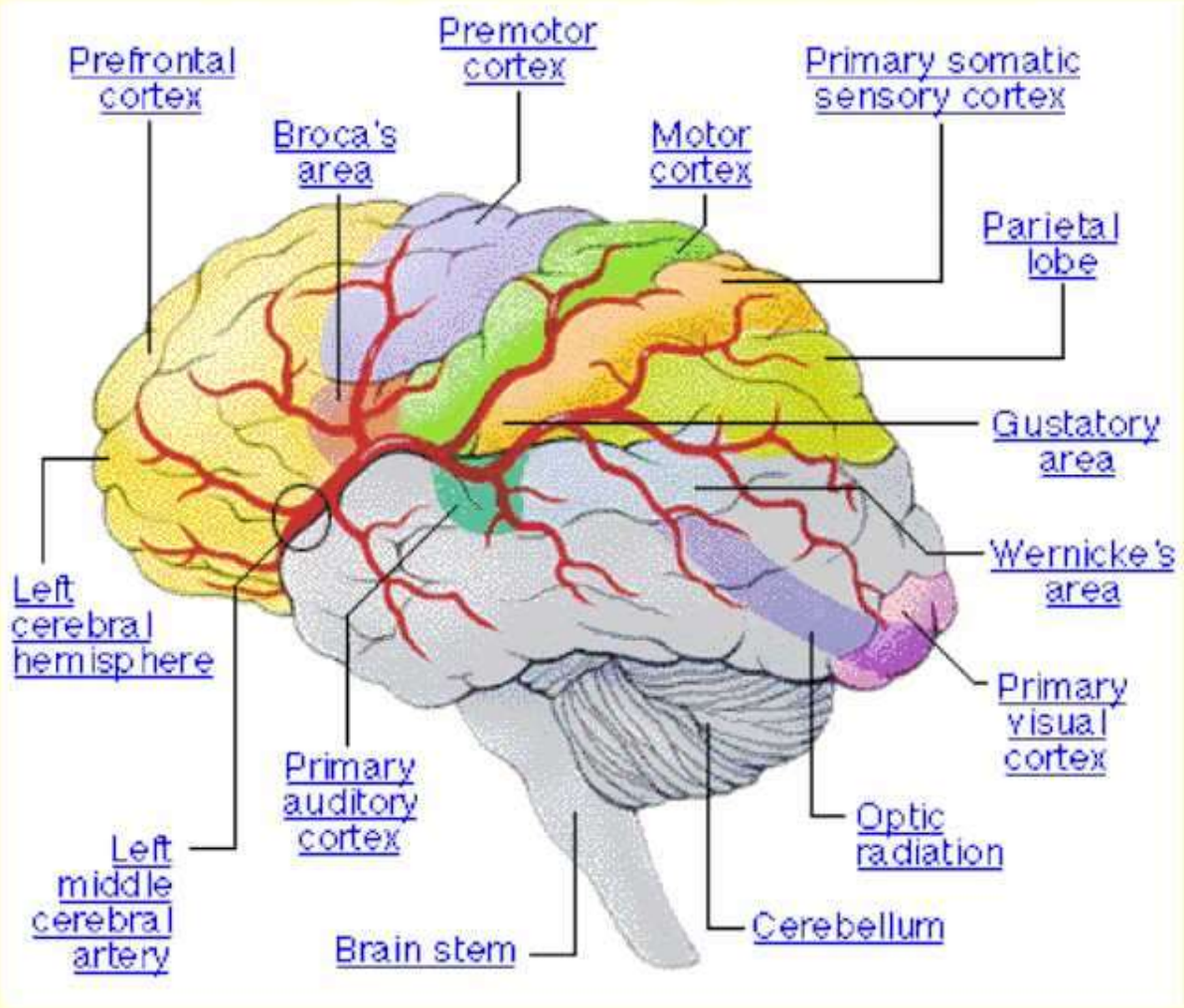
Sprawls

Your Mind



Sprawls

The Brain...



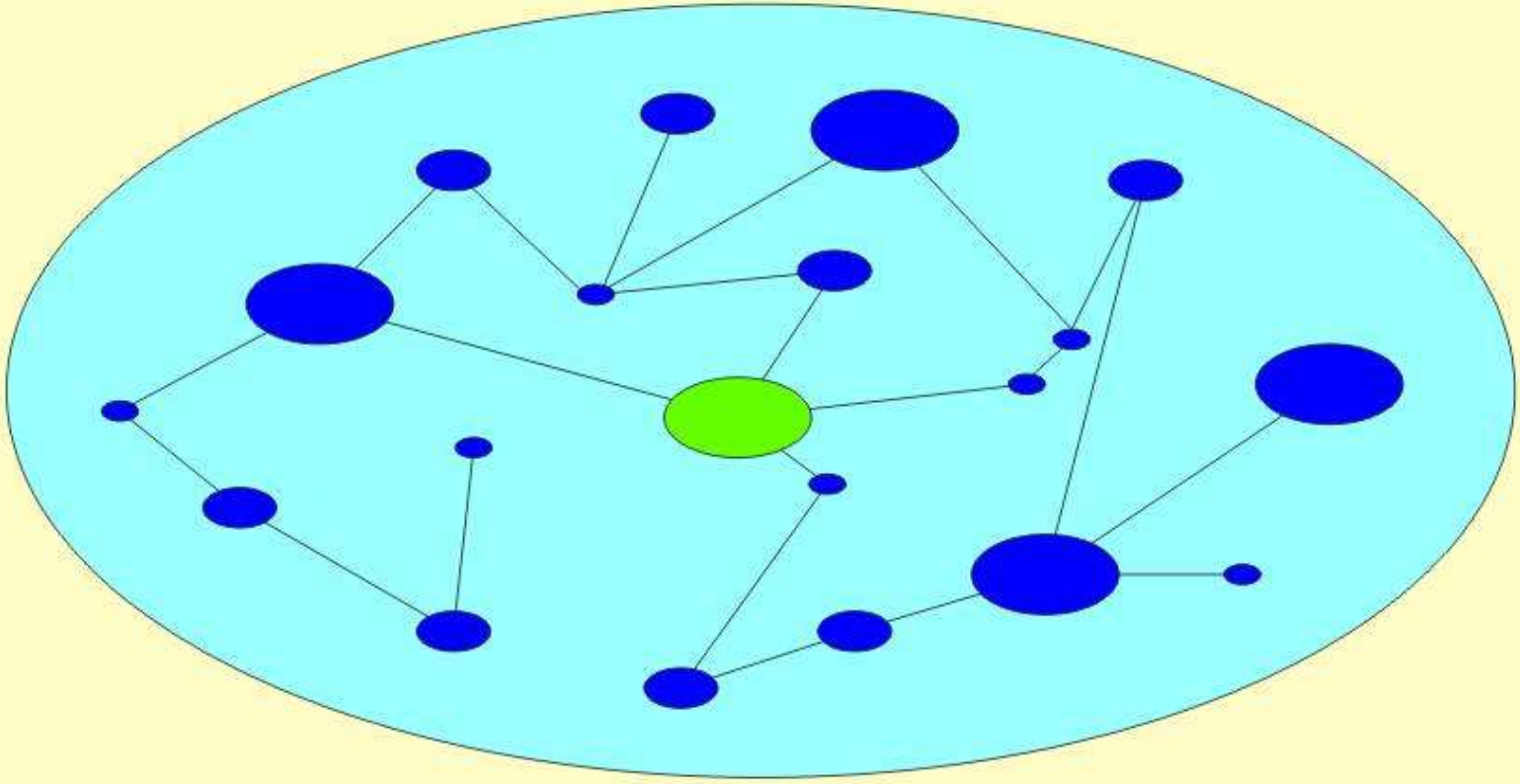
Structure and Function

Image: AMA

Sprawls

Knowledge Structures in the Brain

A Complex Network



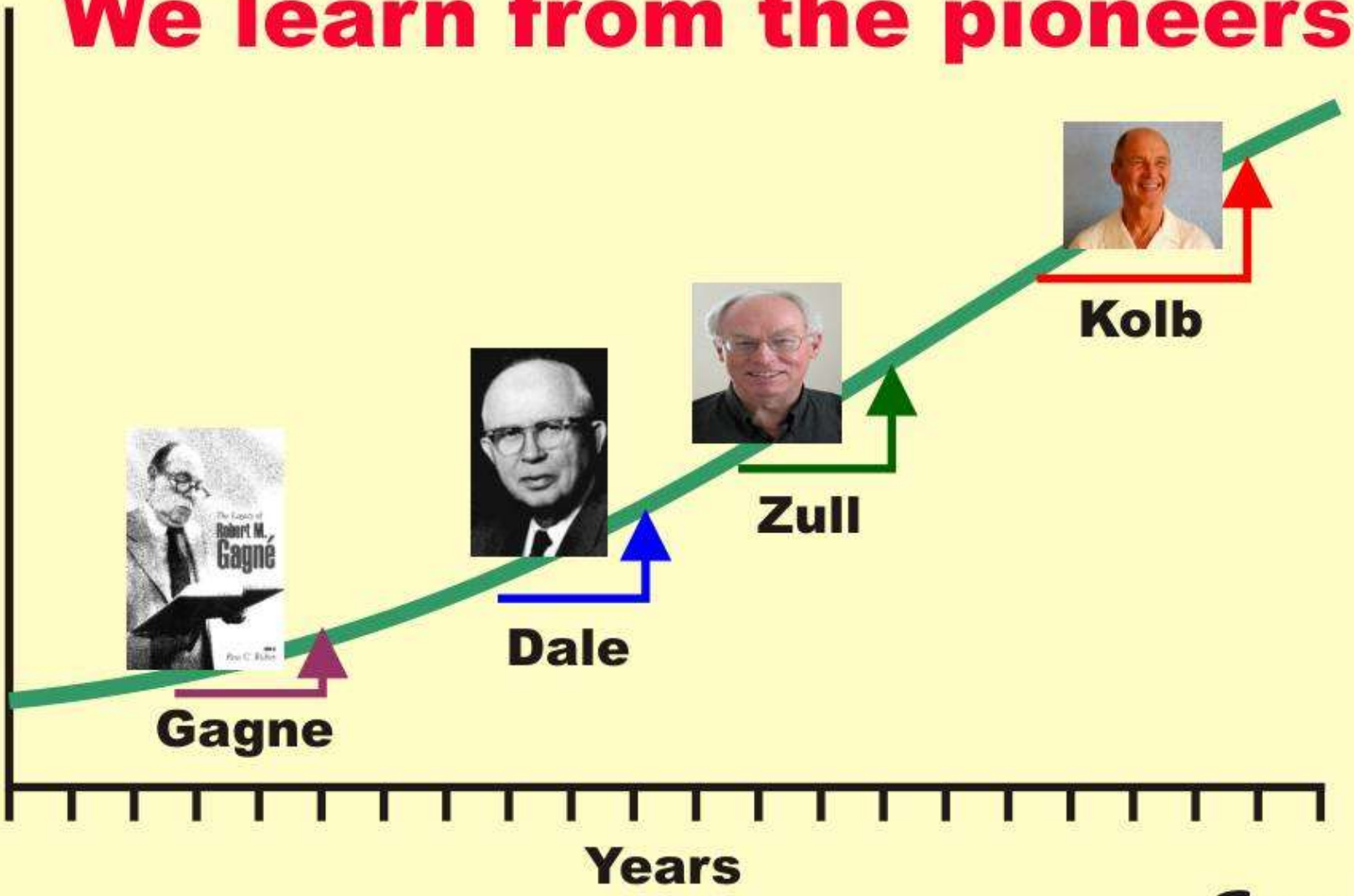
Concepts **Facts**

Images **Language**

Sprawls

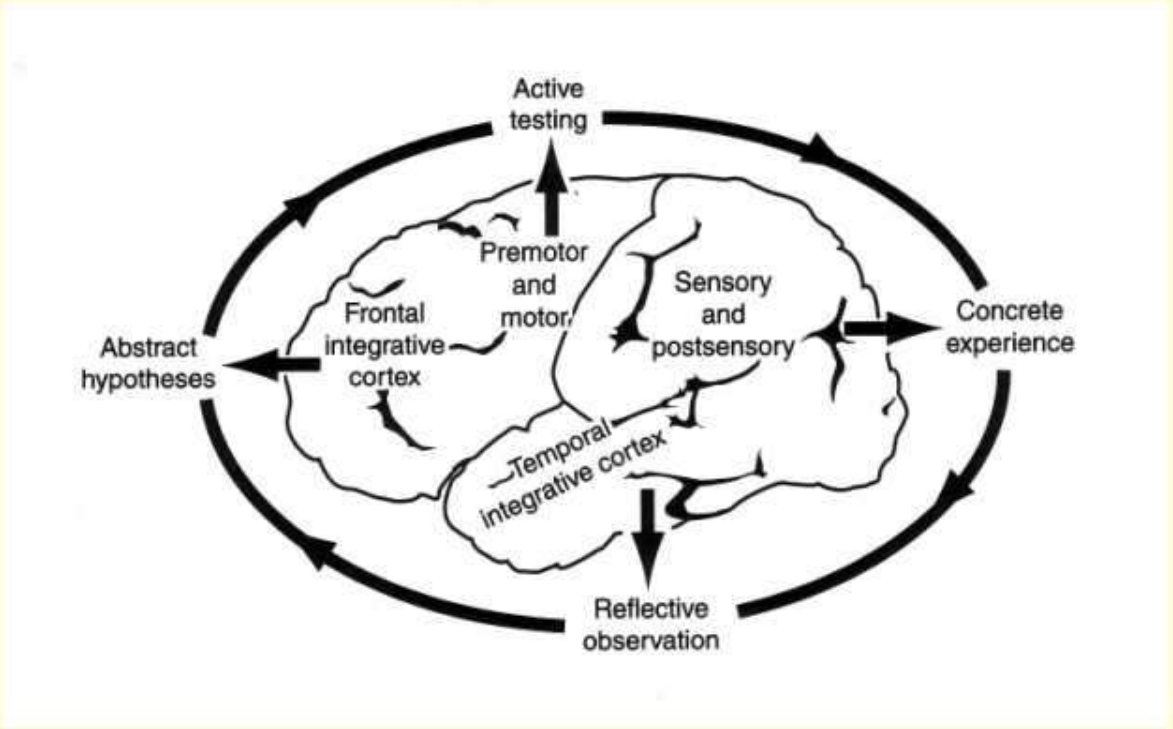
Knowledge of the Learning & Teaching Process

