Informatics for Medical Physics Education

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www.sprawls.org

View and Review
at

www.sprawls.org/ipad

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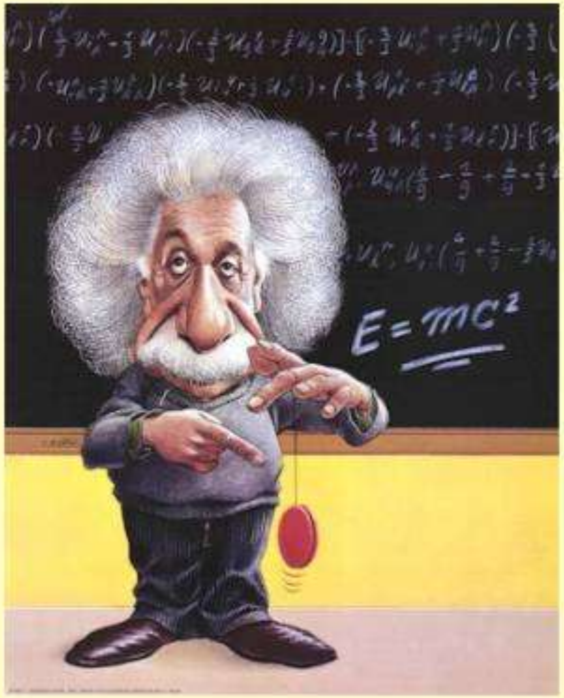
The Physicist as an Educator and Teacher

Our Objectives

Provide more **EFFECTIVE** learning activities.



Be **EFFICIENT** in our teaching

Challenges Opportunities

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Informatics for Medical Physics Education

Learning Objectives

Use Technology to Enhance Human Performance for both Learners and Teachers

Use technology to enrich medical physics learning activities making them more effective and efficient

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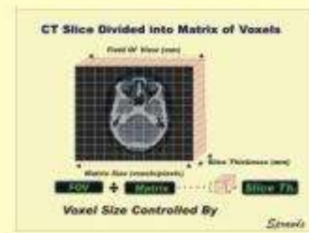
January 23, 1896

January 23, 1896

The Traditional Classroom

“ A Box for Enclosing Students...”



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

The Barrier

Physics Education

Clinical Imaging

Efficiency

Location, Resources, Human Effort, Cost

Limited Experience

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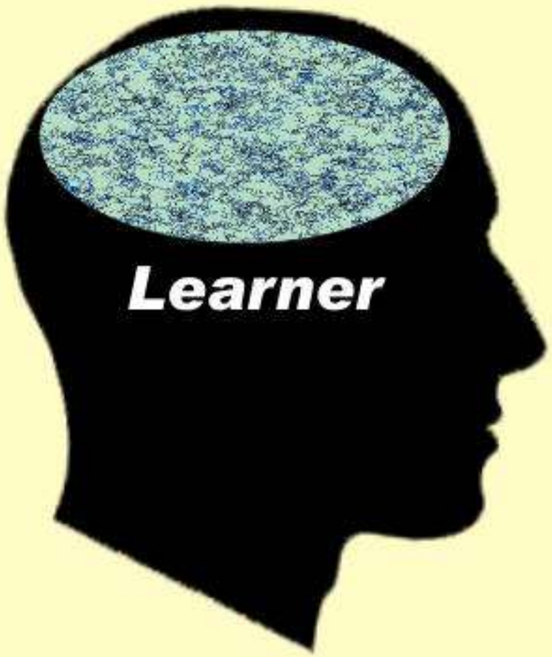
Learning Physics
is
Building a Knowledge Structure
in the Brain



Physical Universe

A mental representation of physical reality

Sprawls

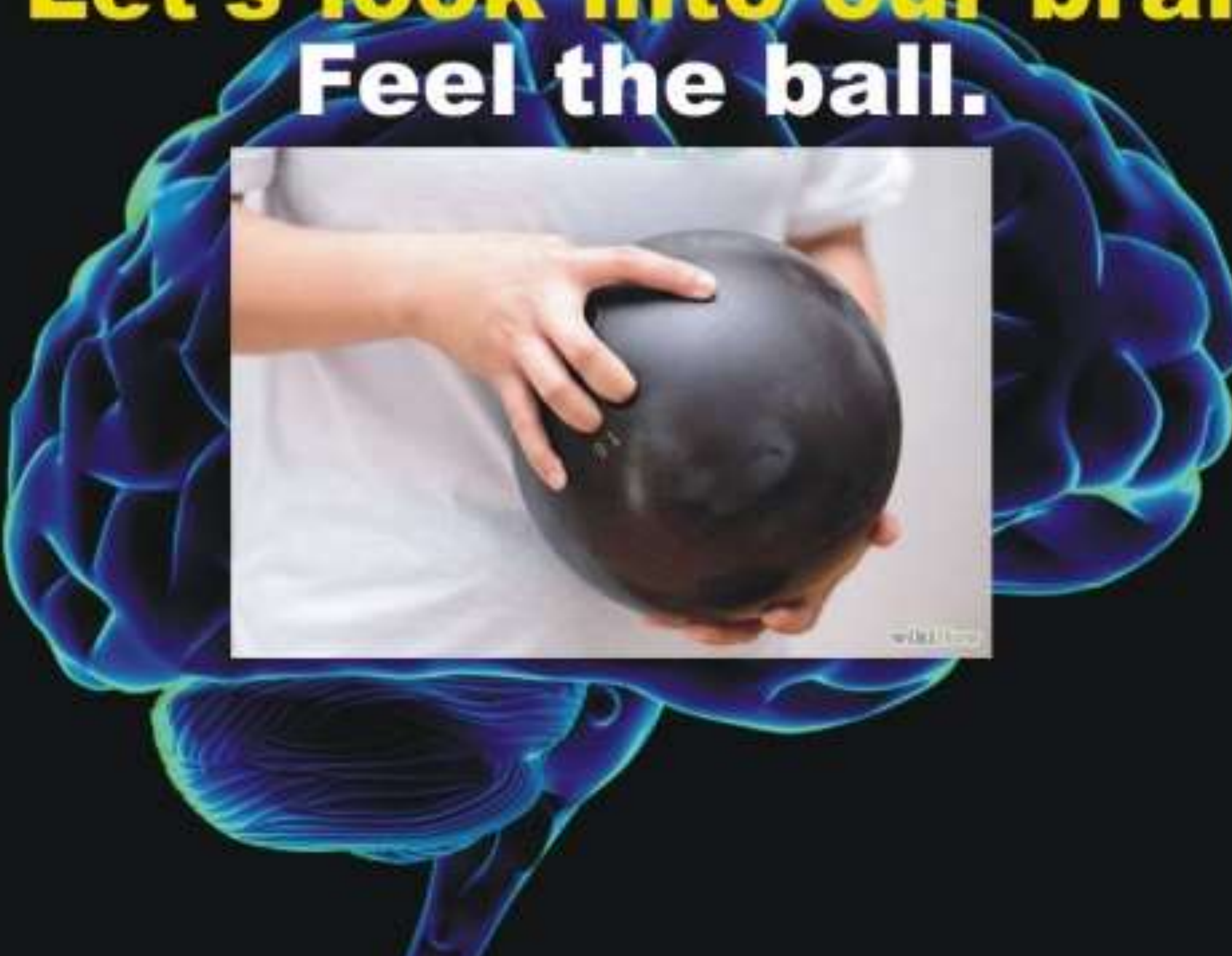
Let's look into our brain.

Let's look into our brain.

Look for balls.

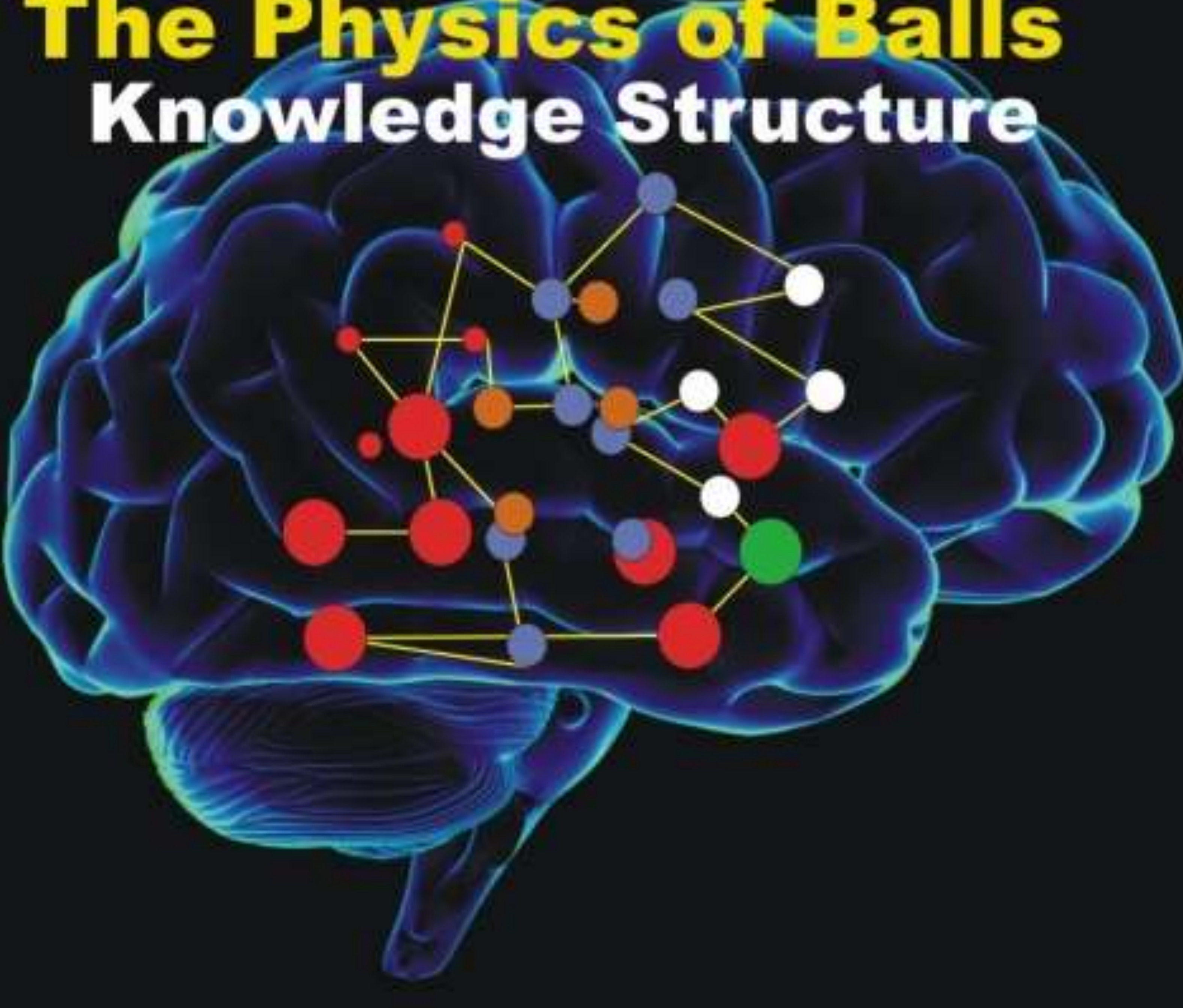
Let’s look into our brain.