We learn from the pioneers



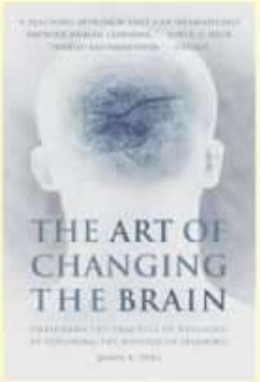
Sprawls

Zull's Model of Brain Function

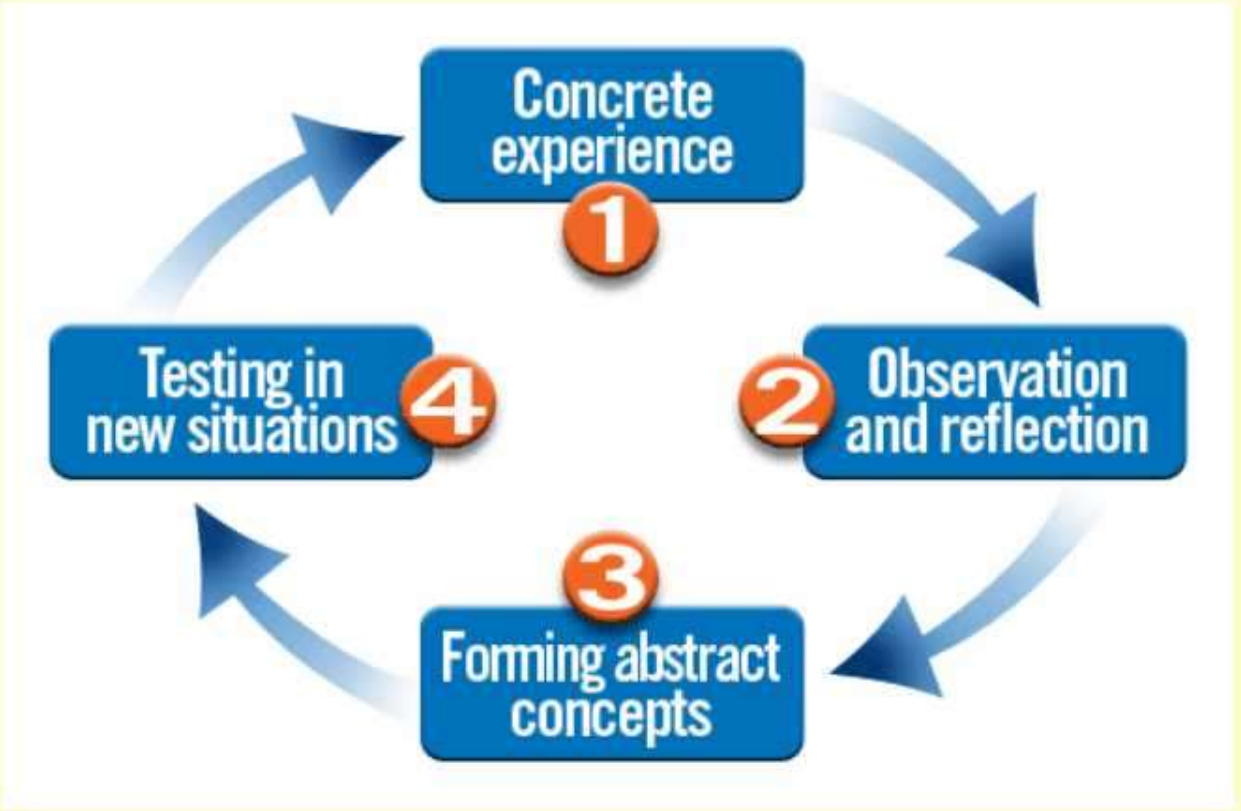


James Zull, Ph.D.
Professor of Biology
Professor of Biochemistry
Director of University Center for Innovation in Teaching and Education
Case Western Reserve

Reference:



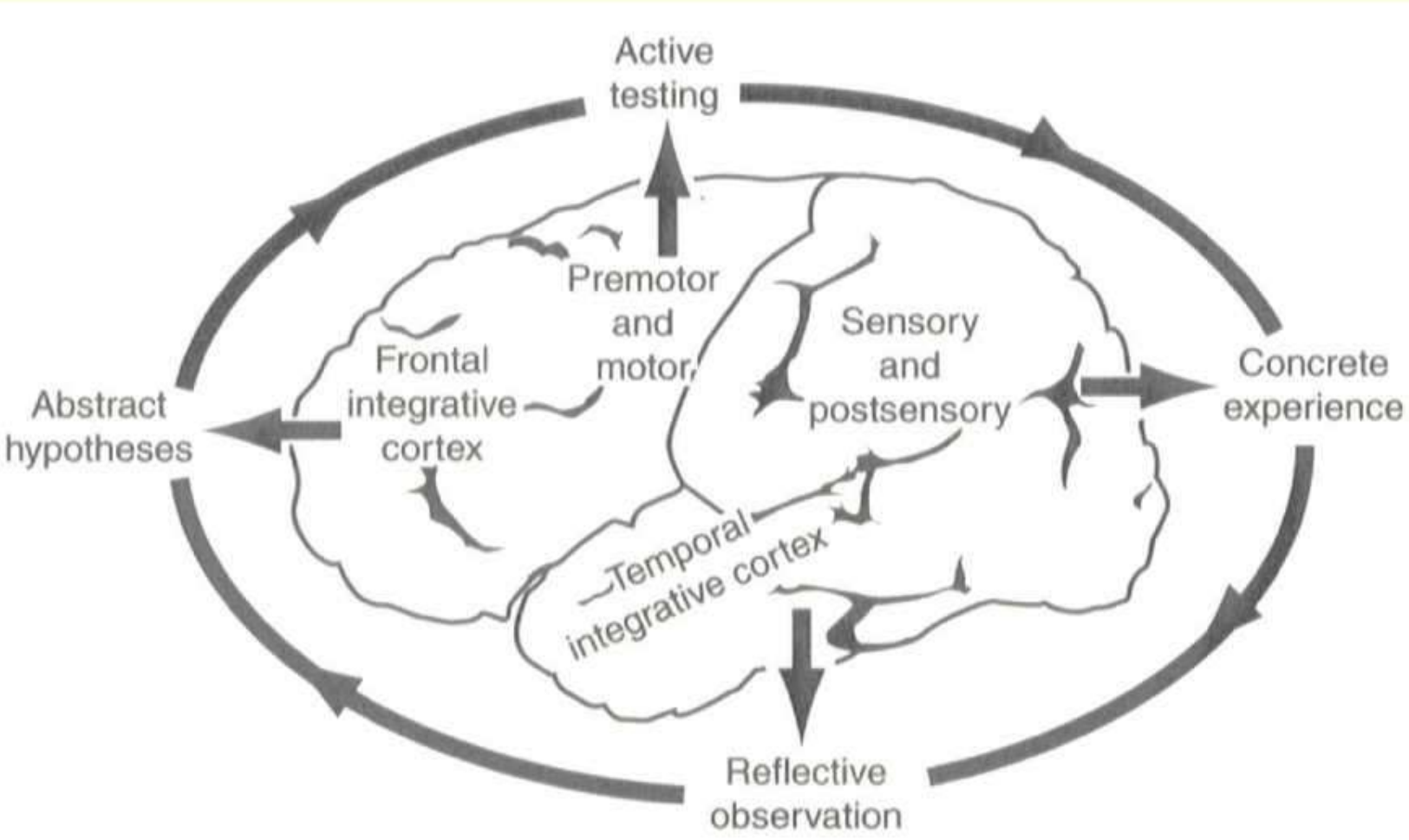
Kolb's Experiential Learning Model



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

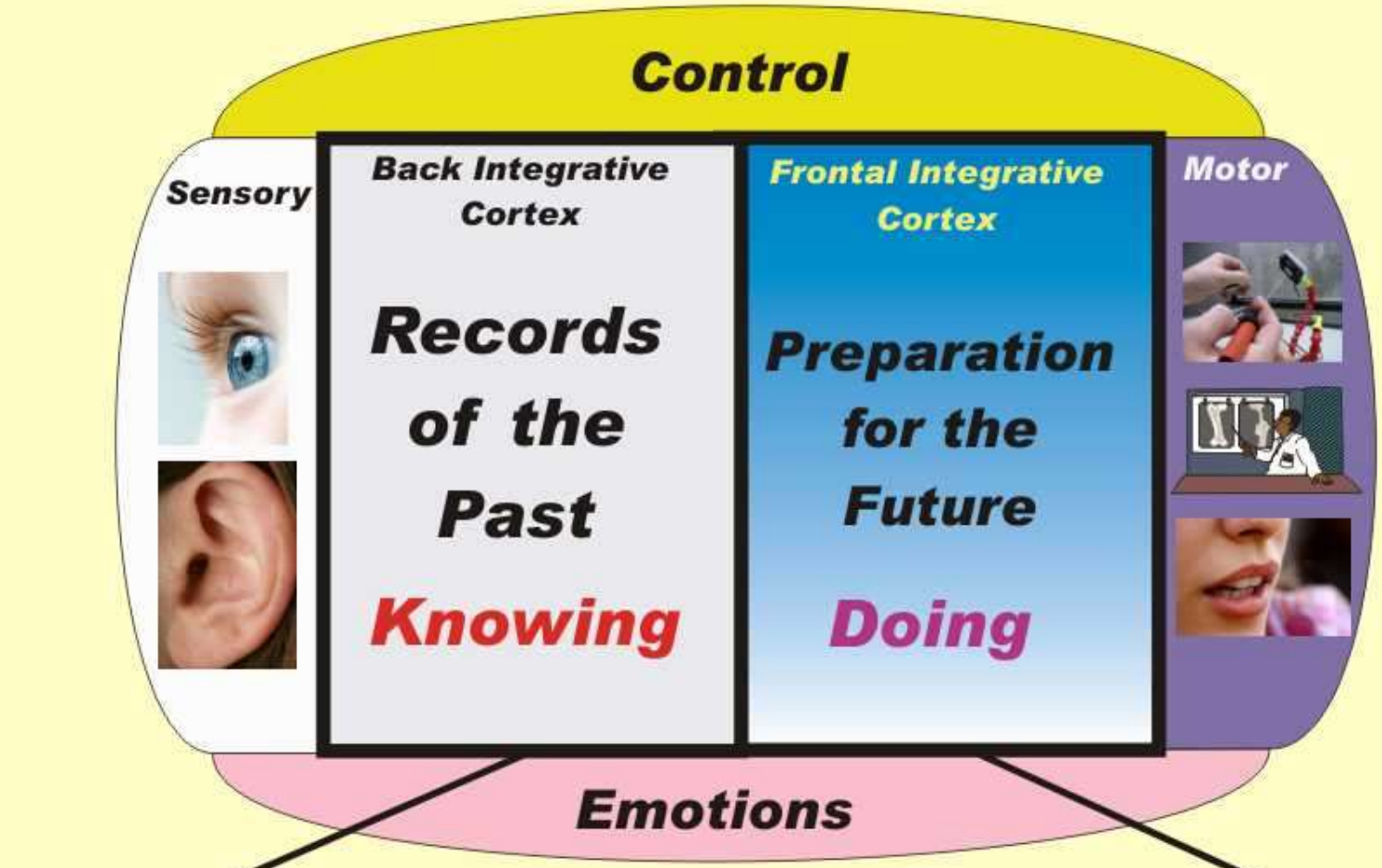
Hypotheses

Motor

Emotions

Sprawls

Brain Functions for Learning Physics



Balanced Education

Sprawls

Forming Knowledge Structures

Physical Universe

Sensory

Back Integrative Cortex

Visible Physical Objects

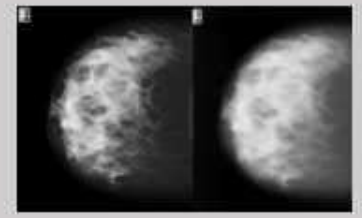
Sprawls

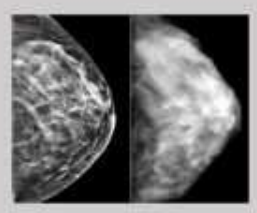
Forming Knowledge Structures

Physical Universe

Sensory

Back Integrative Cortex





Visible Physical Objects

Sprawls

Forming Knowledge Structures

Physical Universe

Back Integrative Cortex

Sensory

Radiation
Electrons
Magnetic
Atomic
Nuclear

? ? ?

Invisible Physical Objects

Sprawls

Forming Knowledge Structures

Physical Universe

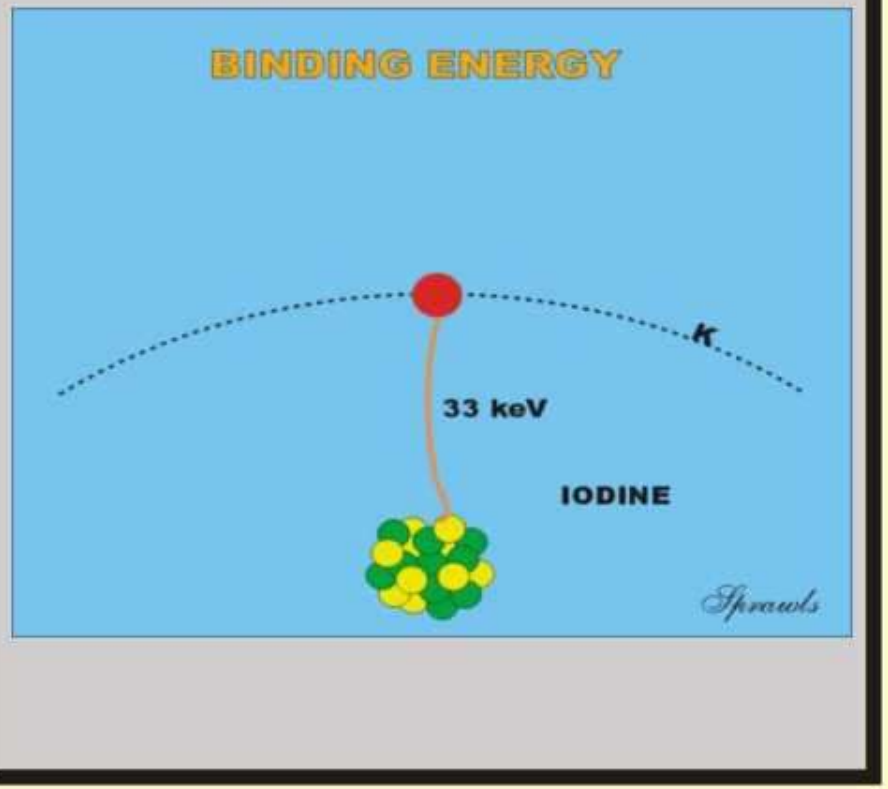
Radiation
Electrons
Magnetic
Atomic
Nuclear