Feel the ball.



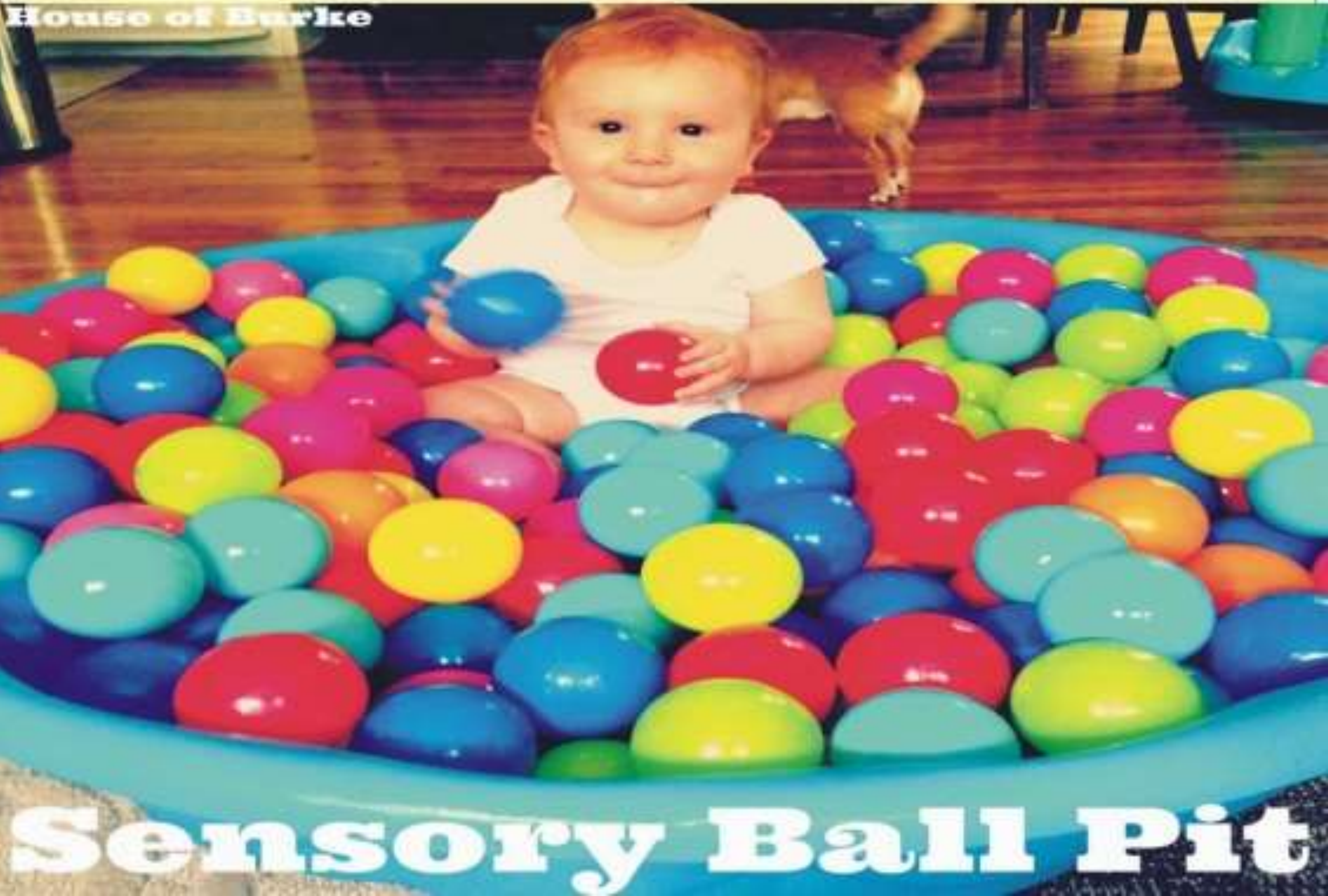
The Physics of Balls

Knowledge Structure



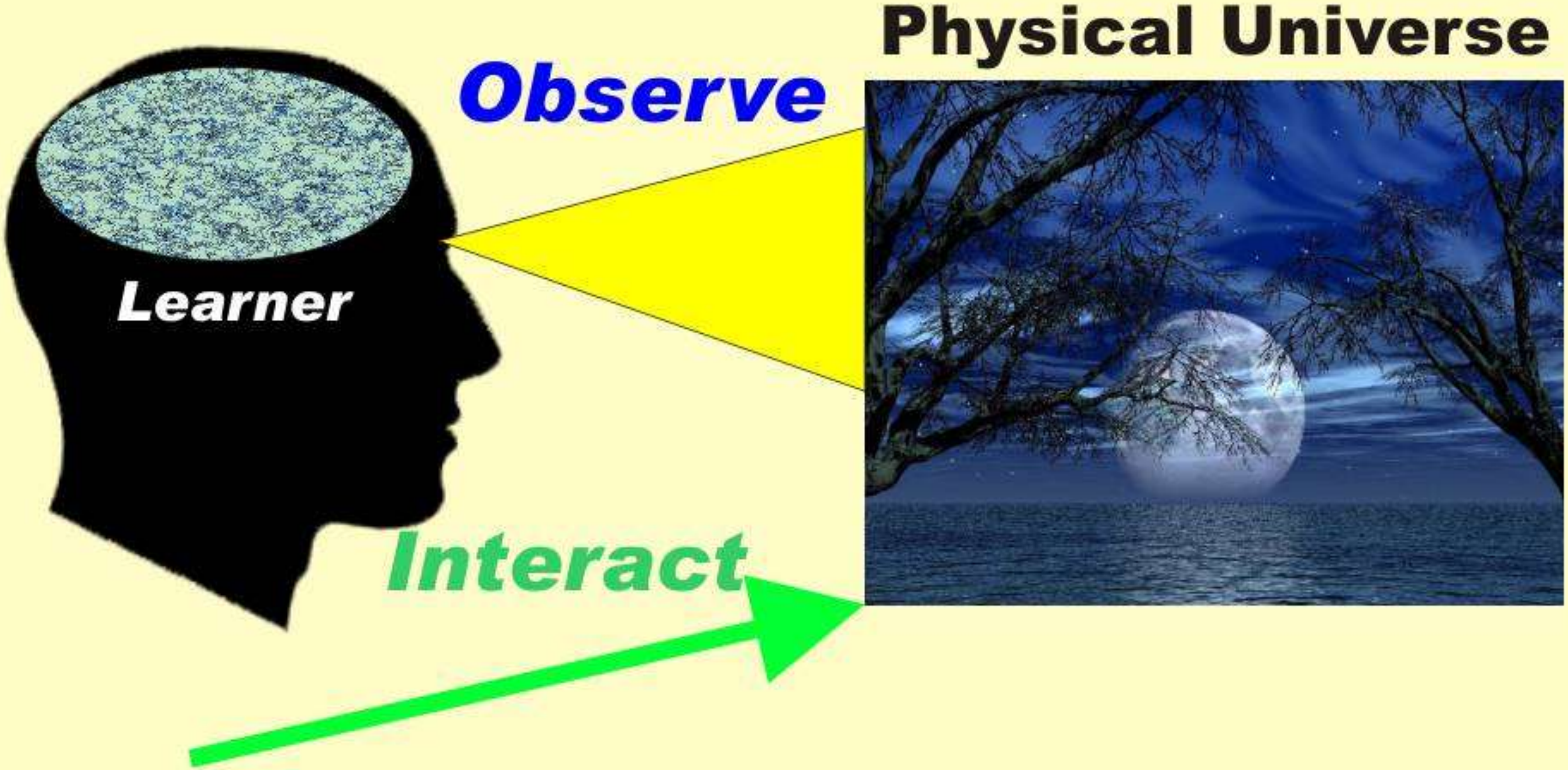
The Classroom Lecture About Balls

One of Our First Physics Lessons



Learning is a Natural Human Process

We Learn by Experience



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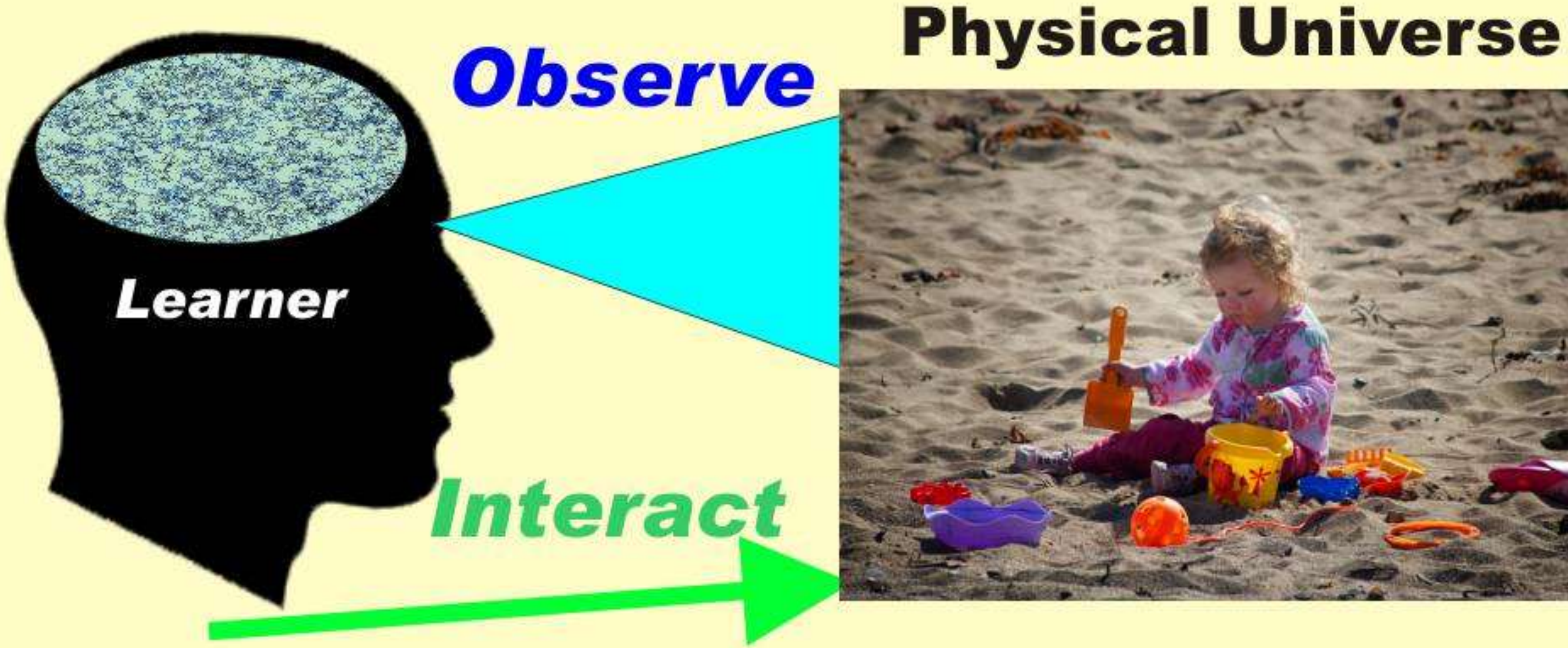
Learning is a Natural Human Process

We Learn by Experience



Our Early Physics Learning Activities

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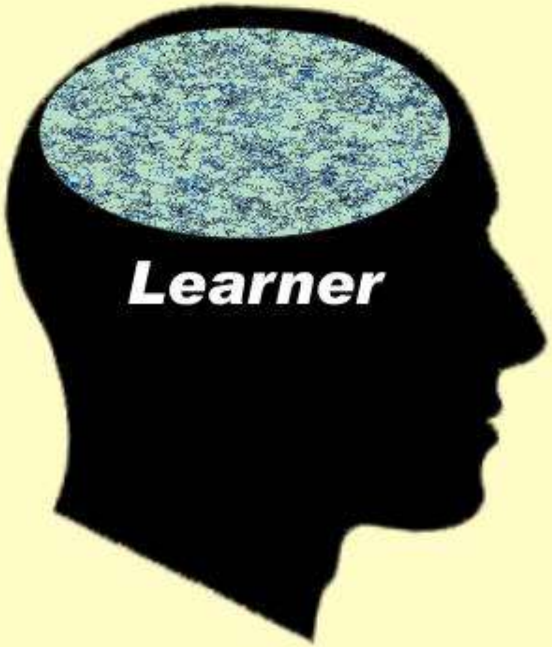
Teaching

is helping someone

Building a Knowledge Structure in the Brain



Physical Universe

A mental representation of physical reality

Connect **Organize** **Guide**

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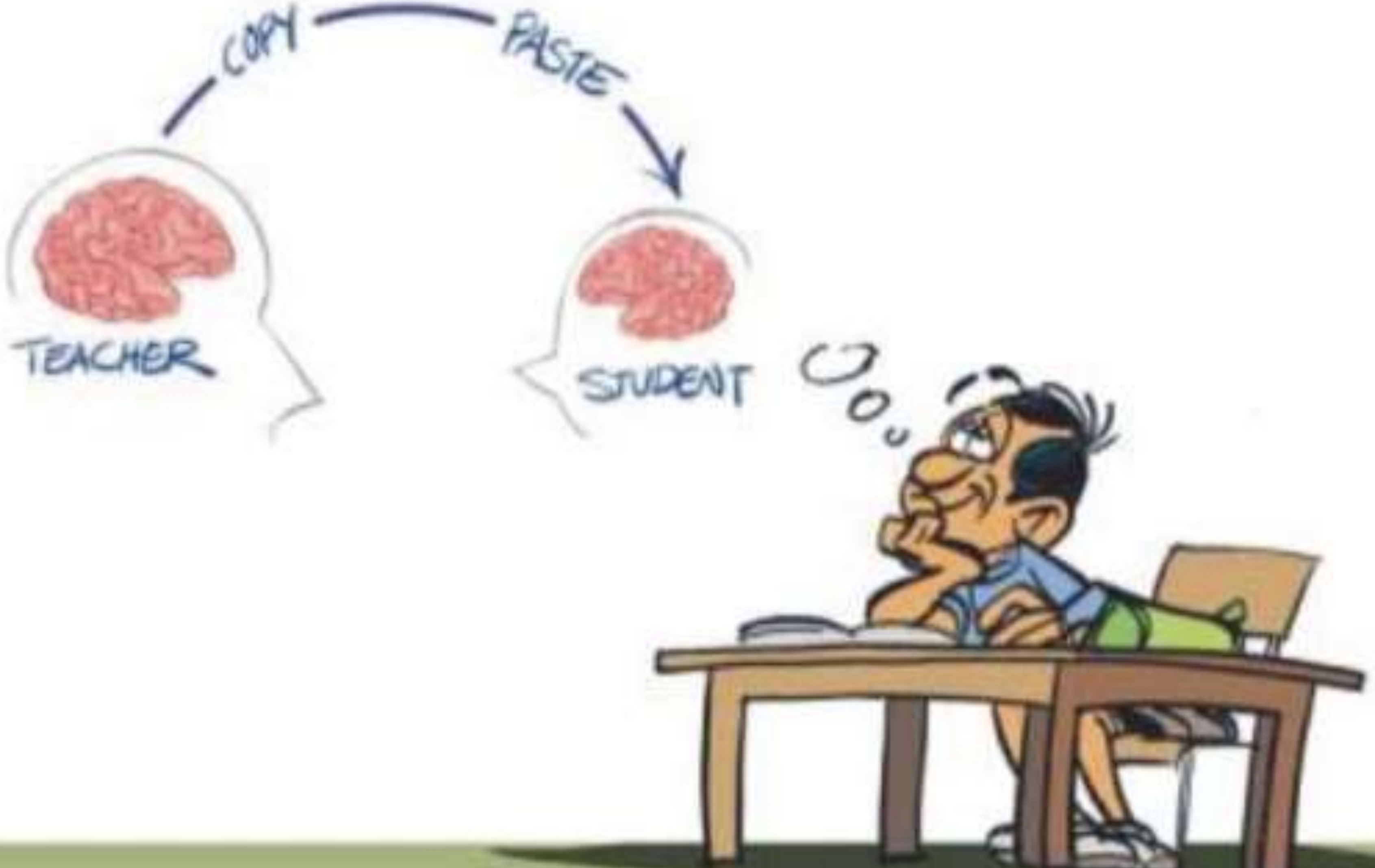
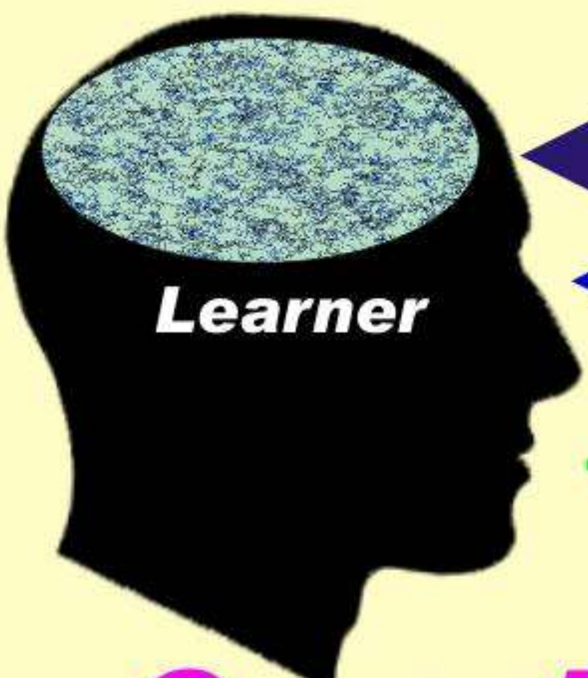
Teaching Physics Is Not