Invisible

Physical Objects

Back Integrative Cortex

Sensory



Visuals

Sprawls

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Verbal

Sensory

Mathematical

Sprawls

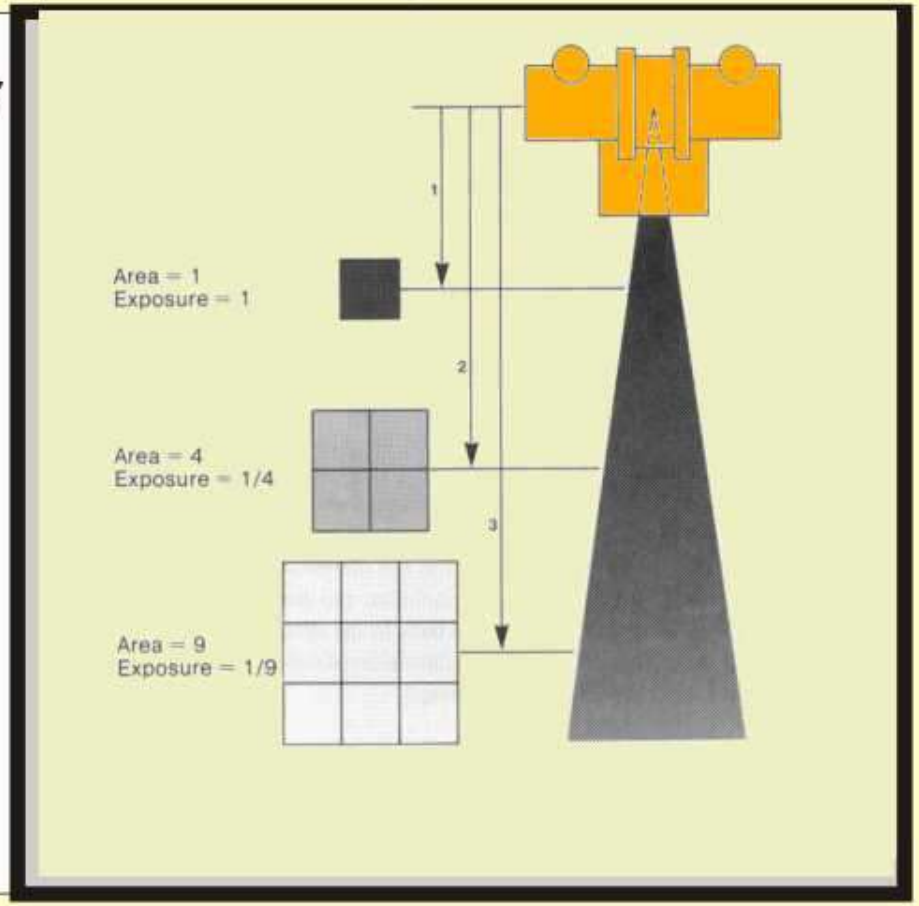
Forming Knowledge Structures

Physical Universe

Back Integrative Cortex

Inverse Square Effect

Sensory



Invisible

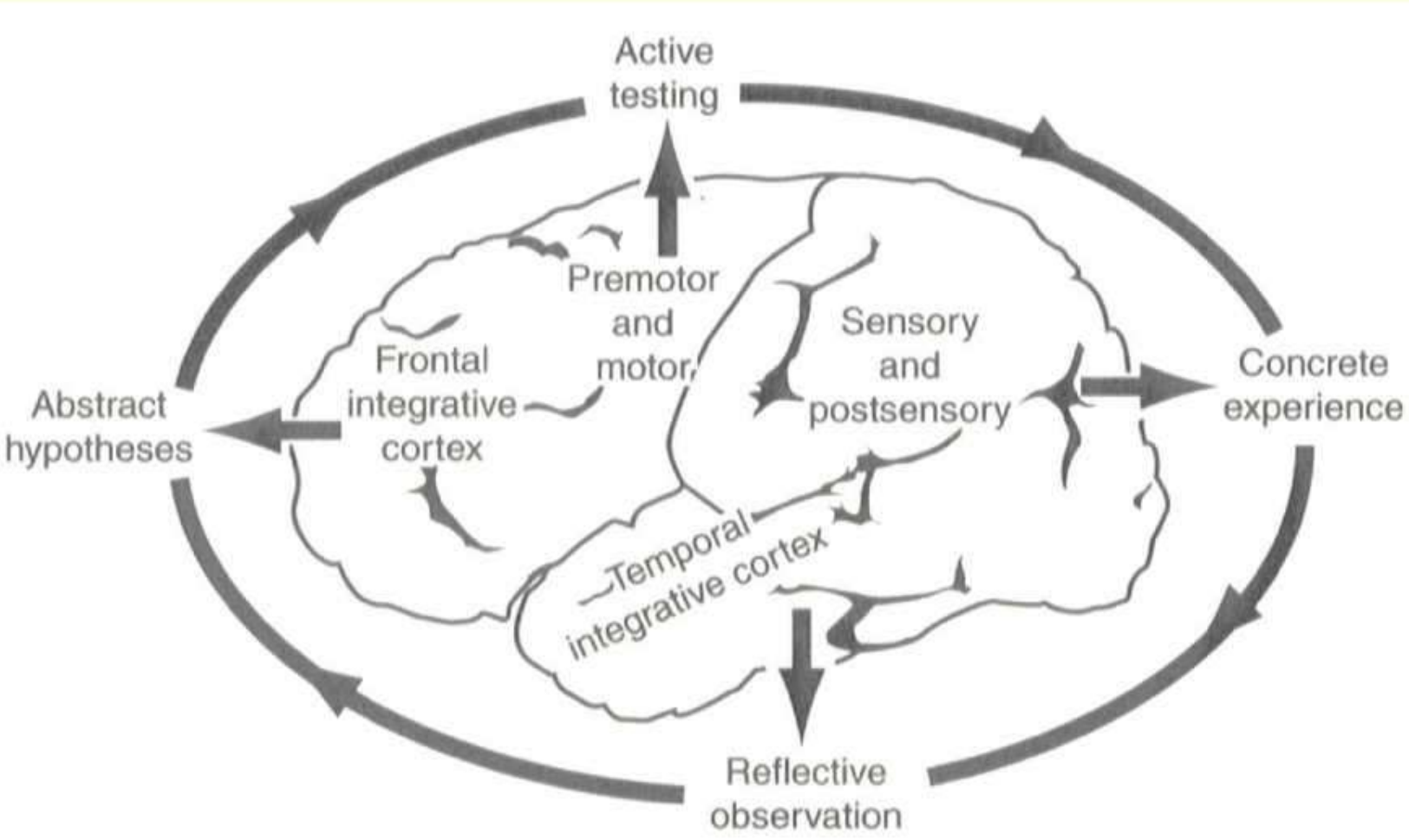
Concepts

Ideas

Visuals

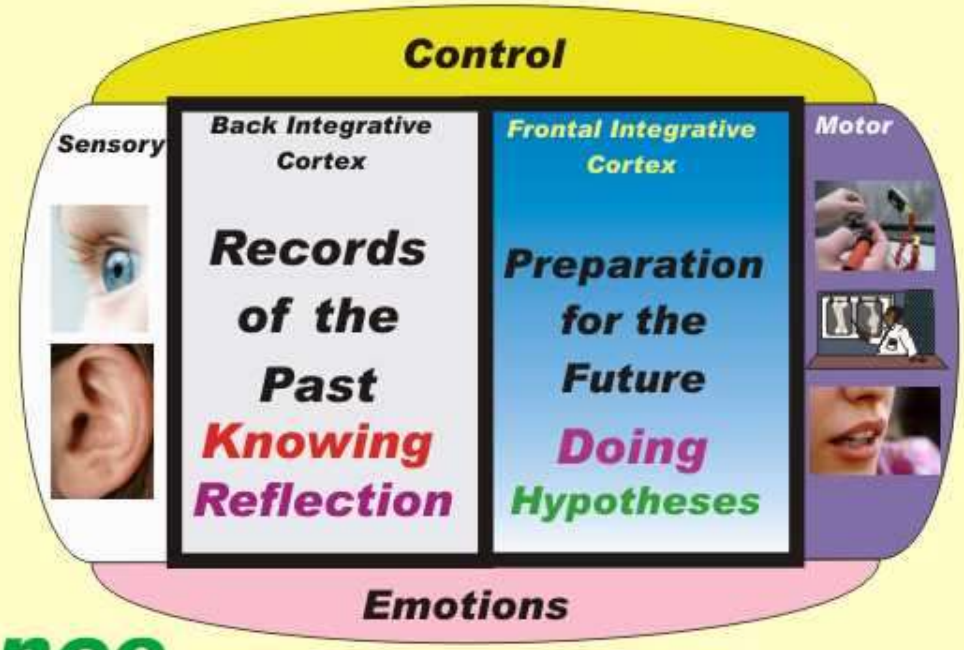
Sprawls

Zull's Model of Brain Function



Brain Functions for Learning Physics

Active Experimentation and Testing



Sense and Experience Observe

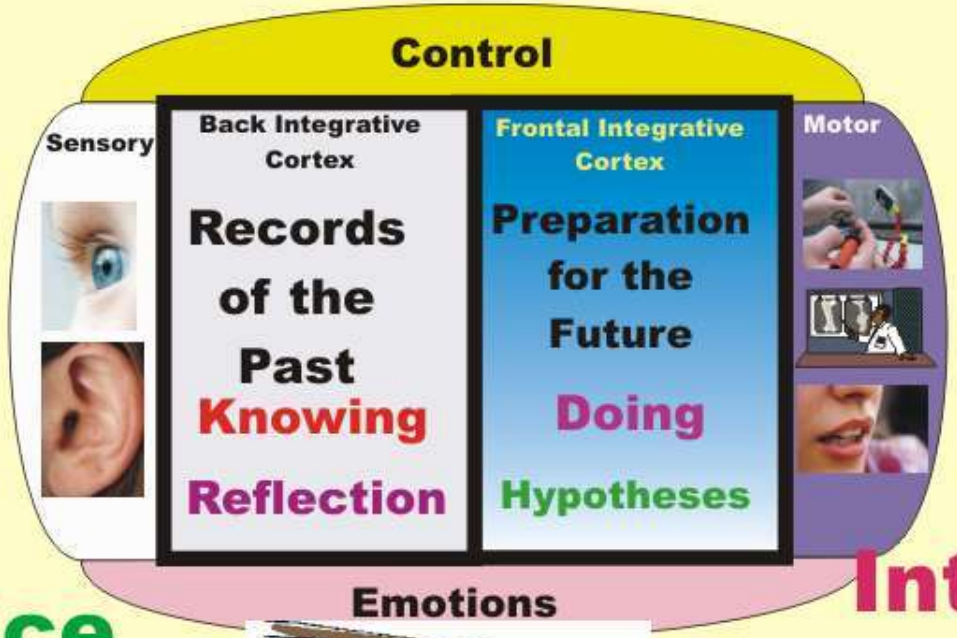
Interact and Affect

Physical Universe

Sprawls

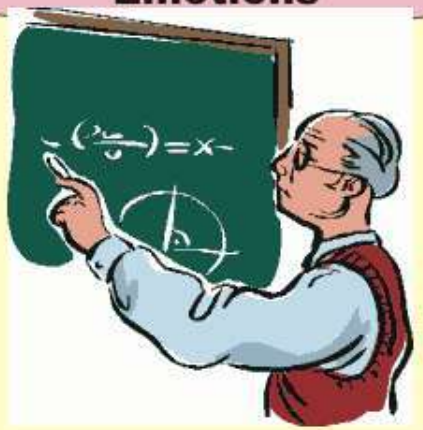
Brain Functions for Learning About

Learning Physics



Sense and Experience Observe

Interact and Affect



Our Teaching

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

PROBLEM SOLVING

RULE LEARNING

CONCEPT LEARNING

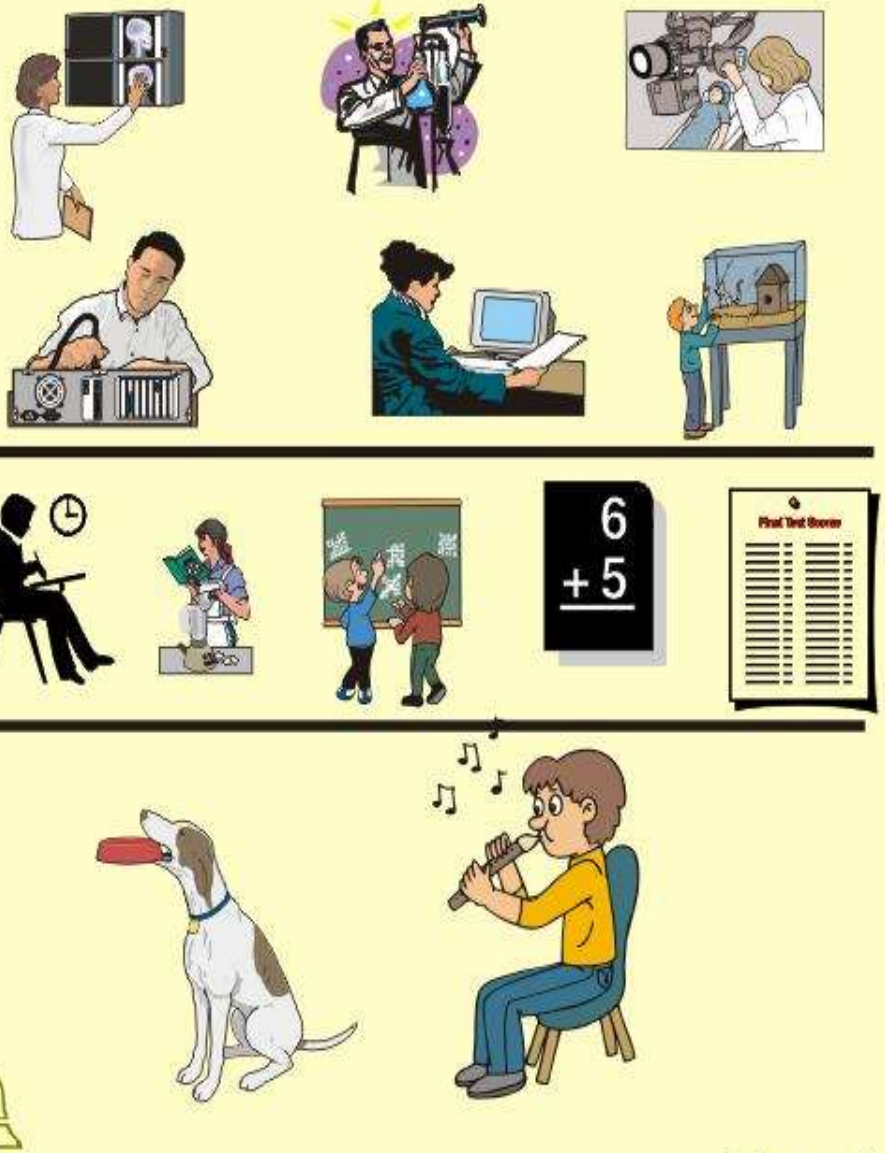
DISCRIMINATION LEARNING

VERBAL ASSOCIATION

CHAINING

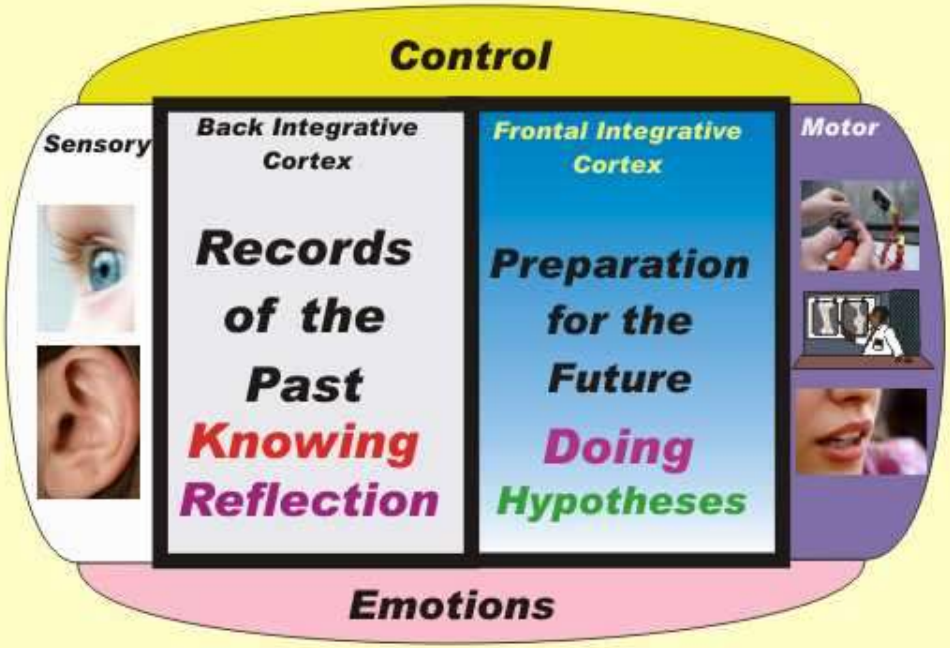
STIMULUS RESPONSE

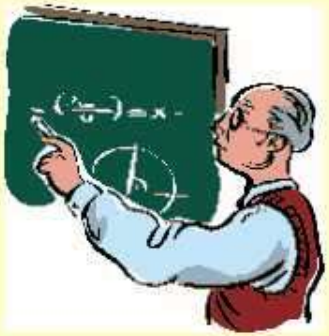
SIGNAL LEARNING



Sprawls

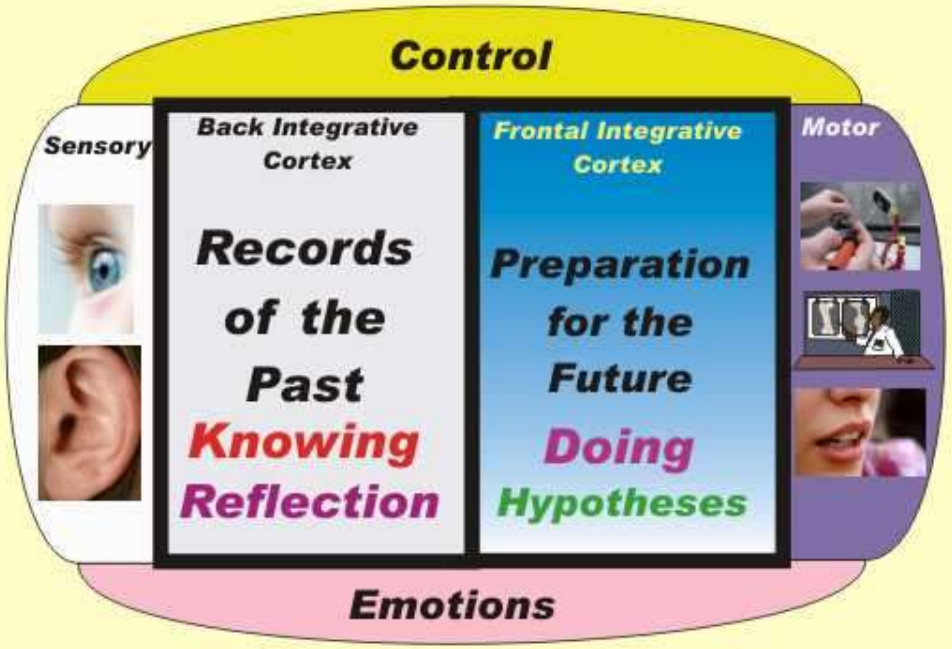
Challenging Learning Environments





Sprawls

Rich Learning Environments

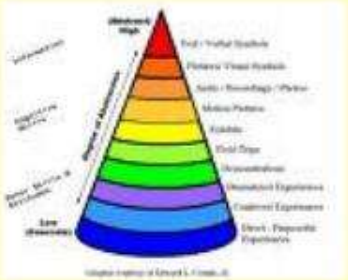


Sprawls

Edgar Dale (1900-1985)