The Role of Formal Education

Connect

Physical Universe

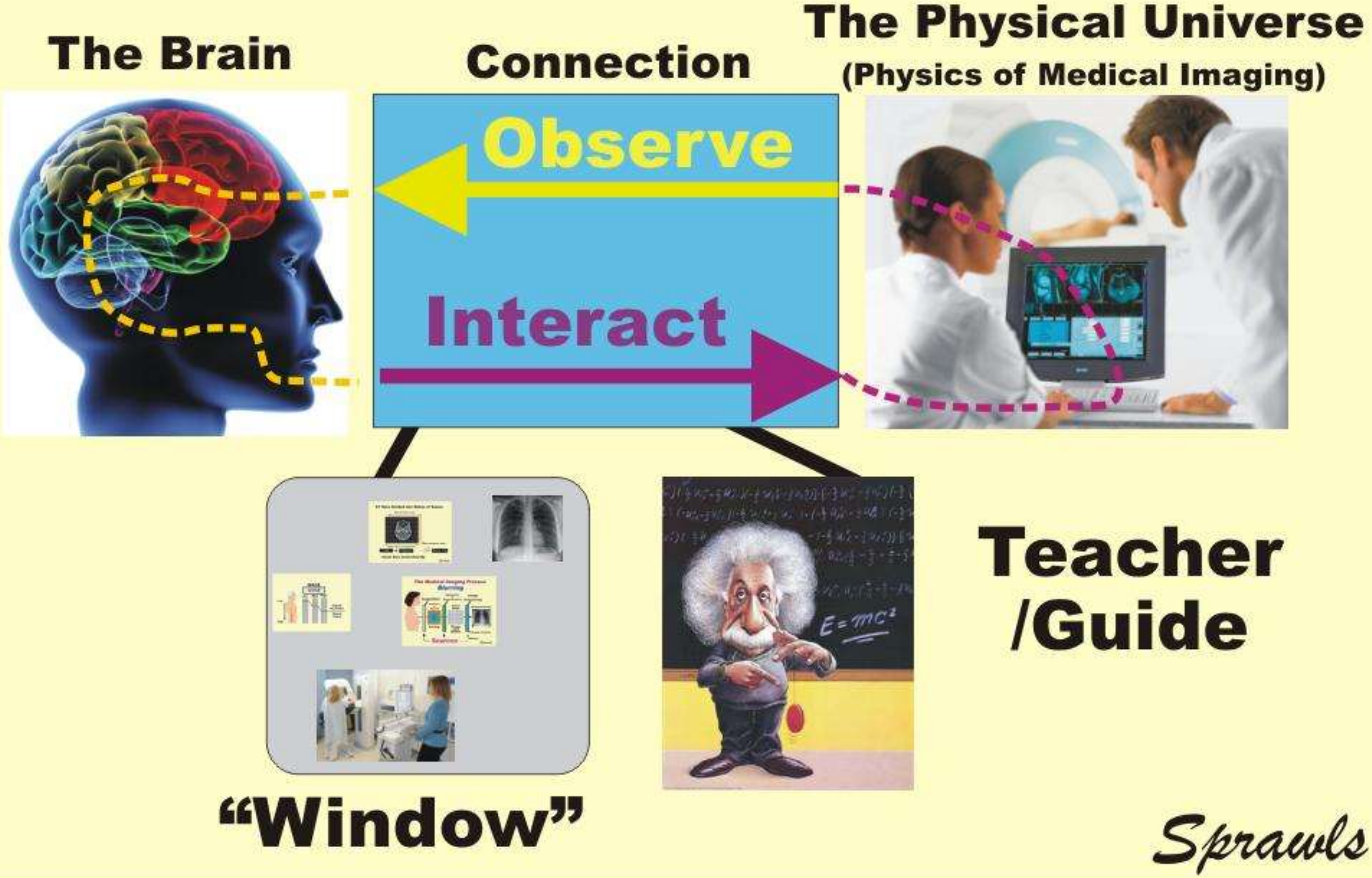


Observe

Interact

Organize and **Guide**

The Elements of A Highly Effective Educational Session



Our Plan for Today

Human Brain

Knowledge Structures

How We Learn

What we need to know

Learning Activities

Effectiveness

Efficiency

Medical Physics Universe

Clinical Applications

Human Teacher

Technology Tools

&

Applications

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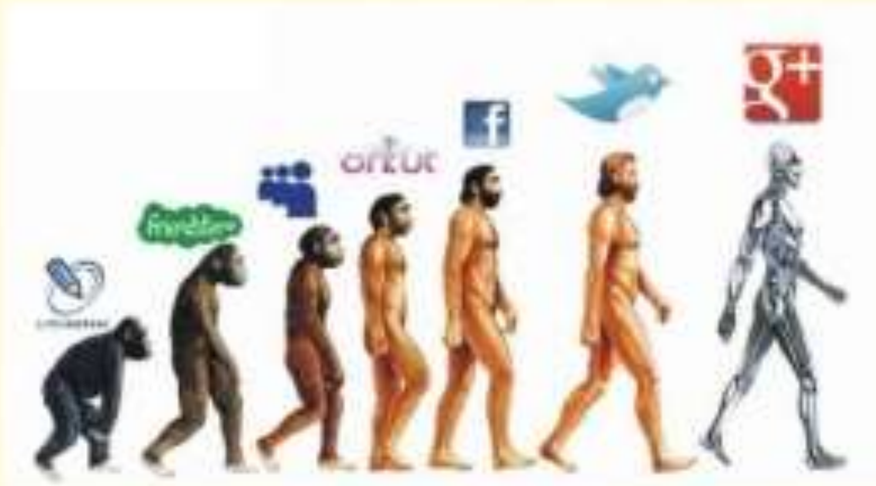
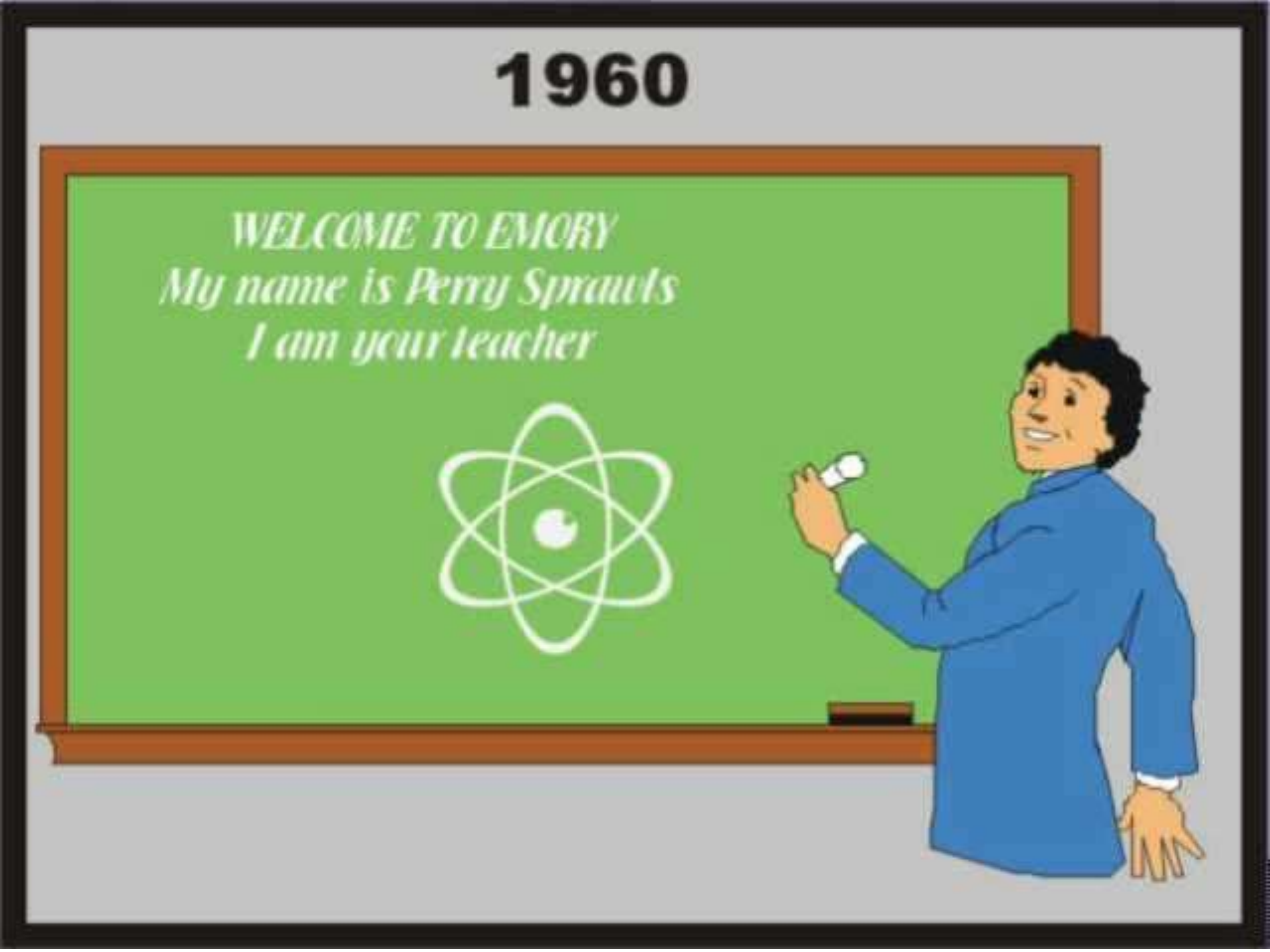
Informatics
for
Medical Physics Education