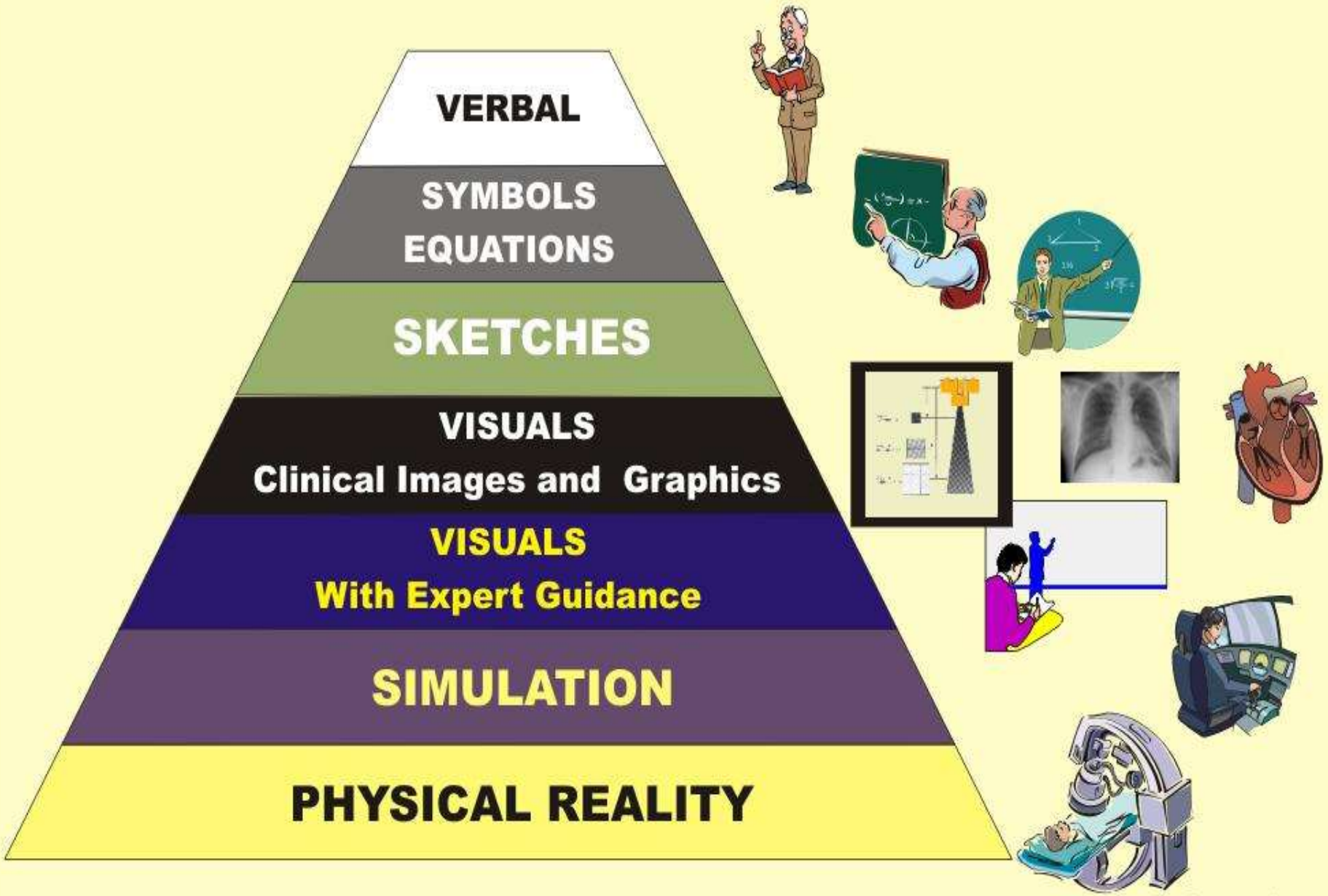
Educationalist who developed the famous

Cone of Experience theory

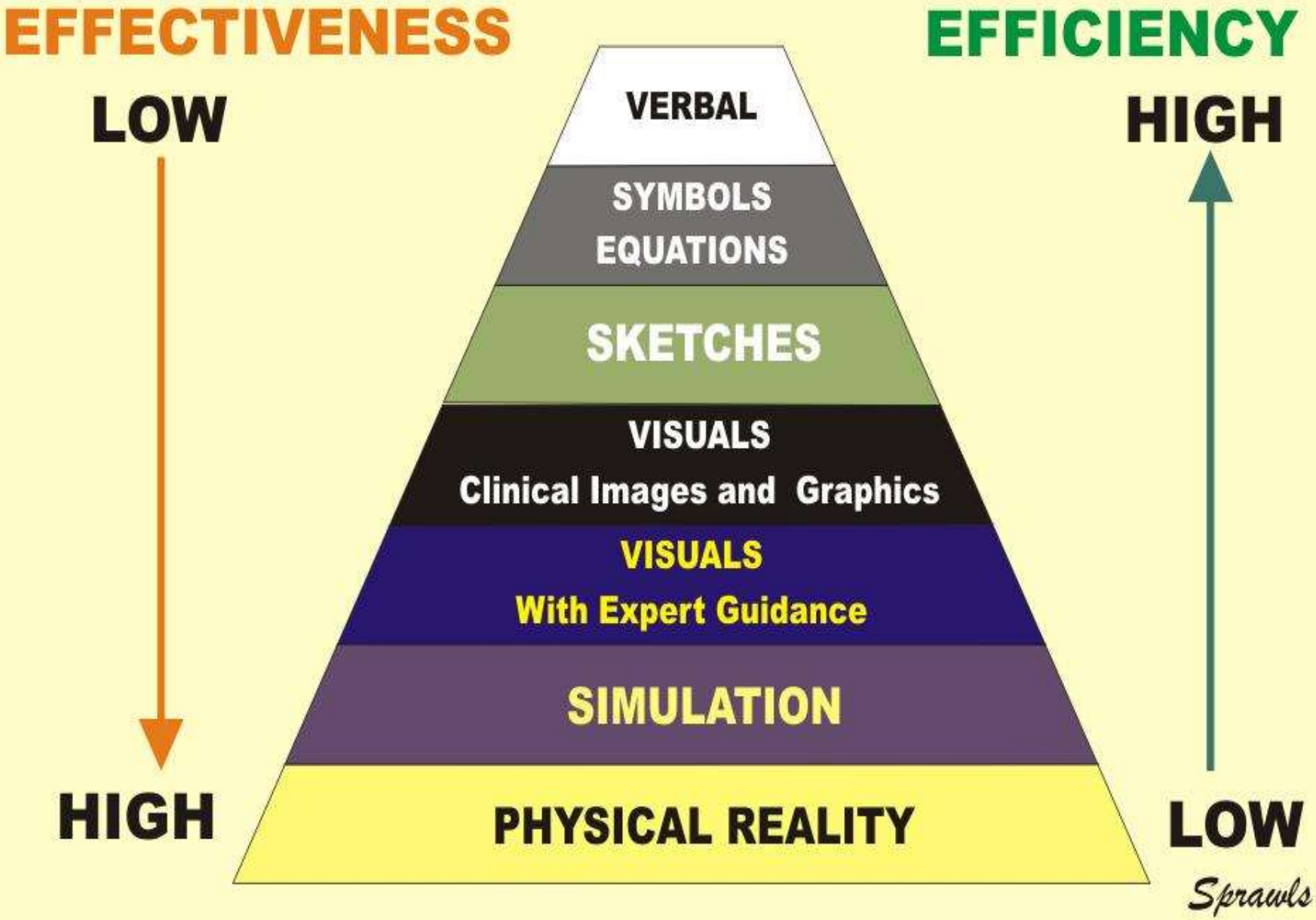


Sprawls

Cone of Experience for Medical Imaging Education

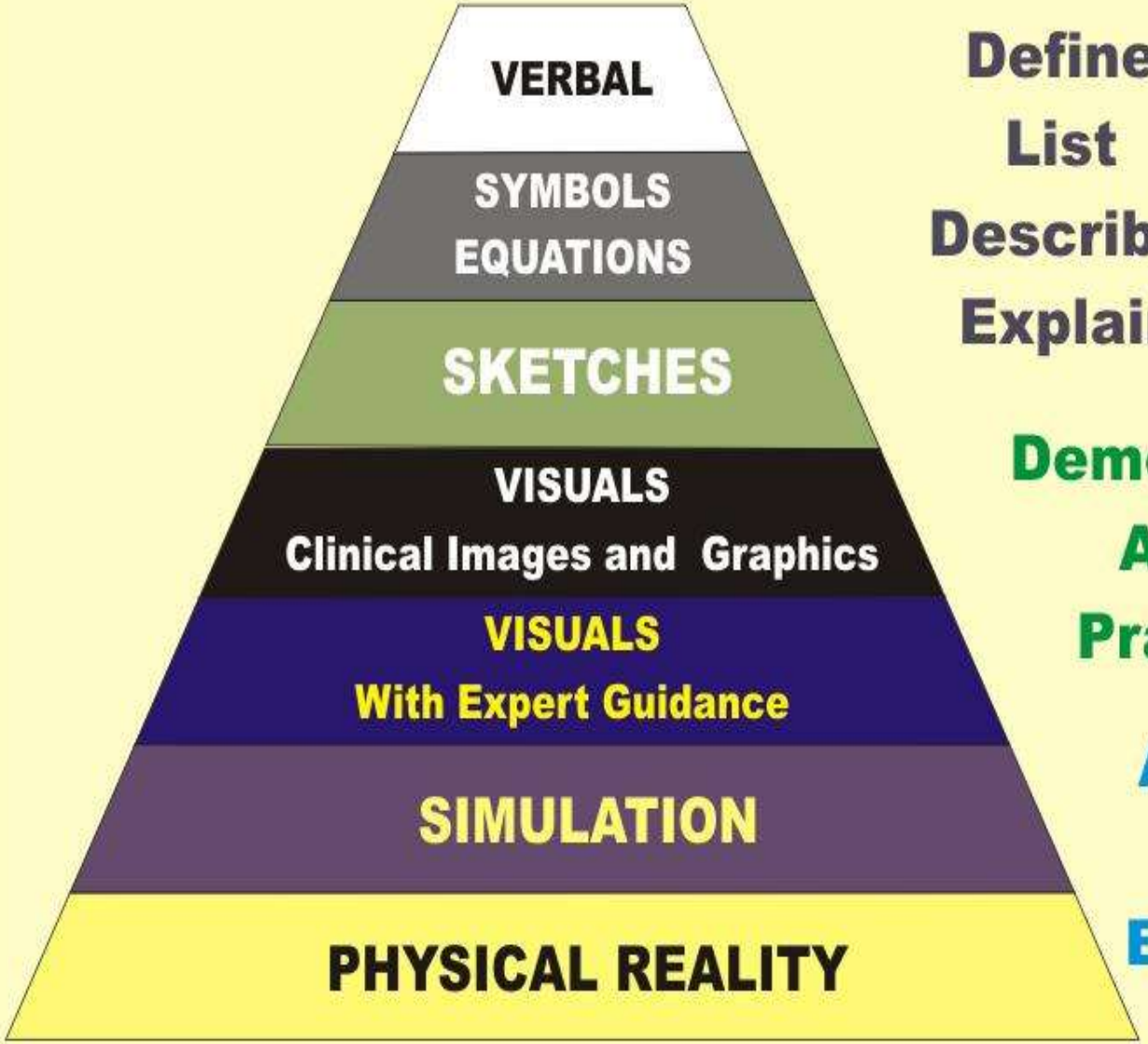


Cone of Experience for Medical Imaging Education



Sprawls

Cone of Experience for Medical Imaging Education



LEARNING OUTCOMES

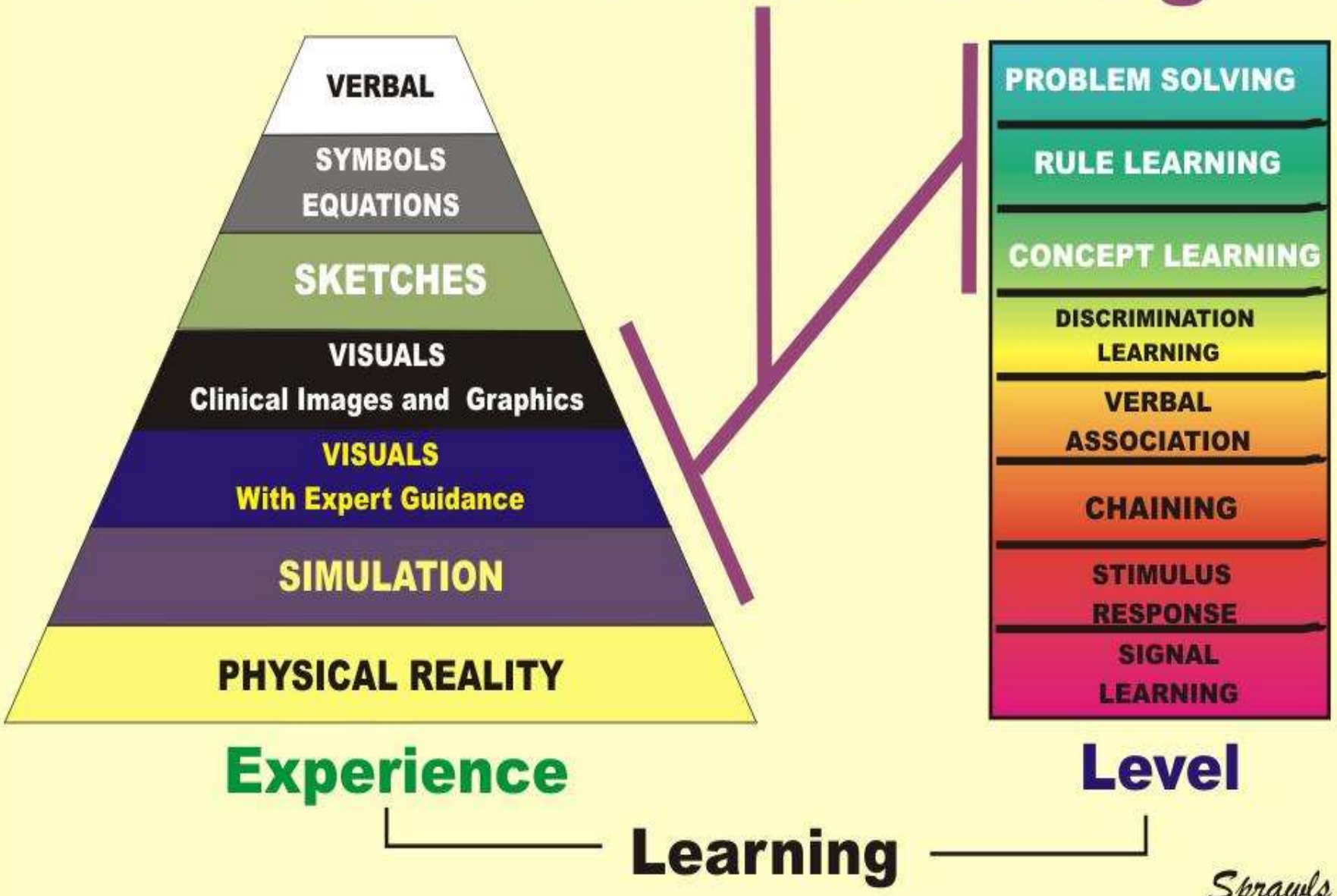
Define
List
Describe
Explain

Demonstrate
Apply
Practice

Analyze
Create
Evaluate

Sprawls

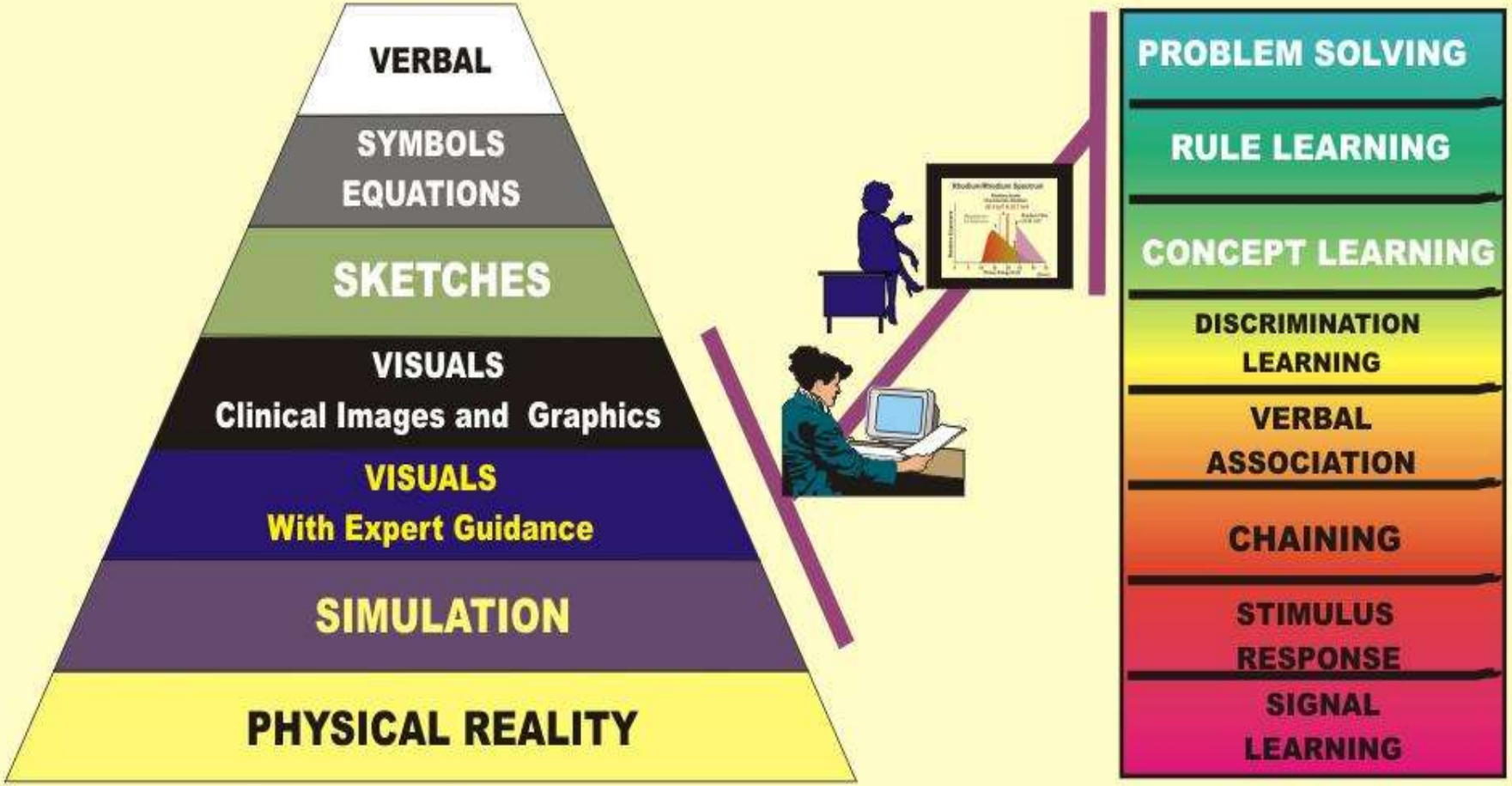
Effective Learning



Sprawls

Technology Enhanced

Learning and Teaching



Sprawls

Clinically Focused Physics Education

Classroom | Clinical Conference | Small Group | "Flying Solo"

Highly Efficient

For
General Physics
and
Related Topics

Highly Effective

Clinically Rich Learning Activities

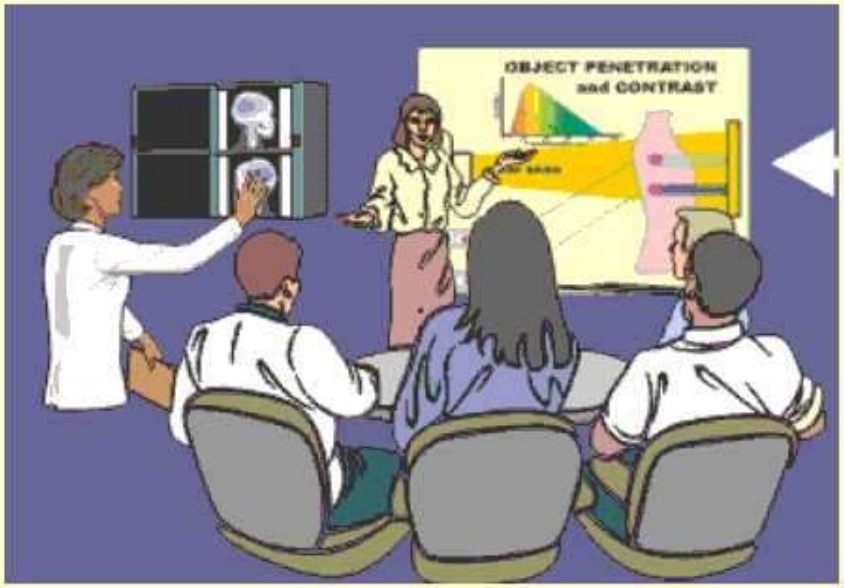
Visuals **Images** **Online Modules**

Resources and References

Sprawls

Rich Classroom and Conference Learning Activities