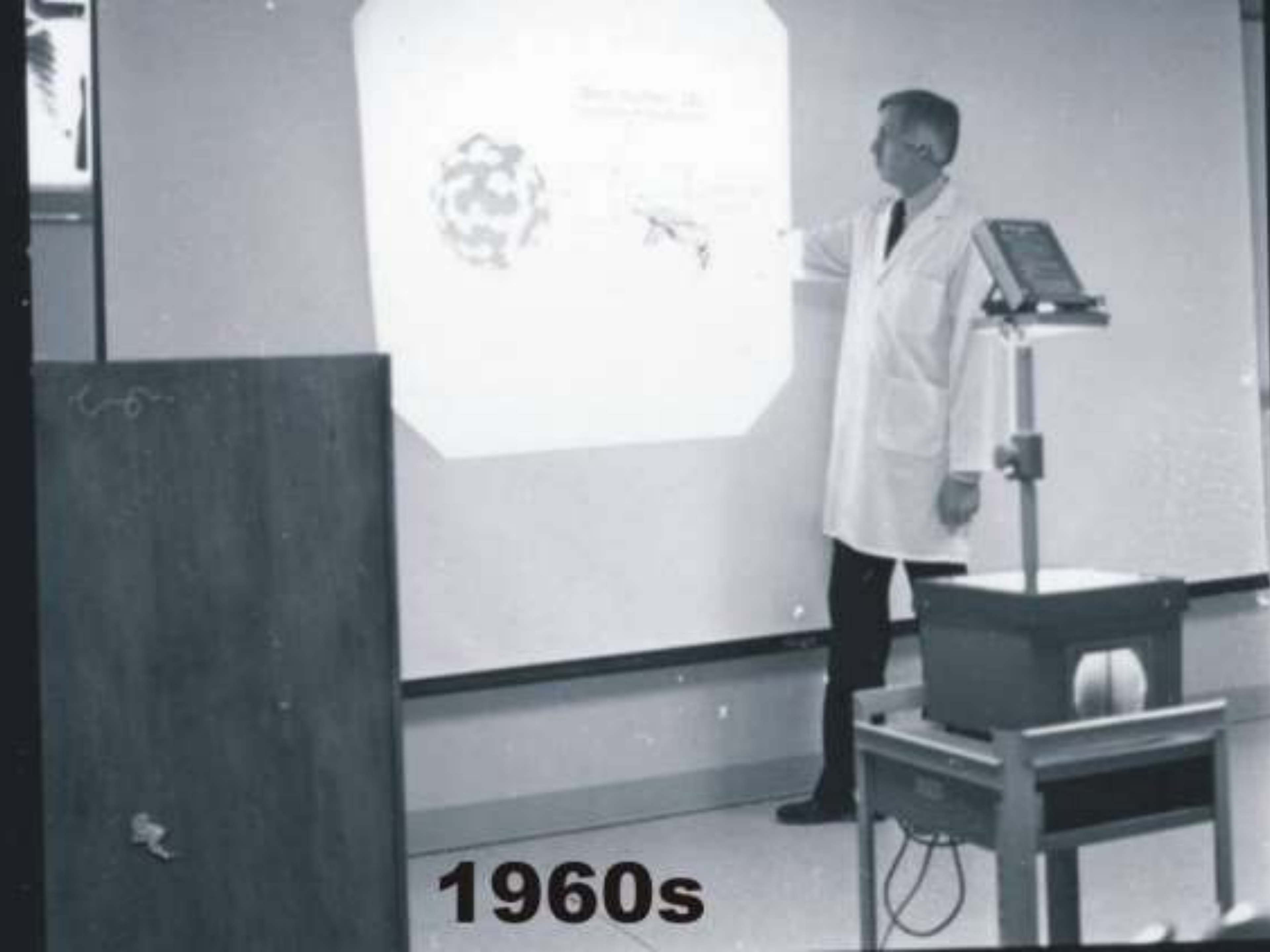
Works In Progress

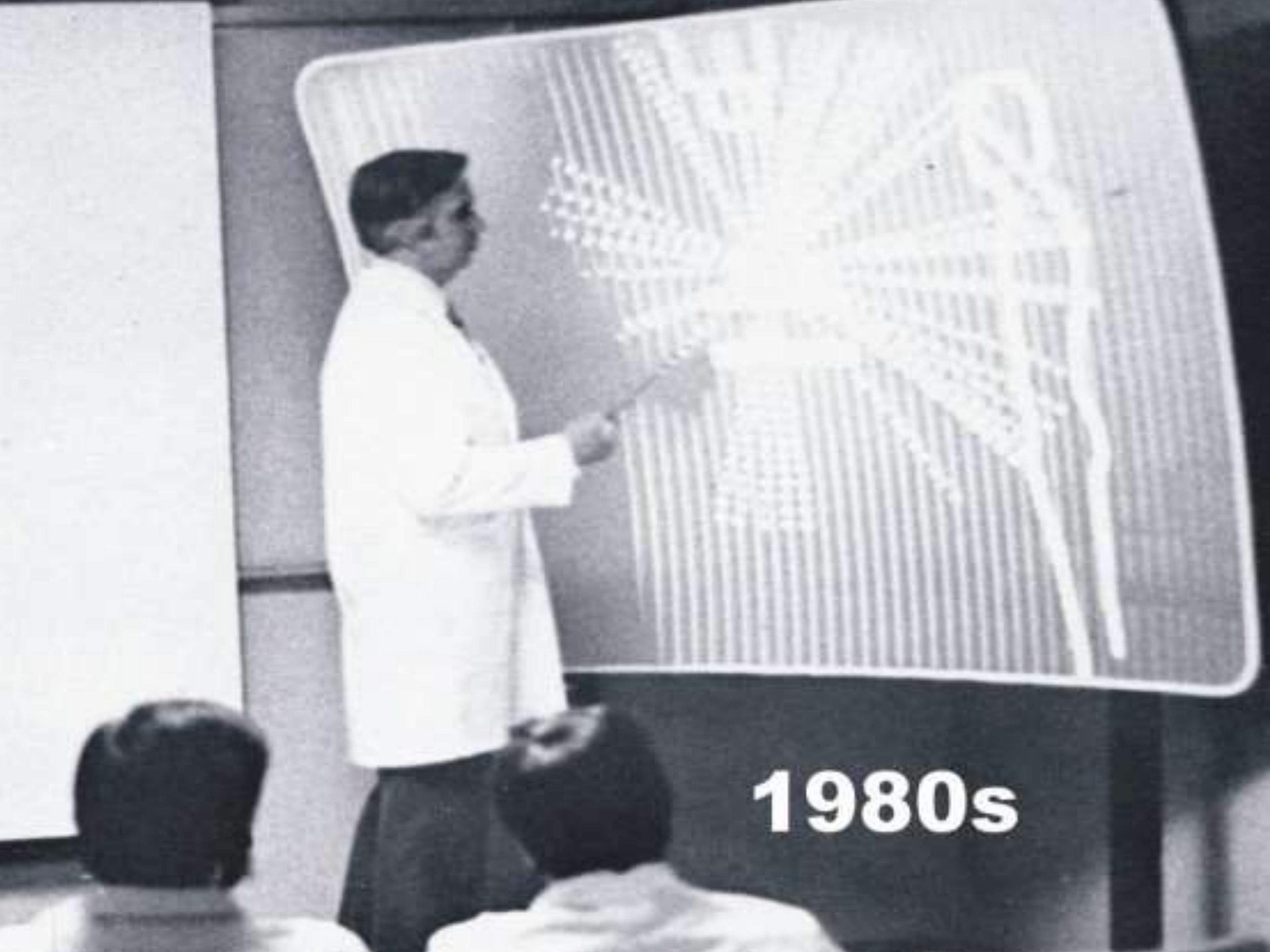
Development of Applications



Evolution of Technology


1960
WELCOME TO EMORY
My name is Perry Sprawls
I am your teacher


1960s


1980s

Digital Resources to Enrich Learning Activities

The Web

Connecting and Sharing

Textbooks Modules

Visuals

Clinical Images

Modules

References Teaching Files


Classroom

Clinical Conference

Small Group

"Flying Solo"

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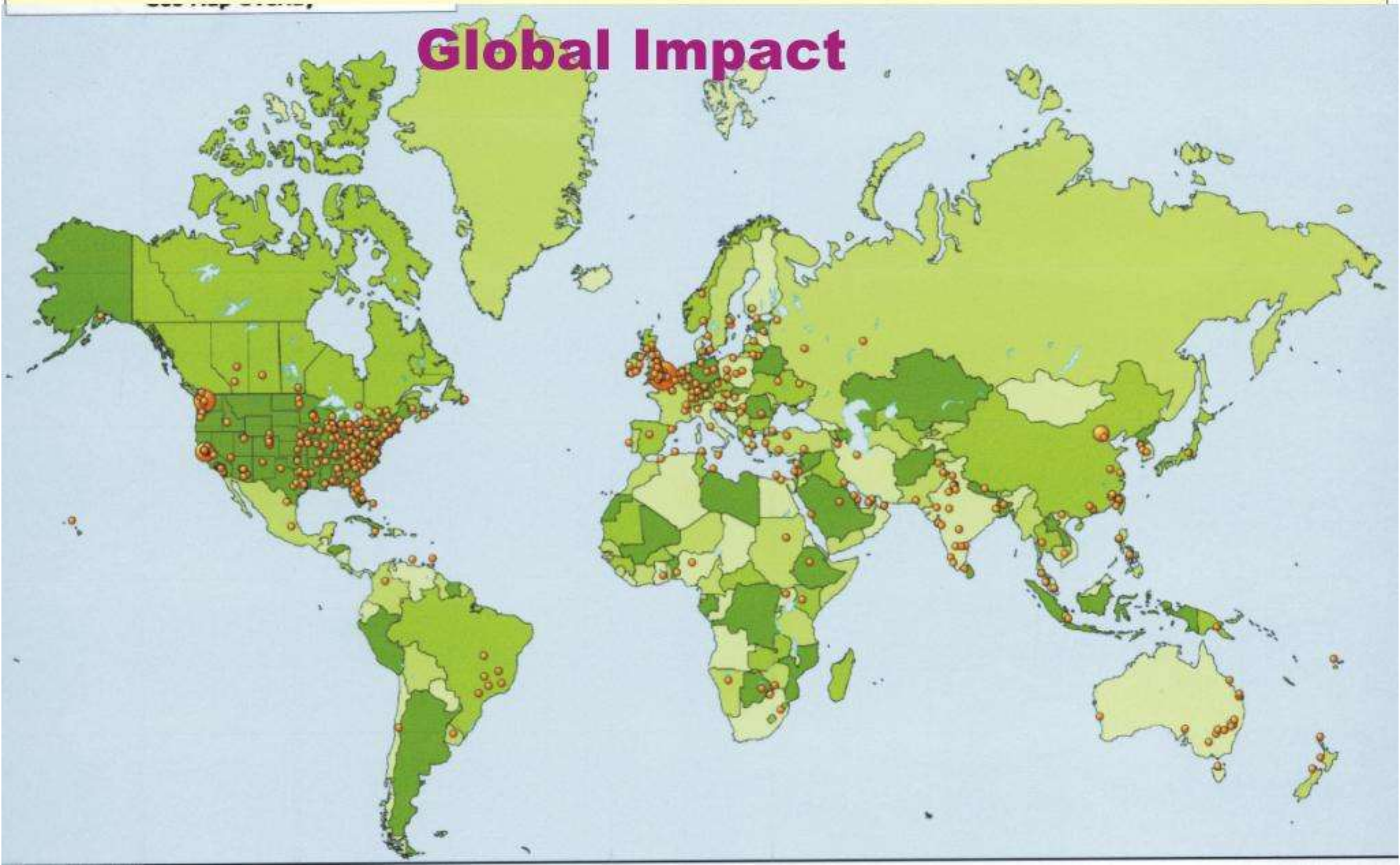
The Sprawls Resources

Users, April 2013



The Elements of A Highly Effective Educational Session

The Brain

The Physical Universe

(Physics of Medical Imaging)

Developing a knowledge structure.

Needs Analysis

Learning Objectives

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Who needs a knowledge of Physics applied to clinical imaging?

Radiologists, Residents and Fellows

Technologists

Medical Physicists

Each provides unique challenges and opportunities.

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Physics Learning Objectives for Radiologists

Image Physical Characteristics

Identify

Relationship to Visibility

Anatomy and Pathology

Evaluate

Control and Optimize

Risk

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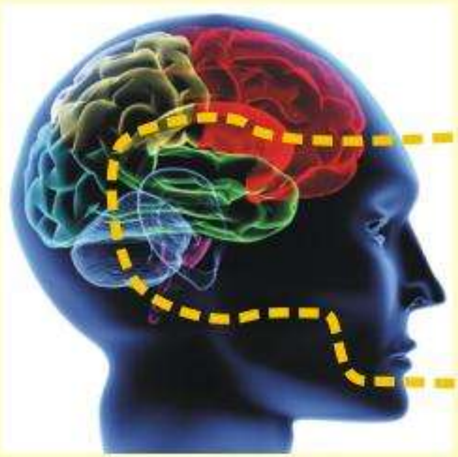
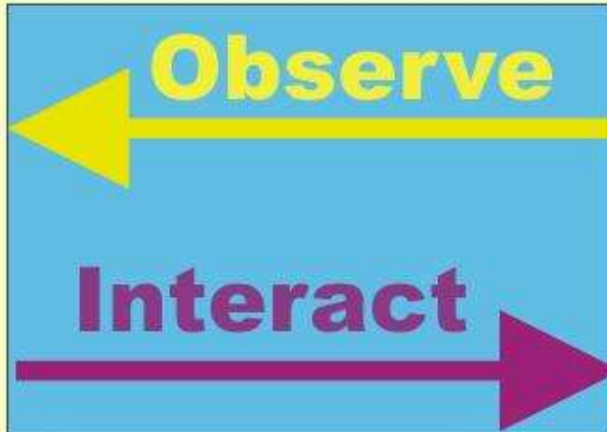
The Elements of
A Highly Effective Educational Session

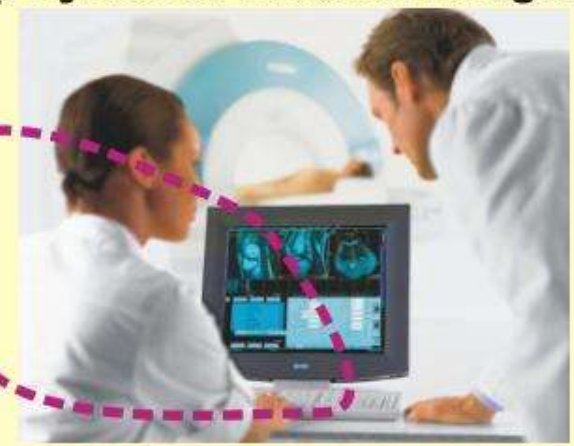
The Brain



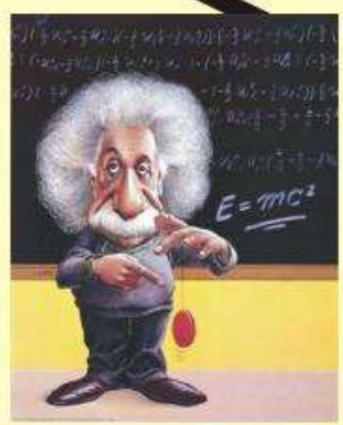
Connection



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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Digital Resources to Enrich Learning Activities

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Clinical Images

Modules

References Teaching Files

Classroom

Clinical Conference

Small Group

"Flying Solo"

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Educational Informatics

A Large Umbrella

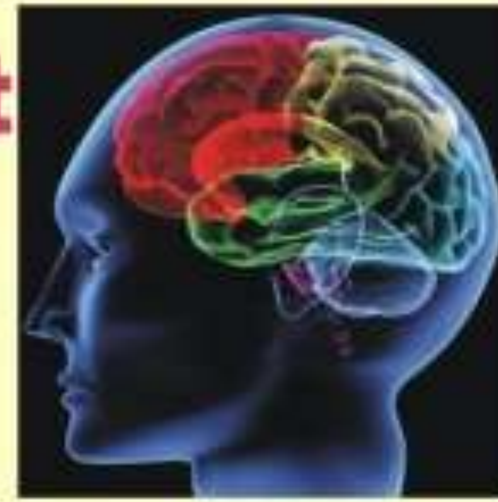
Sprawls

Educational Informatics

Technology

Impact

Human Brain



Does it enhance or deteriorate human performance?

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Educational Informatics

Warning
There are risks of adverse effects

for both

Learners and Teachers

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My Value...

Technology is a Tool
it is not
The Teacher

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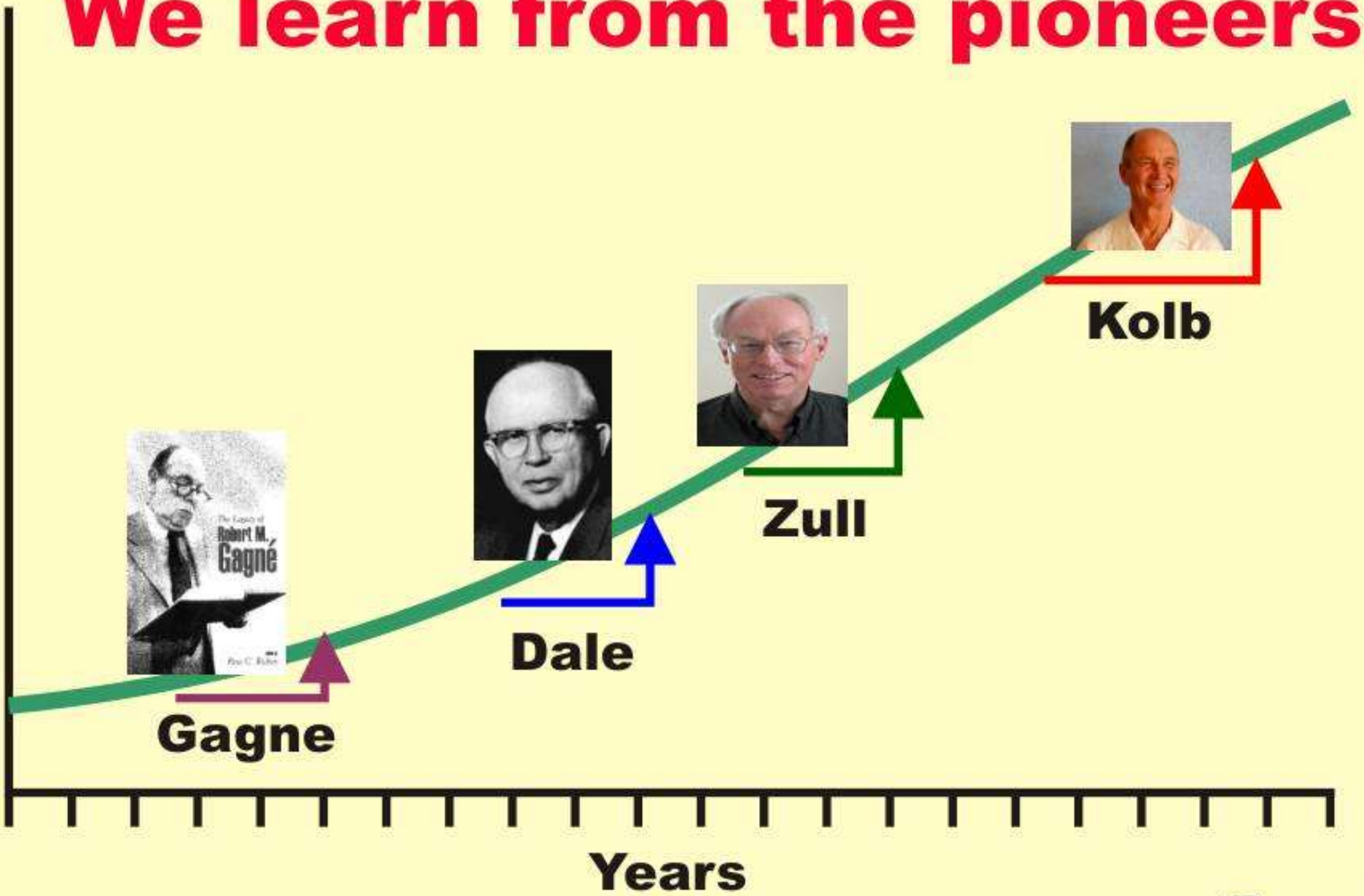
Knowledge of the Learning & Teaching Process

We learn from the pioneers



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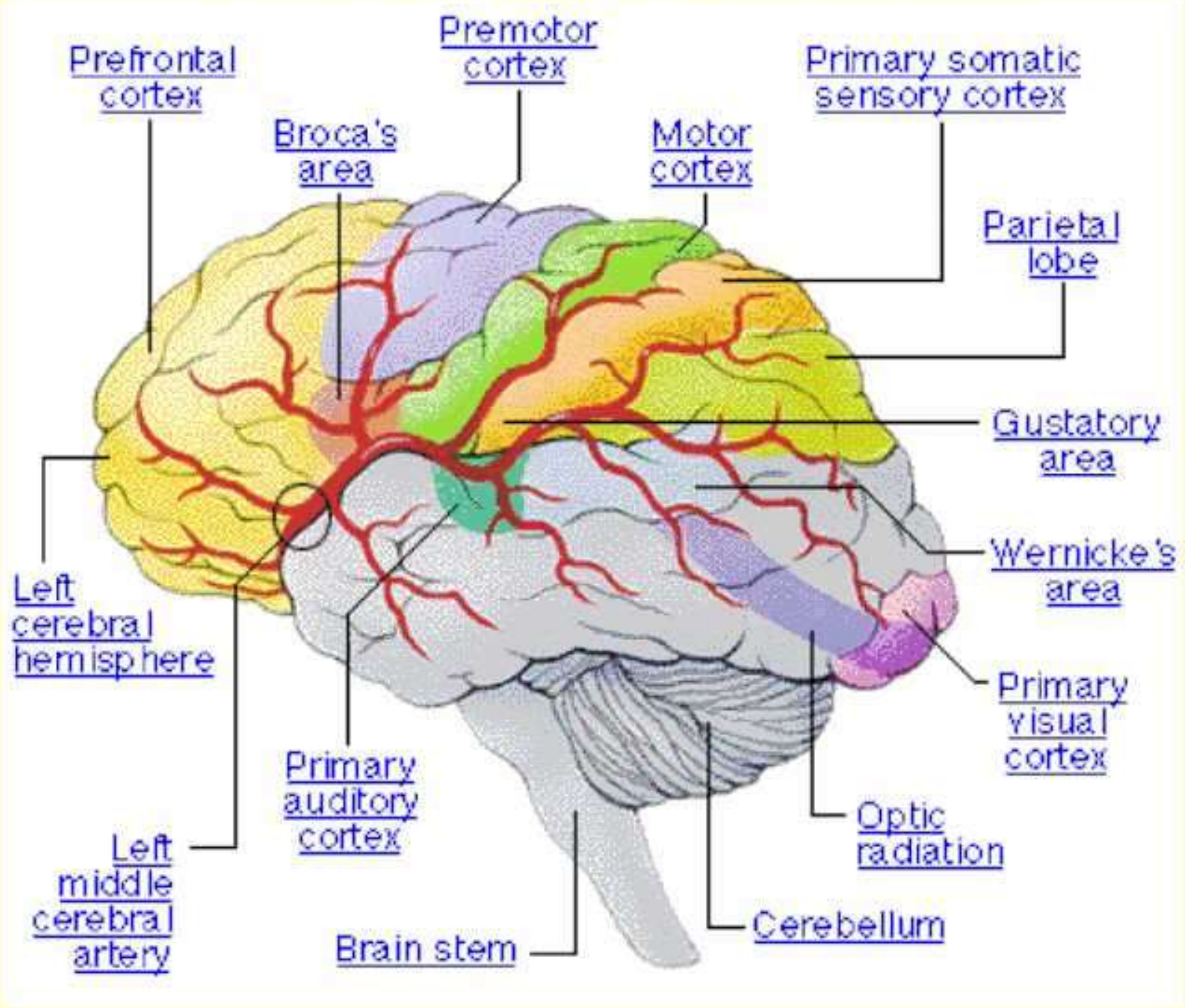
The Brain...