Learning Facilitator "Teacher"



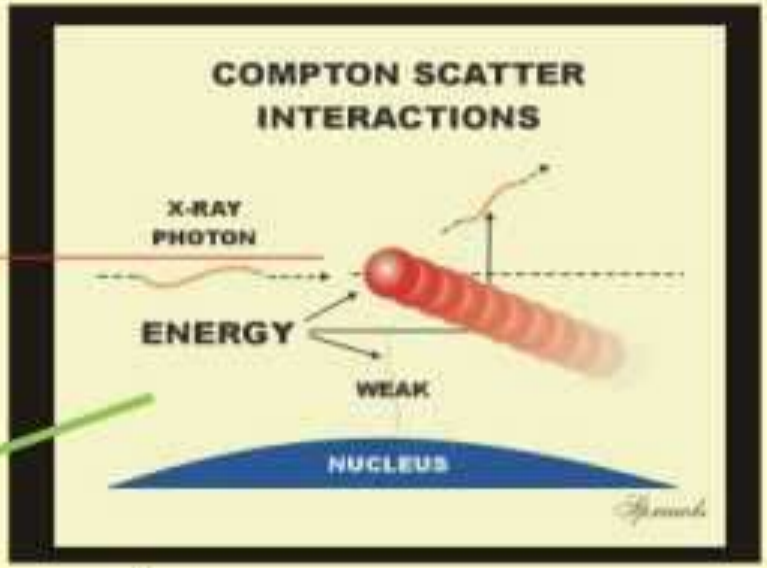
Visuals

Representations of Reality

- **Organize and Guide the Learning Activity**
- **Share Experience and Knowledge**
- **Explain and Interpret What is Viewed**
- **Motivate and Engage Learners**

Sprawls

Technology Enhanced Learning



Learning Guide

Learner

Visuals for Classroom

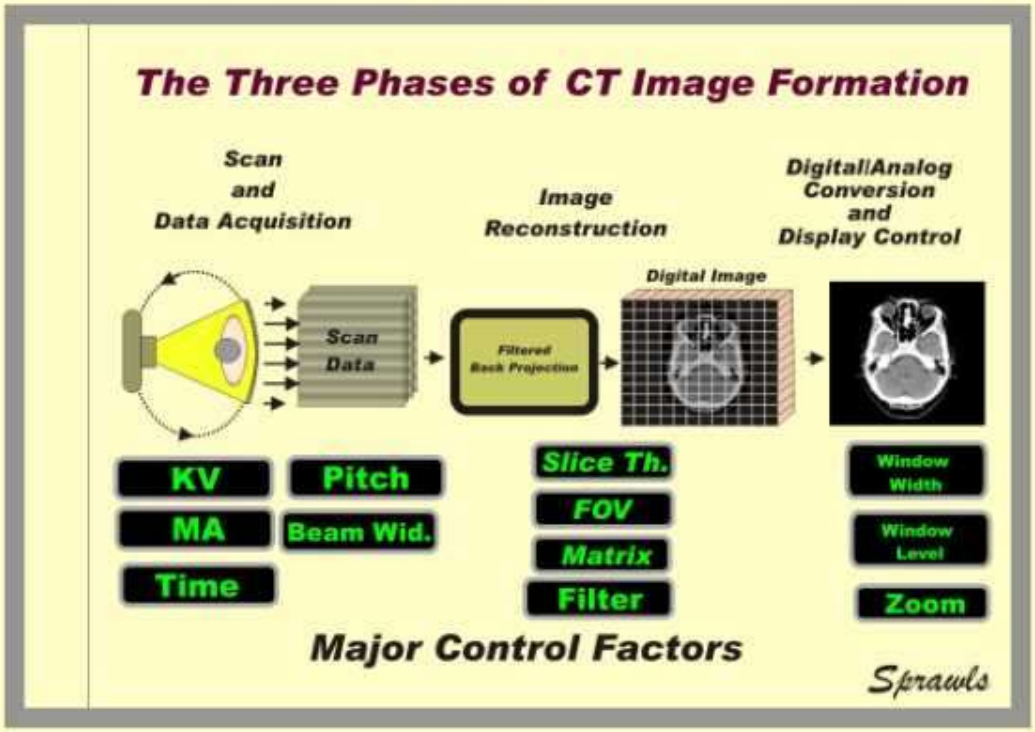
Notes
and
Text

Online
Resources

Sprawls

Visuals for Learning and Teaching

The Imaging Process



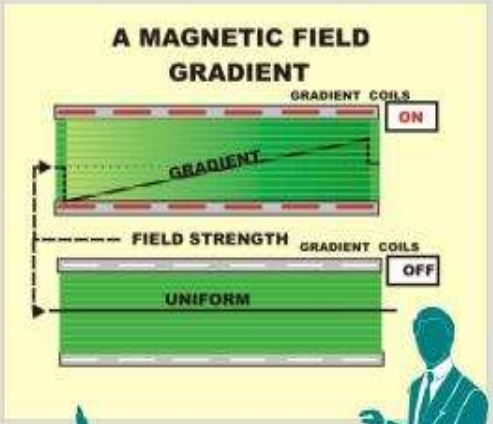
Clinical Images

Sprawls

WINDOW or BARRIER

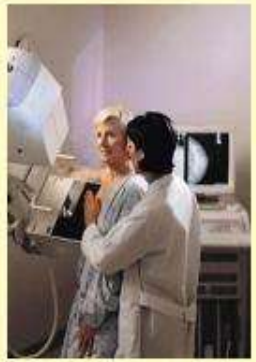
THE LEARNERS

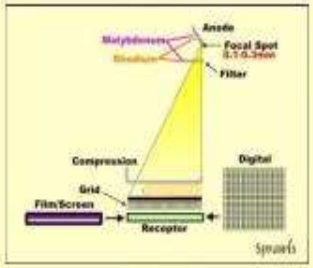
Visuals



Physicists

PHYSICAL UNIVERSE





Sprawls

Technology Tools

Developing Digital Images

"Paint"

Bitmaps

This illustration is a raster file, made up of pixels.

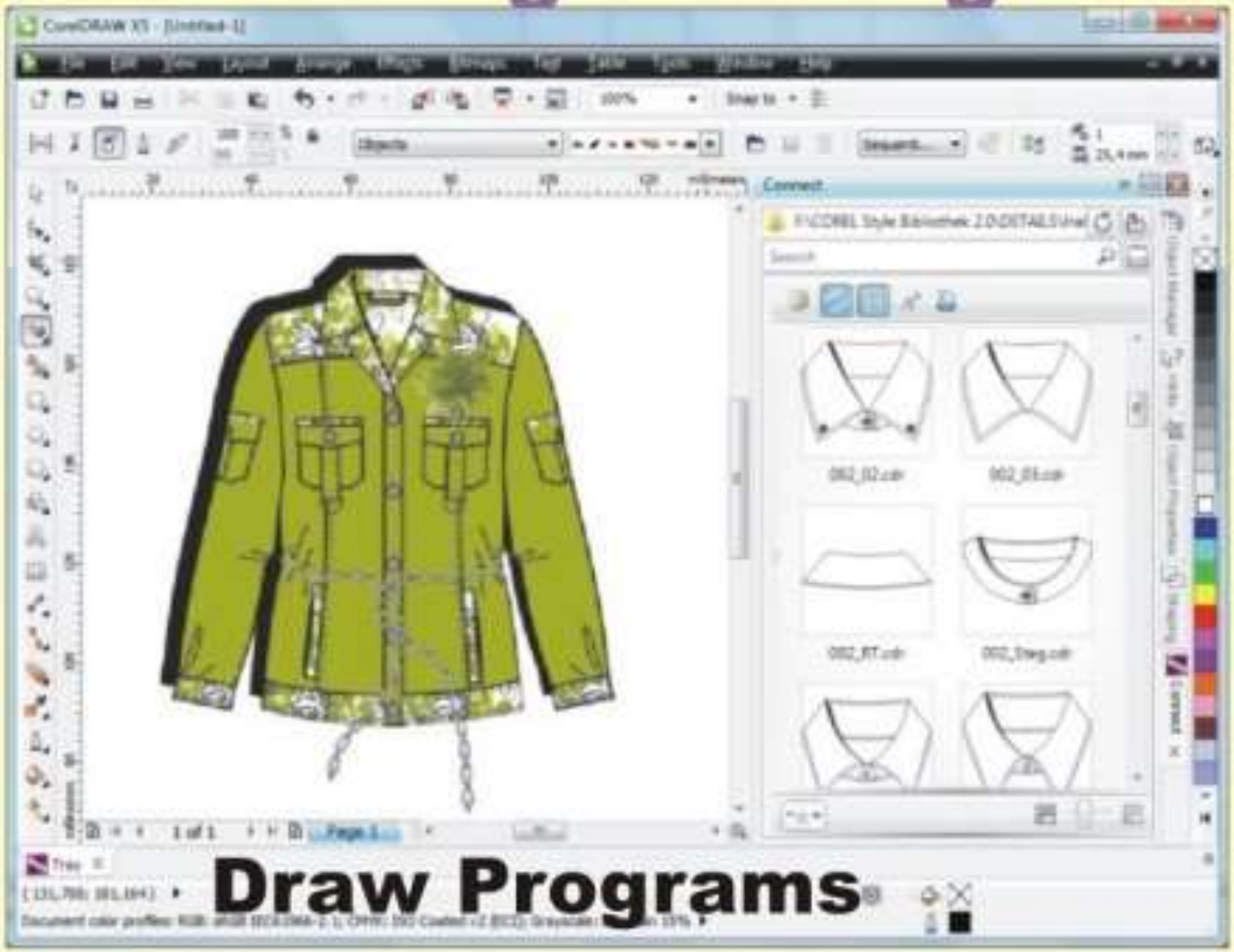
"Draw"

Vectors

This illustration is a vector file. The paths have been highlighted for comparison.

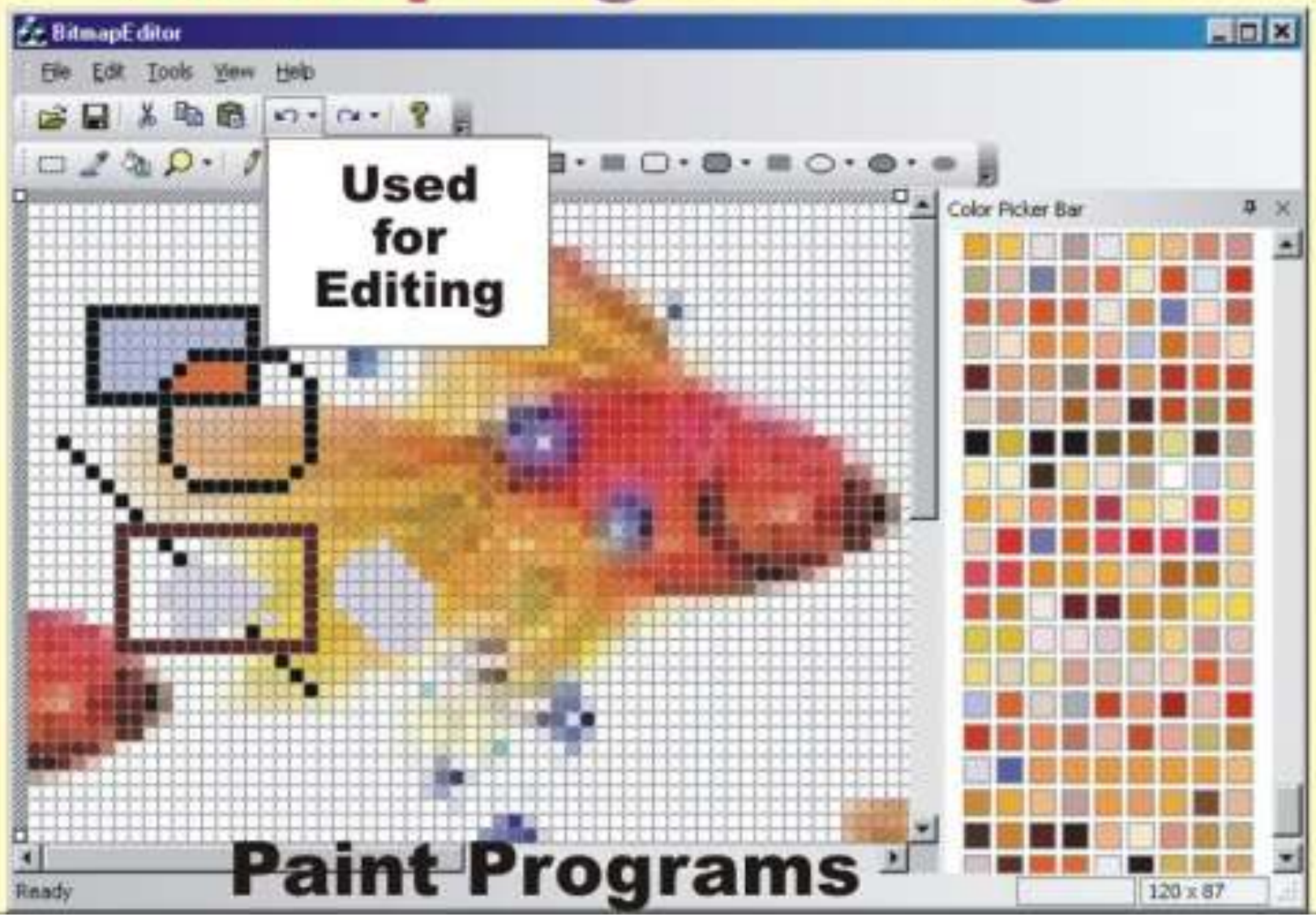
Technology Tools

Vector Digital Images



Technology Tools

Bitmap Digital Images



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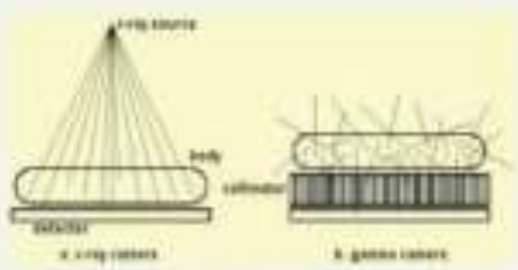
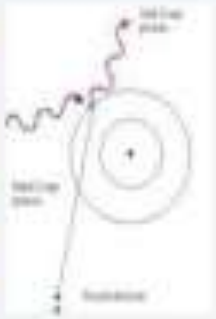
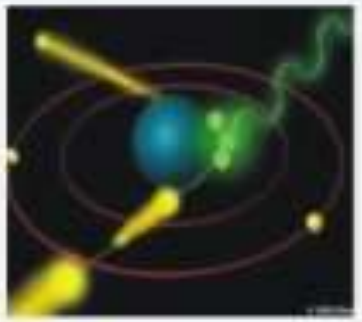
Google xray photons

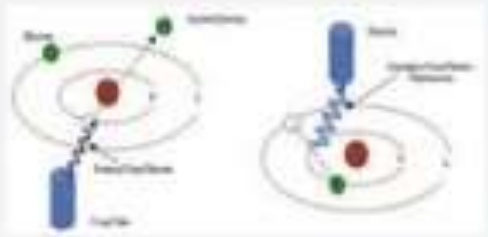
Web Images Videos Shopping News More Search tools

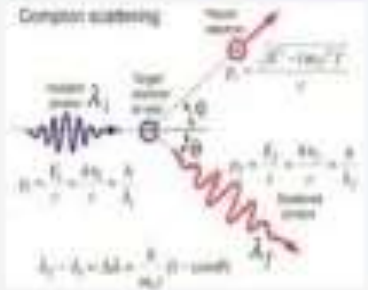
Did you mean: *x ray photons*

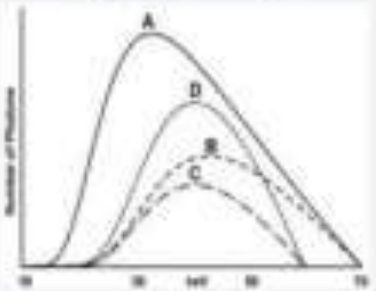


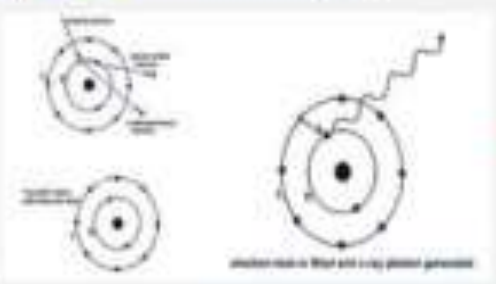


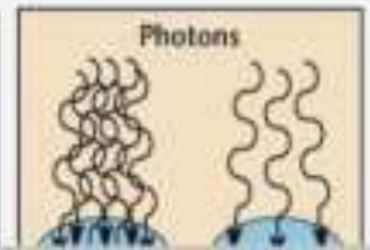












Google Images

The Sprawls Resources

Sharing the Emory Experience with the World

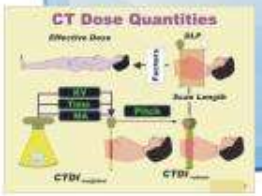
With Emphasis on the Developing Countries

Emory

www.sprawls.org/resources

Open Access

Educational Resources



Visuals **Books** **Modules**

Global Impact

Enhancing Radiology Education in Every Country of the World

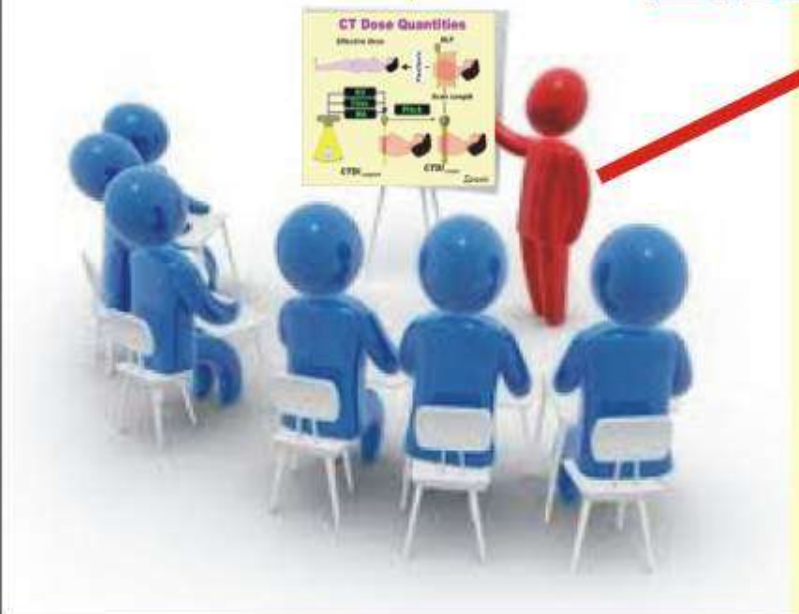
Collaborative Teaching is Sharing the Work

Resource Physicist

Create visuals and related resources

Share with the World

Medical Physics Universe



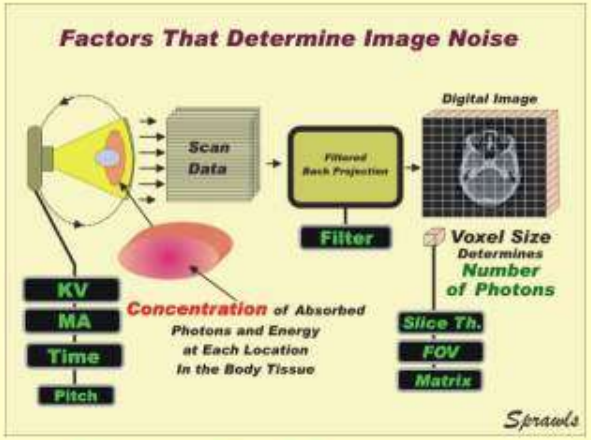
Local Physicist

Organizes
Guides
Shares Experience
Motivates
Role Model

Sprawls

Collaborative Teaching is Sharing Experience, Perspectives, and Opportunities

Physicist



Radiologist

Clinical Applications

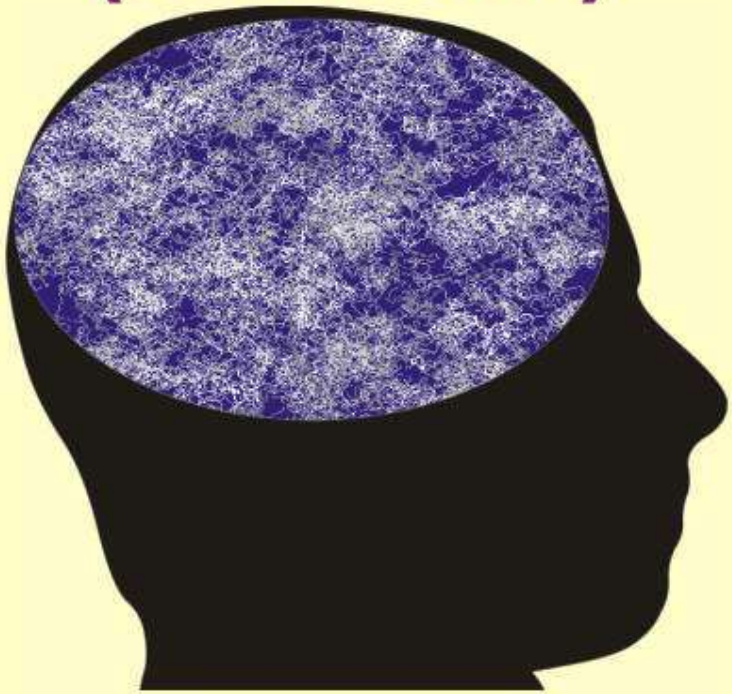
Radiology Residents

Principles and Concepts

Sprawls

What do they need?

Learner (Resident)

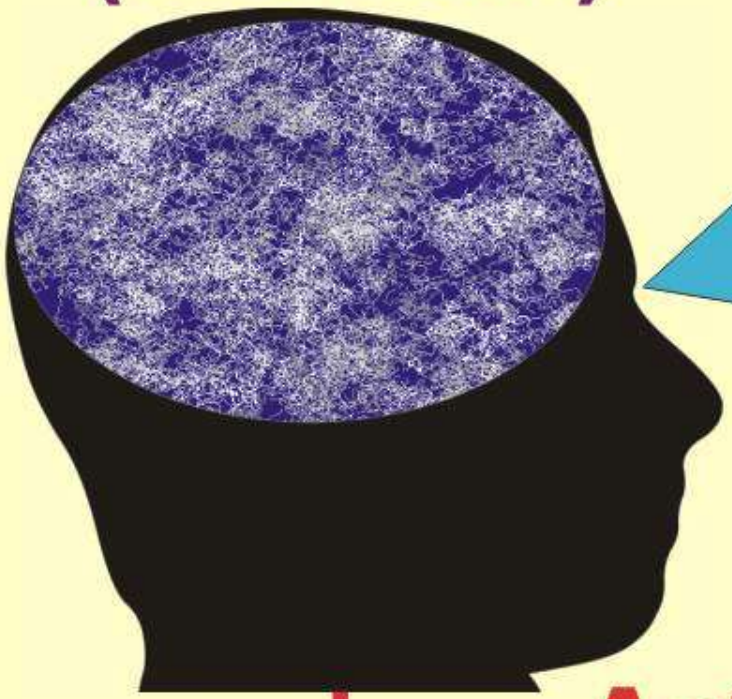


Optimize CT image quality and manage dose.

Sprawls

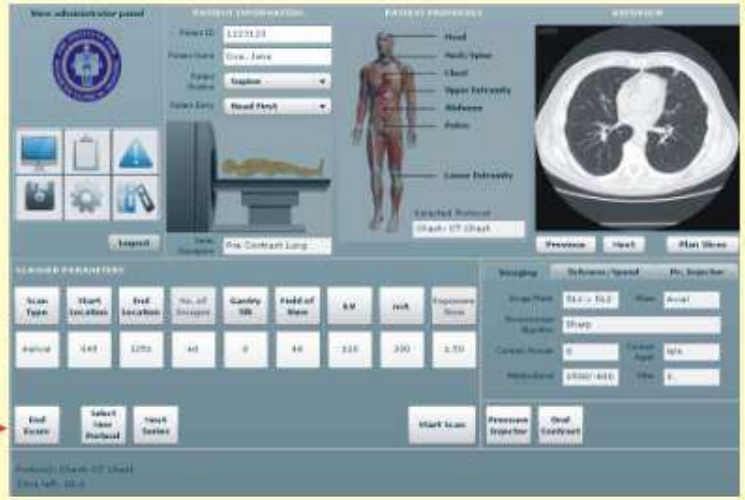
What do they need to DO?

Learner (Resident)



View

Action



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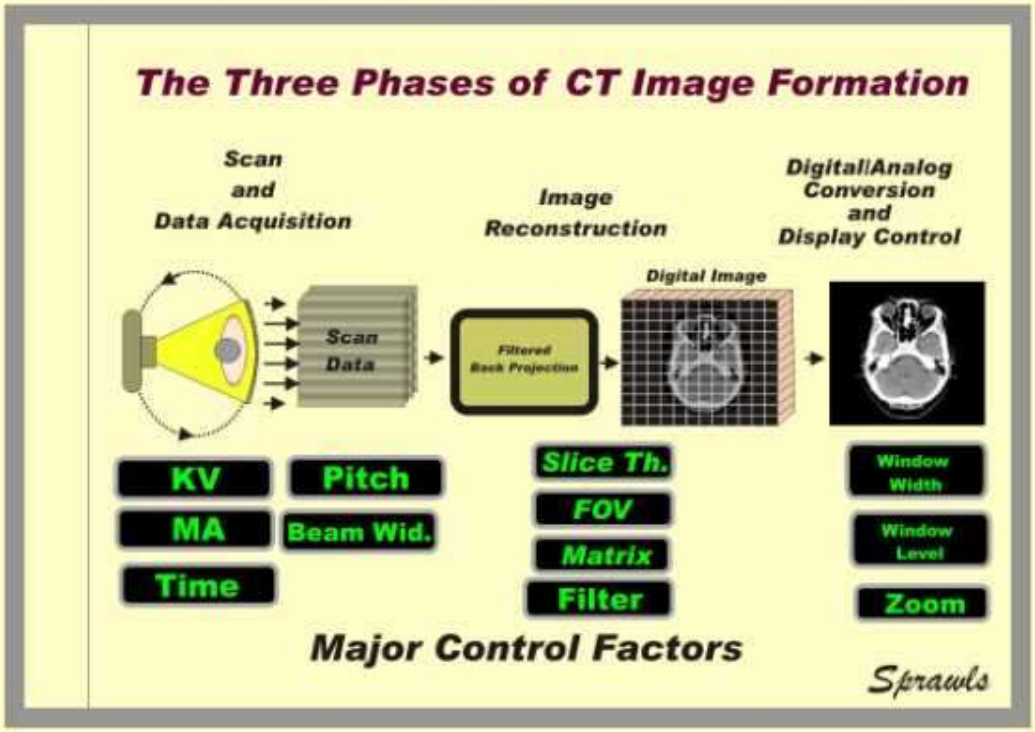
Visuals for Learning and Teaching

The Imaging Process



Clinical Images

Sprawls

Visuals

to be used by

Physicists in Classroom and Conference Discussions

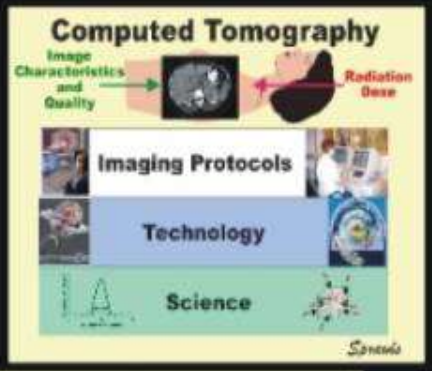
SPRAWLS EDUCATIONAL FOUNDATION
Open Resources for Learning and Teaching
The Physical Principles of Medical Imaging

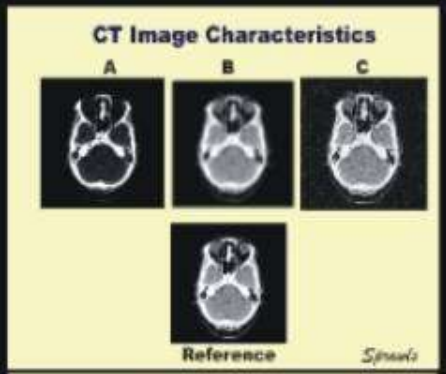
Visuals
for
Classroom, Conference, and Collaborative Learning

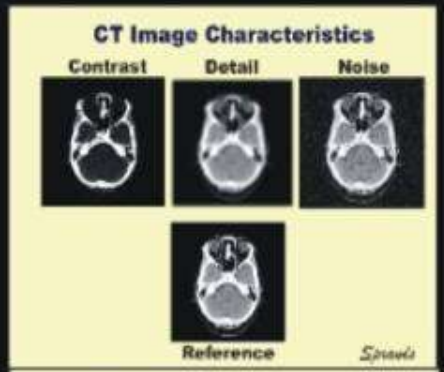
RIGHT CLICK on each visual to download and use in PowerPoint or other display programs.

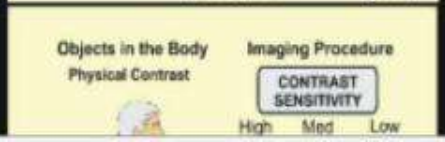
Computed Tomography Image Quality Optimization and Dose Management

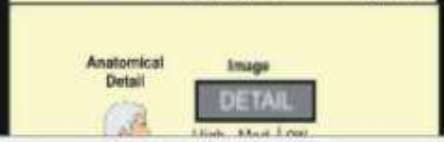
Companion Module
http://www.sprawls.org/resources/CTIQDM/











Modules for Self Study
and
Collaborative Learning in the Clinic

How to Use This Resource

Table of Contents and List of Topics

Computed Tomography Image Quality Optimization and Dose Management

Perry Sprawls, Ph.D.

To step through module, CLICK HERE.
To go to a specific topic click on it below.

Introduction and Overview	Image Quality Characteristics	Contrast Sensitivity
Visibility of Detail	Visual Noise	Spatial (Geometric) Characteristics
Artifacts	Identifying Characteristics	Characteristics Identified
Image Quality and Dose	CT Image Formation Process	The Scanning Motions
Views and Rays	Multiple Row Detectors	Helical and Spiral Scanning
Image Reconstruction and Voxels	CT Numbers	Hounsfield Unit Scale
Optimizing CT Procedures	Absorbed Dose	Dose Distribution Within Patient
CT Dose Index (CTDI)	Weighted CTDI	Volume CTDI
Dose for Multiple Slices	Dose Length Product (DLP)	Effective Dose
Summary of CT Dose Quantities	Factors That Determine Dose	Factors Affecting Image Detail
Measuring CT Image Noise	Controlling Image Noise	Voxel Size Compromise

Effective Medical Imaging Physics Learning ...In The Clinic

The Real World **Motivating** **Interactive** **Collaborative**

The Physicist Provides:
Learning Modules & Collaboration

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How to Use This Resource

Table of Contents and List of Topics

Mammography Physics and Technology
for effective clinical imaging

Perry Sprawls, Ph.D.

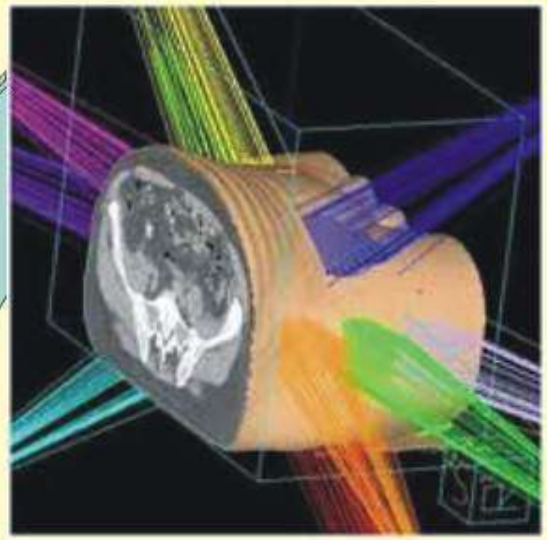
Outline	Mind Map	Learning Objectives	Visuals for Discussion		Text Reference

To step through module, CLICK HERE.

To go to a specific topic click on it below

The Most EFFECTIVE way to
Build Physics Knowledge Structures

Visuals



Technology

Audio

Human

(Teacher)

Guiding The Process

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Visuals

to be used by

Physicists in Classroom and Conference Discussions

SPRAWLS EDUCATIONAL FOUNDATION
Open Resources for Learning and Teaching
The Physical Principles of Medical Imaging

Visuals
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Classroom, Conference, and Collaborative Learning

RIGHT CLICK on each visual to download and use in PowerPoint or other display programs.

Computed Tomography Image Quality Optimization and Dose Management

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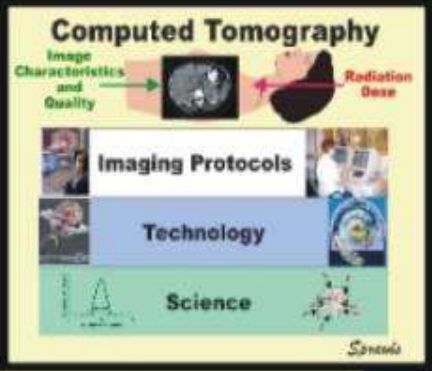
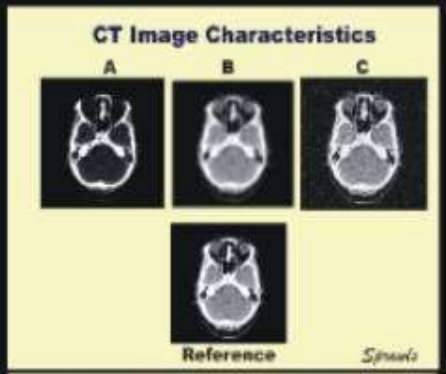
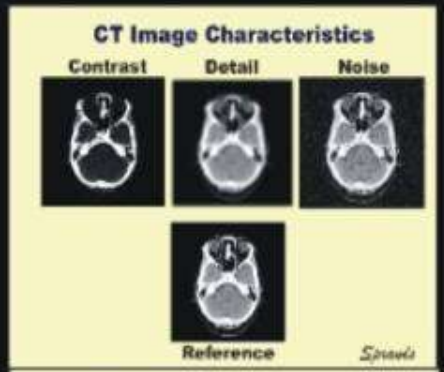
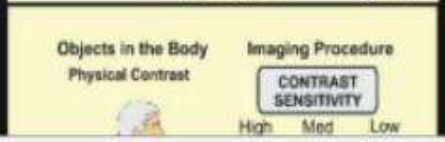
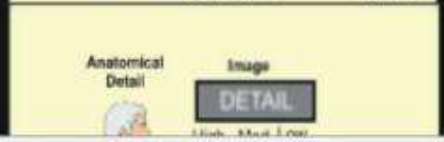
http://www.sprawls.org/resources/CTIQDM/



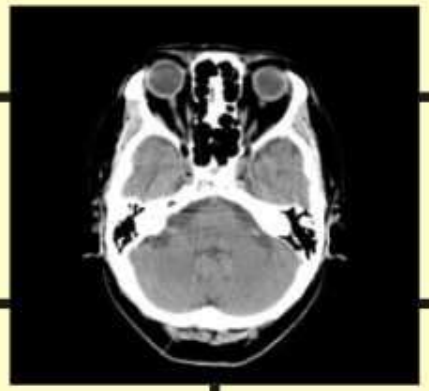








CT Image Characteristics



Spatial

Artifacts

Detail

Noise

Contrast Sensitivity

KV

Pitch

Slice Th.

Window Width

MA

Beam Wid.

FOV

Window Level

Time

Filter

Matrix

Zoom

Major Protocol Factors

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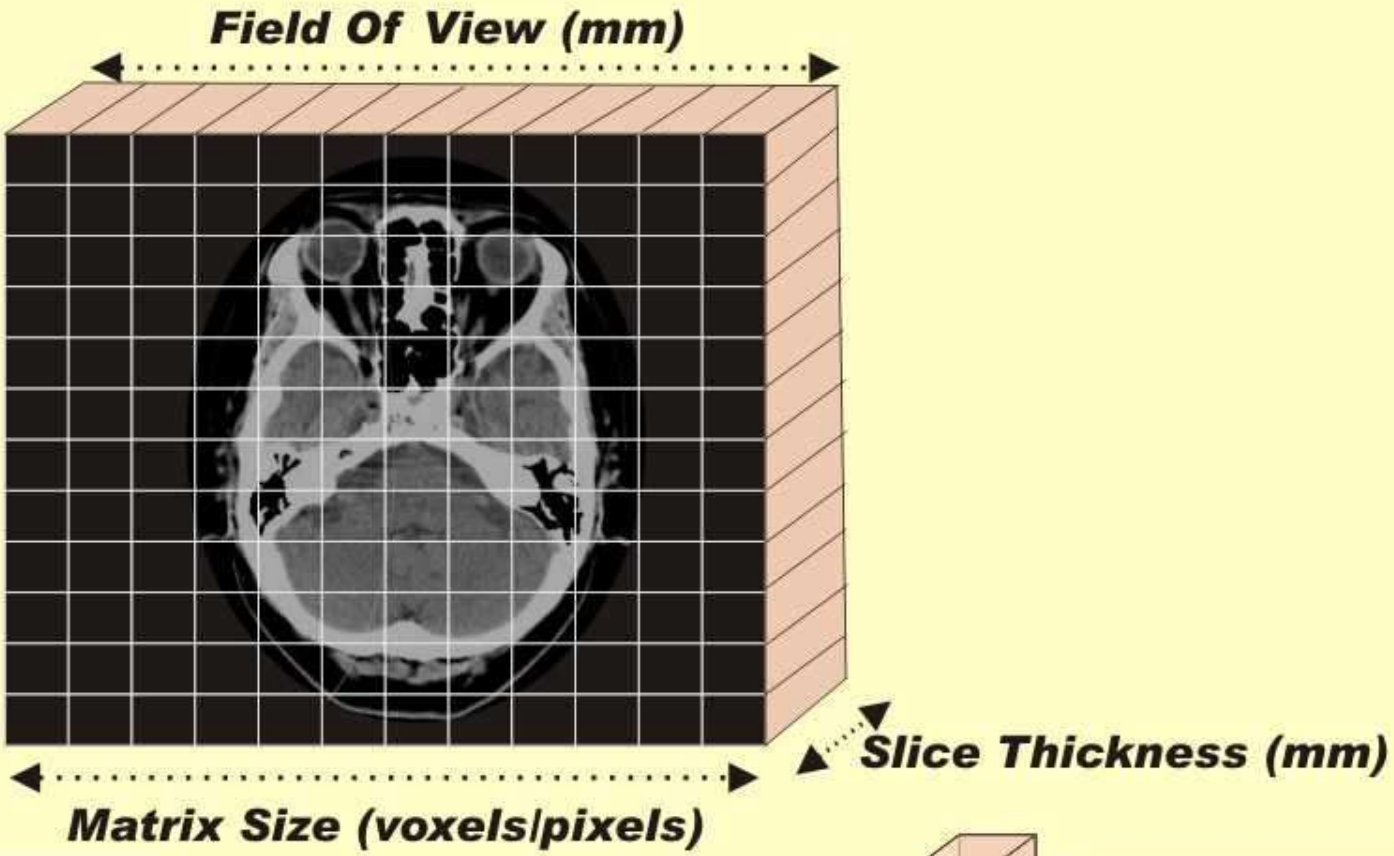
CT Slice Divided into Matrix of Voxels



FOV ÷ Matrix ····· Slice Th.

Voxel Size Controlled By

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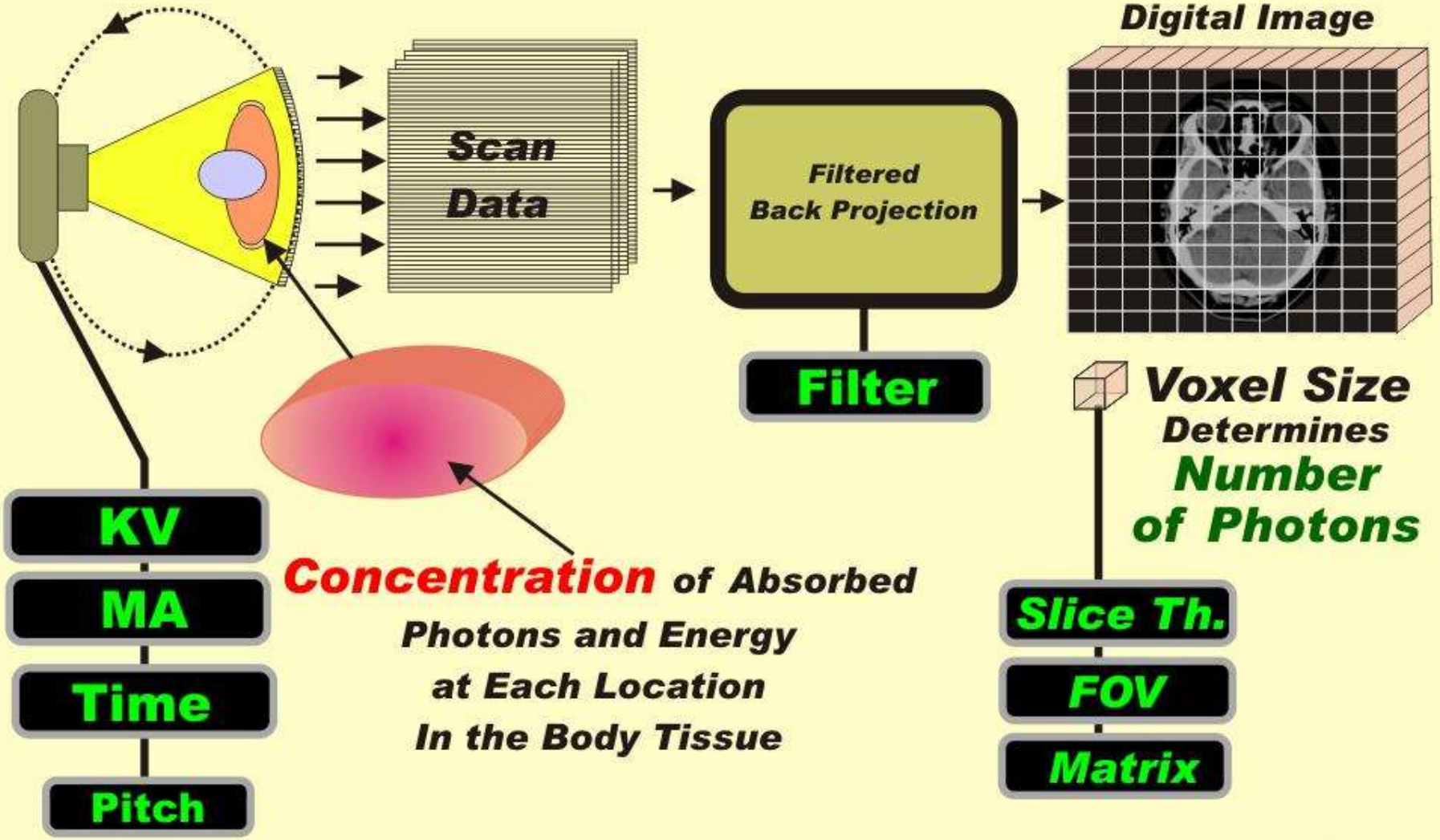
Factors That Determine Image Noise



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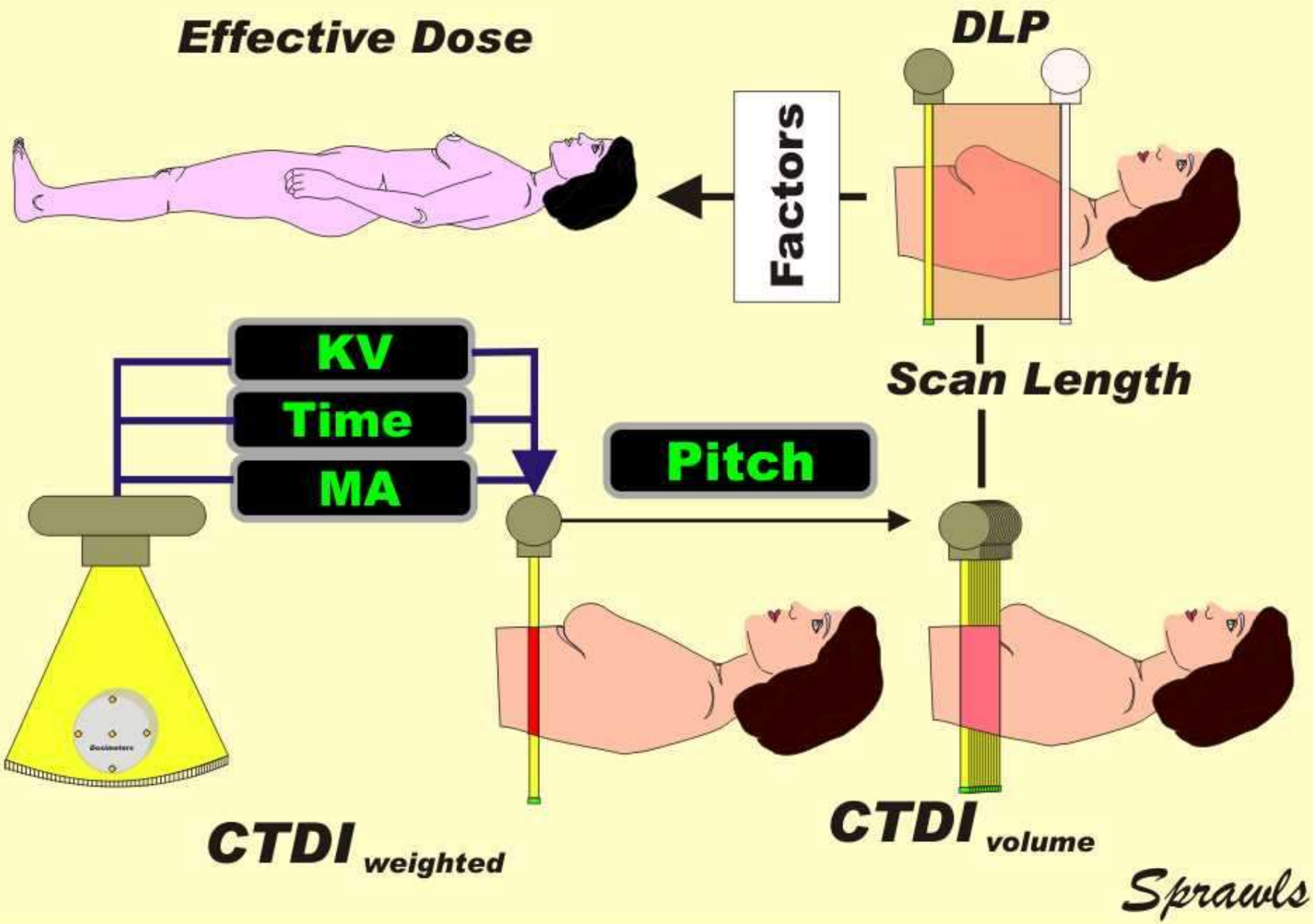
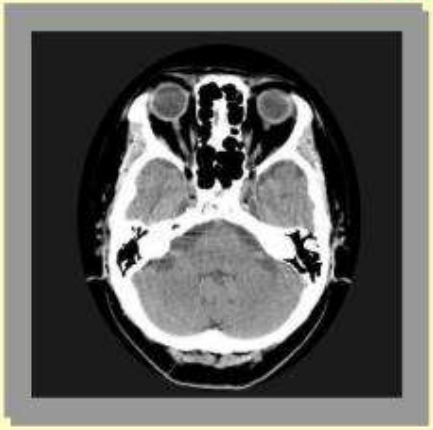
CT Dose Quantities

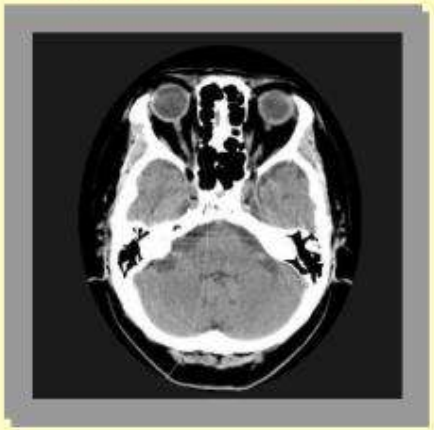


Relationship of Radiation Dose to Image Detail

Lower Dose



Higher Dose

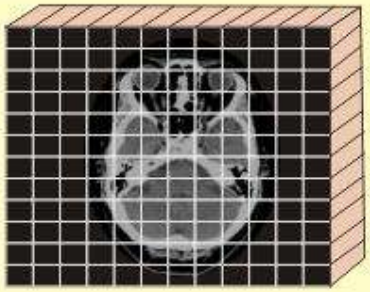


When detail is increased by

- Decreasing **Slice Th.**
- Increasing **Matrix**
- Decreasing **FOV**

Noise Increases

Because of decreased voxel size



Dose must be increased to reduce noise.

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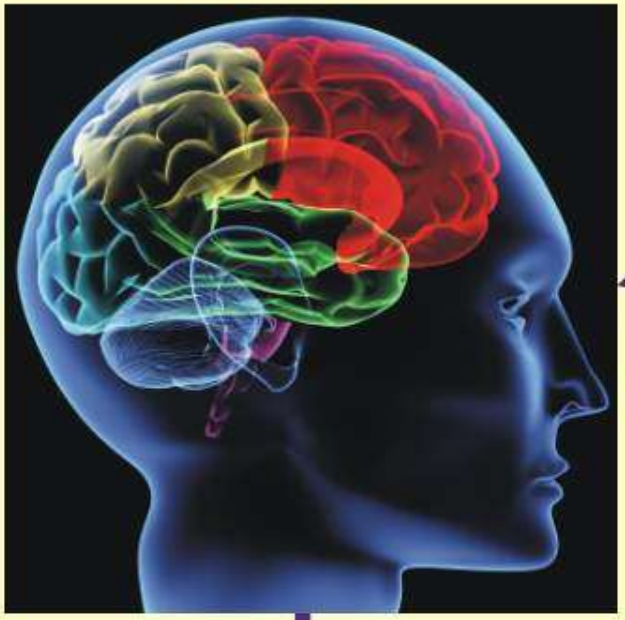
Conclusion

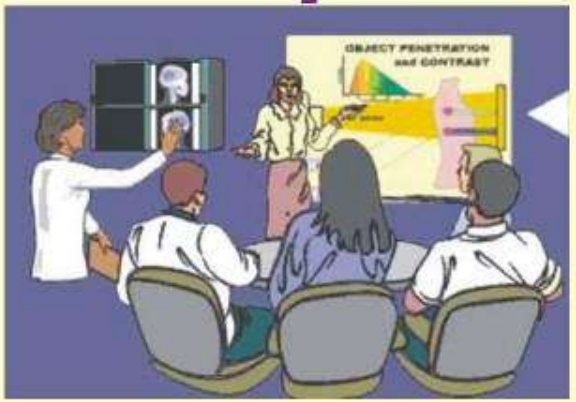
Using Knowledge For

More Effective & Efficient Learning Activities



Evaluate

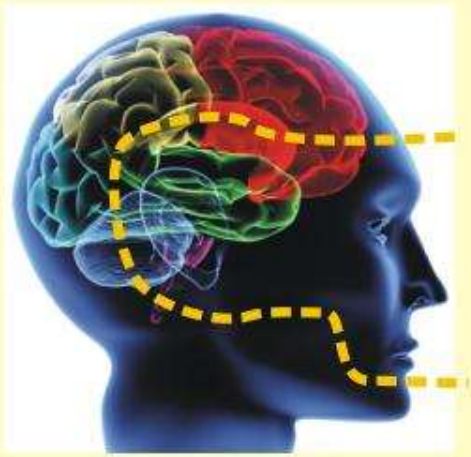
Apply



Sprawls

The Elements of
A Highly Effective Educational Session

The Brain



Follow Up

Review

Refresh

Reflect

Recall

Remember

Re-inforce

The Physical Universe

(Physics of Medical Imaging)

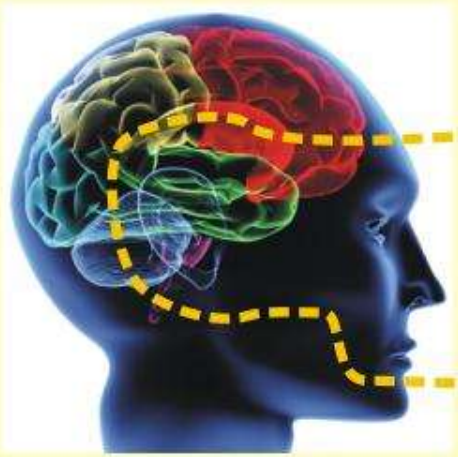
Web-based Resources

(www.sprawls.org/ipad)

Sprawls

The Elements of
A Highly Effective Educational Session

The Brain

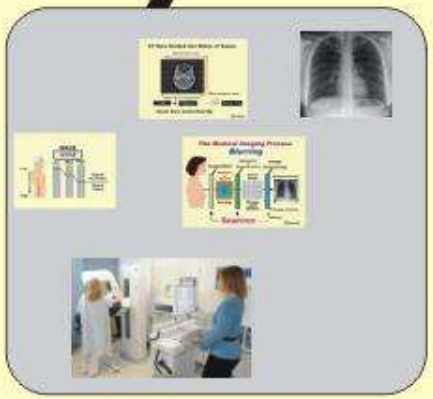


Connection

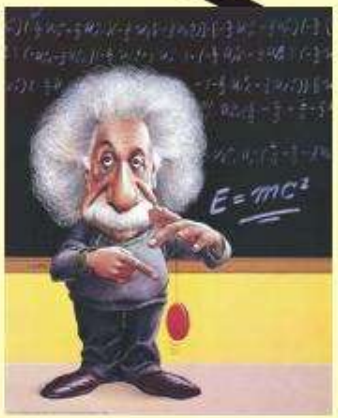
Observe

Interact

The Physical Universe
(Physics of Medical Imaging)



"Window"



Teacher /Guide

Sprawls

What is my contribution to effective medical physics education?

I do windows.

Sprawls

Enriching

Medical Physics Education

by

Visualizing the Invisible

Perry Sprawls, Ph.D
Emory University
sprawls@emory.edu
and
Sprawls Educational Foundation
www.sprawls.org

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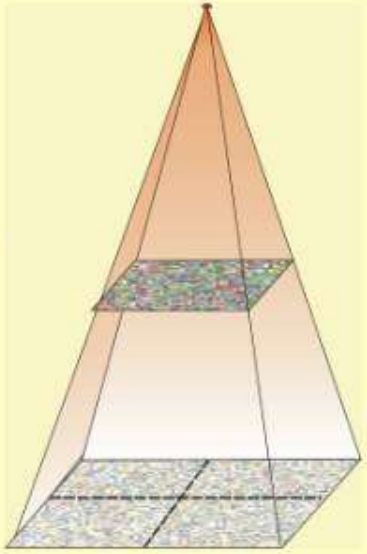
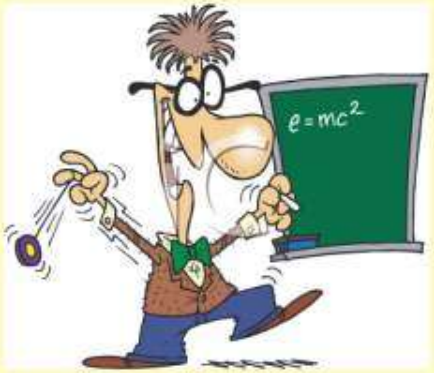


A Collaborative Model of Medical Physics Education Including Online Resources



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Effective

Medical Physics Educational Activities

Models and Methods

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