Structure and Function

Image: AMA

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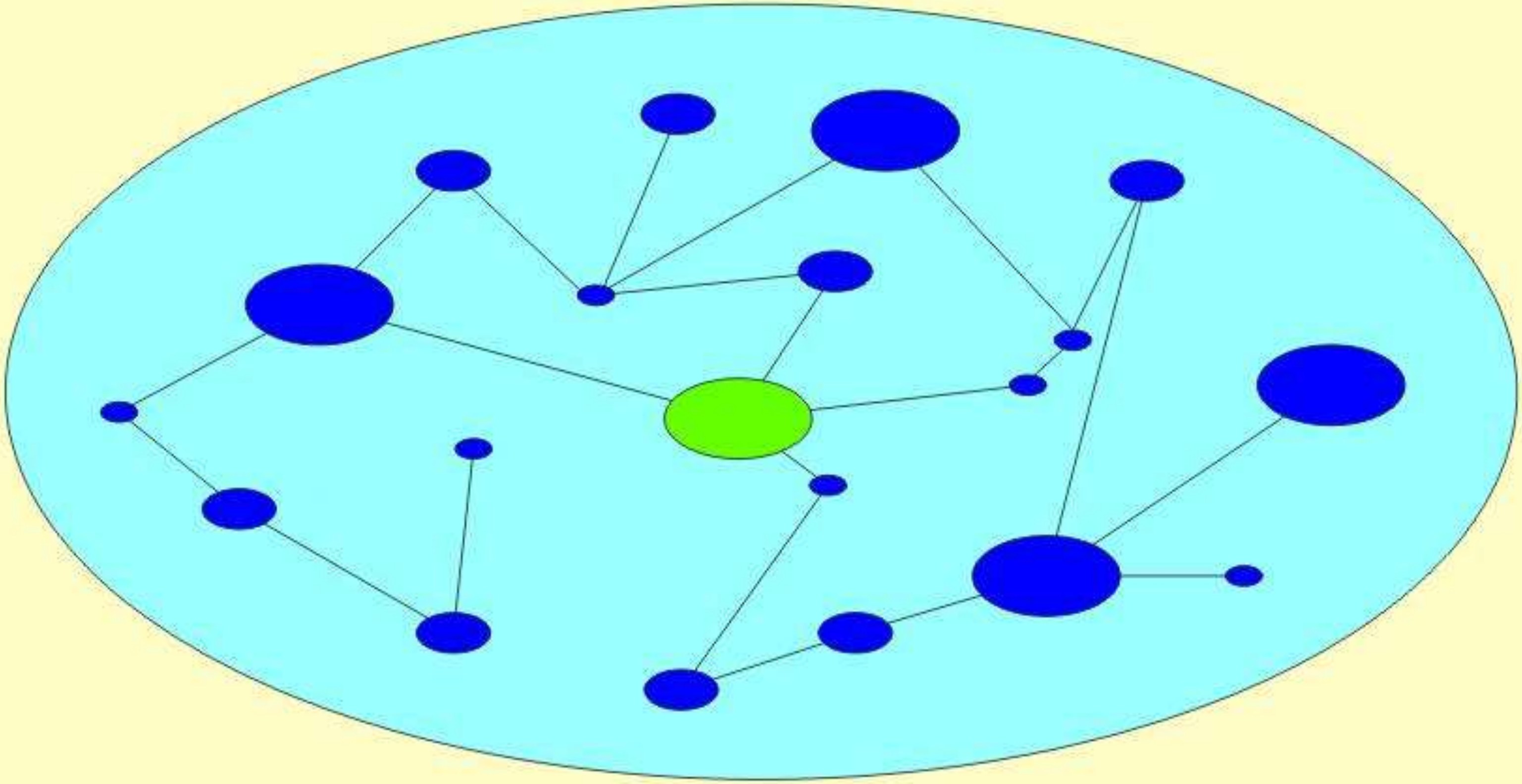
Knowledge Structures in the Brain

A Complex Network



Concepts **Facts**

Images **Language**

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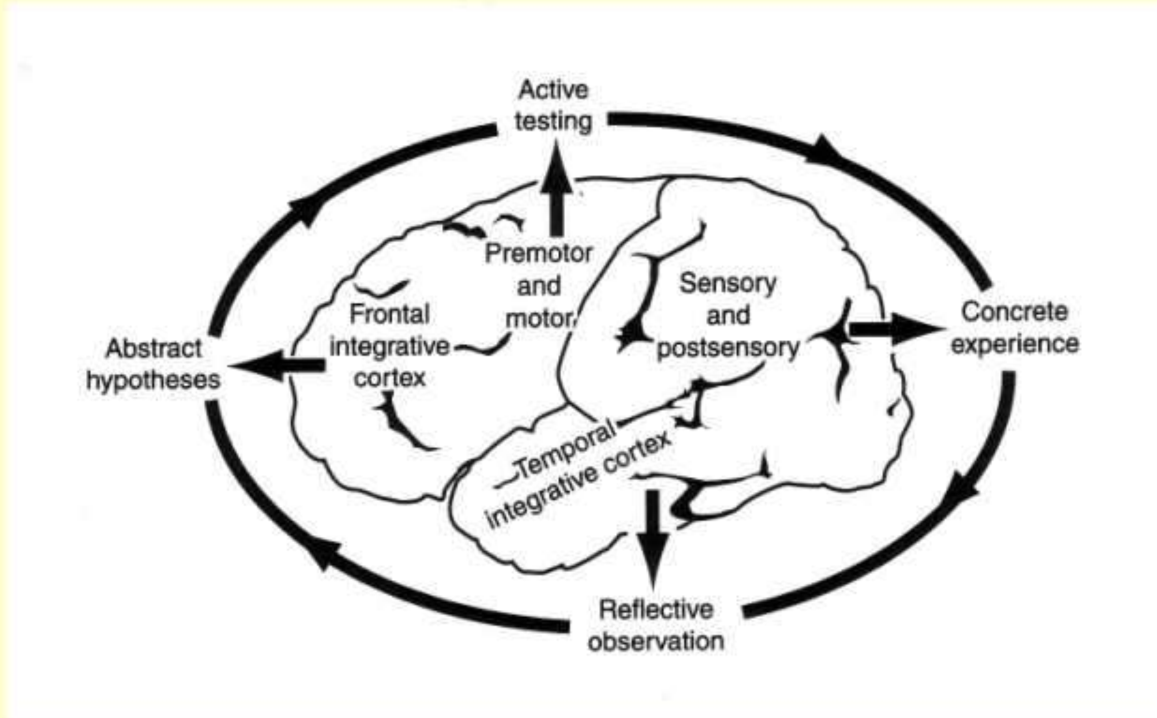
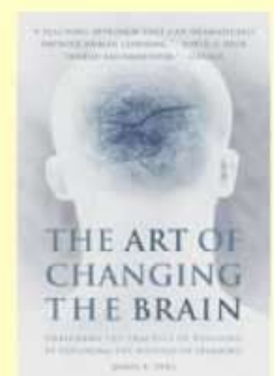
Zull's Model of Brain Function

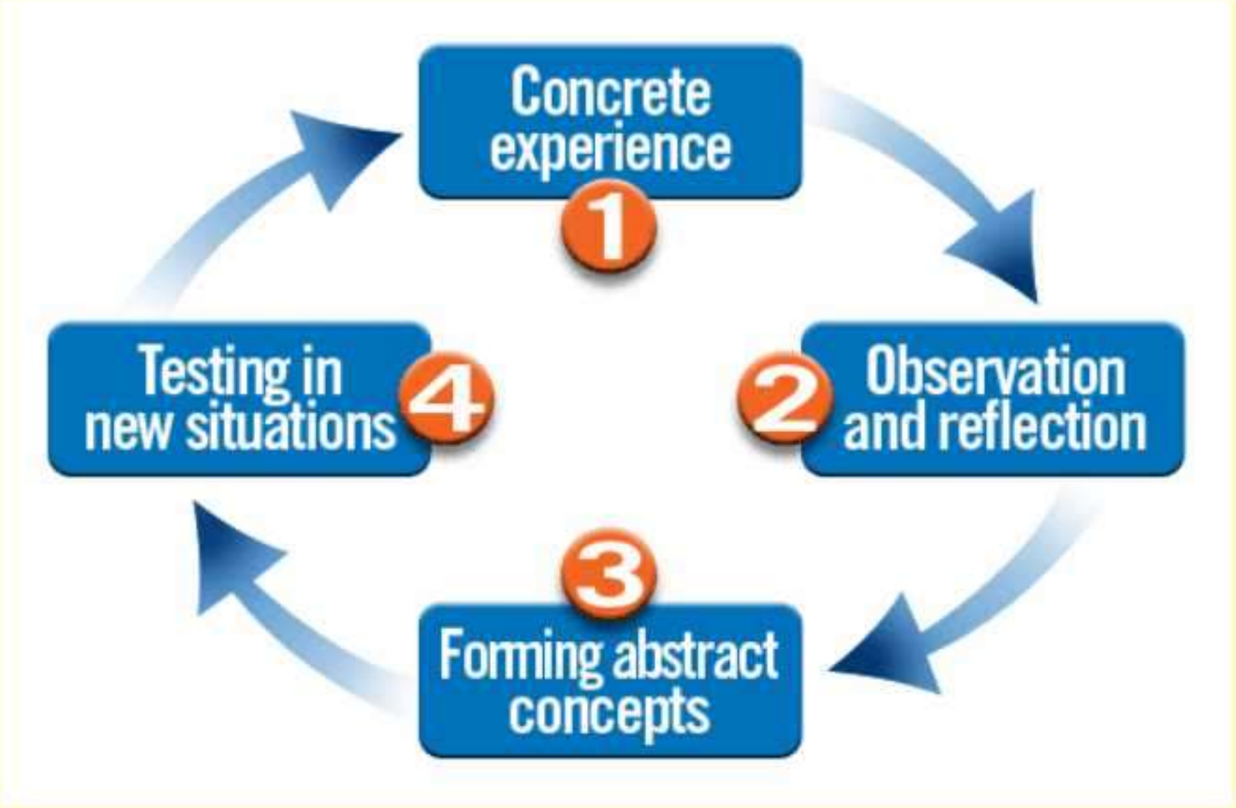


James Zull, Ph.D.
Professor of Biology
Professor of Biochemistry
Director of University Center for Innovation in Teaching and Education
Case Western Reserve

Reference:



Kolb's Experiential Learning Model



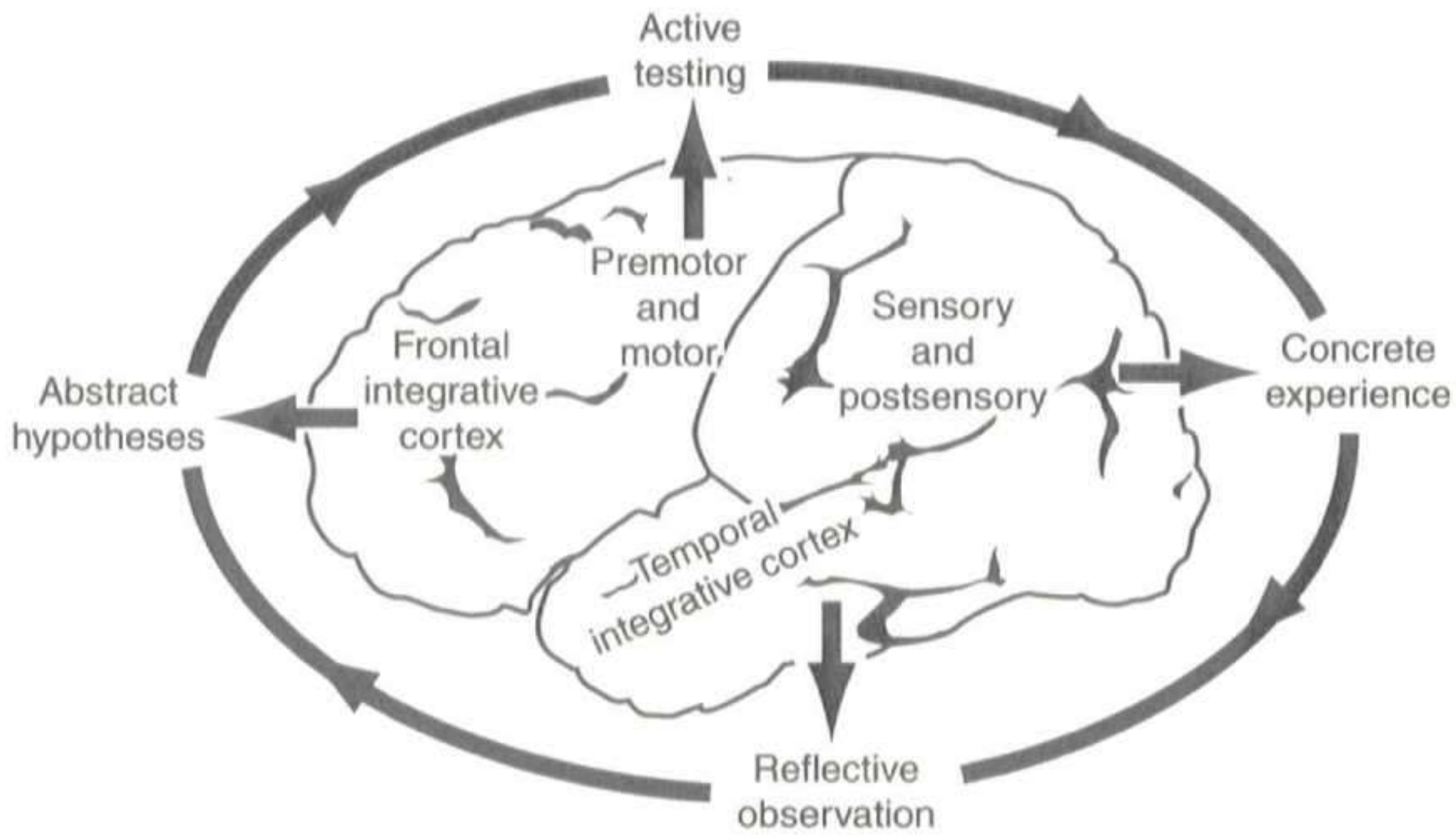
David A. Kolb, Ph.D.

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

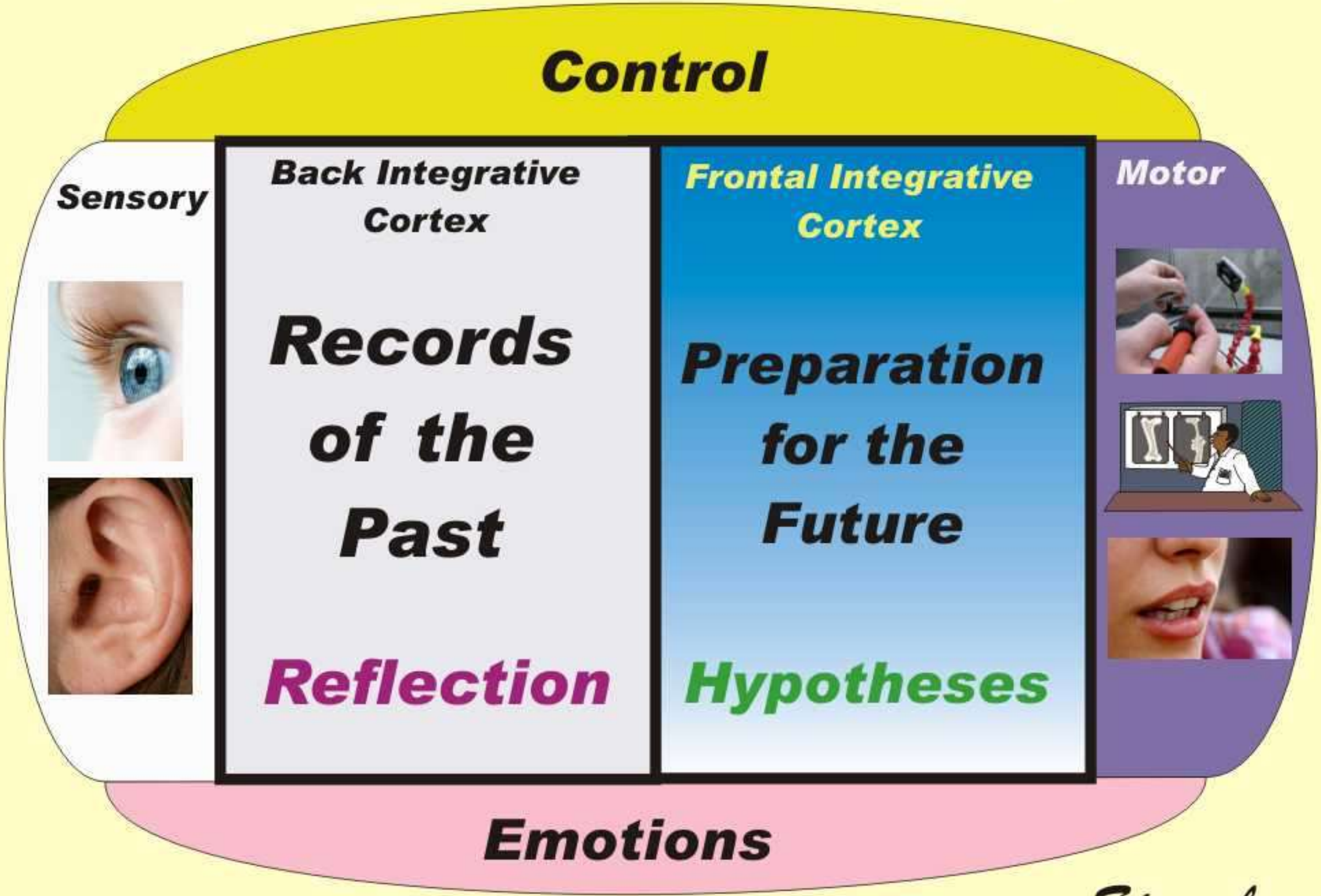
Assembly

Motor

Emotions

Sprawls

Brain Functions for Learning Physics



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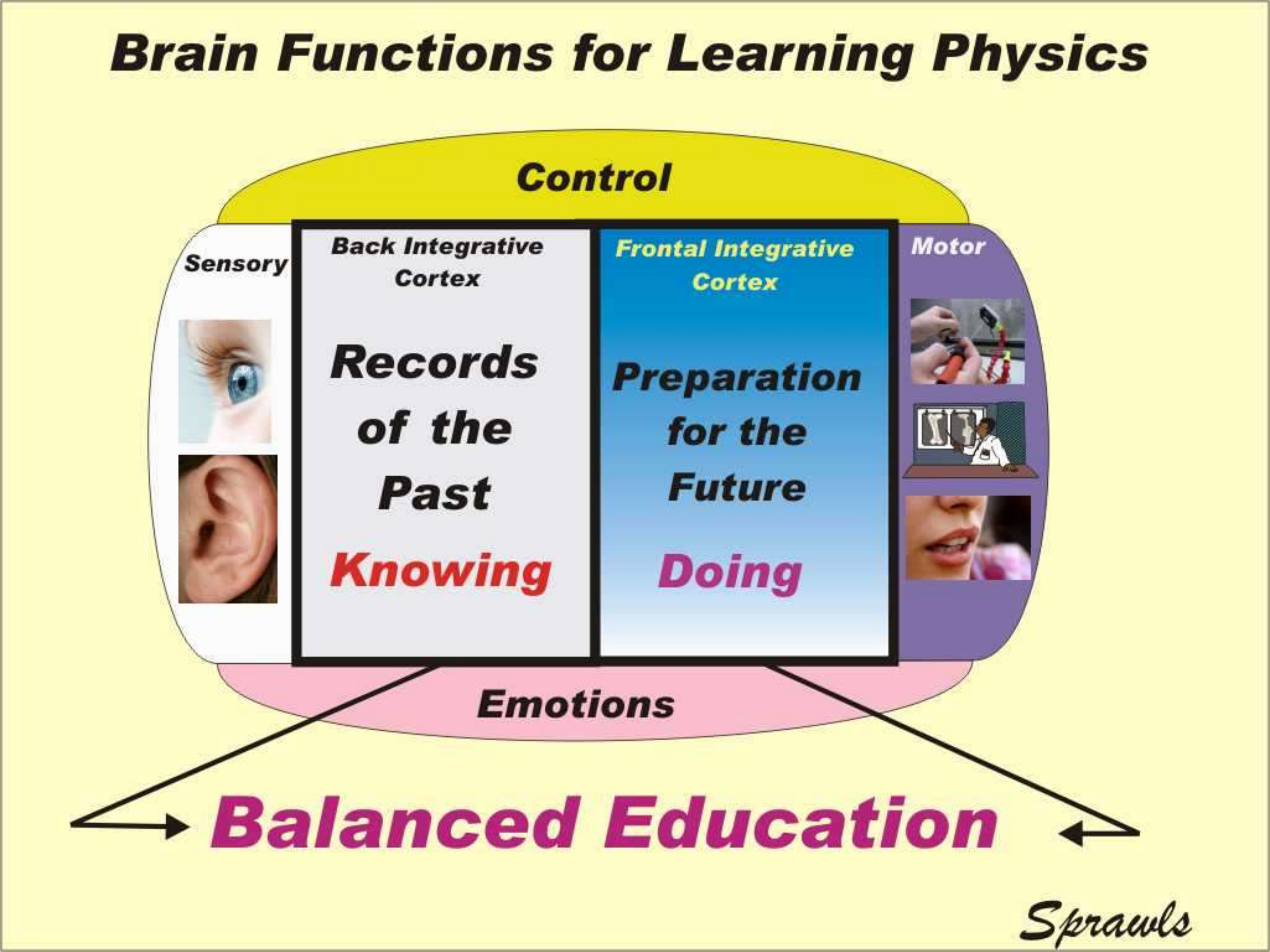

Brain Functions for Learning Physics
Control
Sensory
Back Integrative Cortex
Records of the Past
Knowing
Frontal Integrative Cortex
Preparation for the Future
Doing
Motor
Emotions
Balanced Education
Sprawls

Forming Knowledge Structures

Physical Universe

Back Integrative Cortex

Sensory

Visible Physical Objects

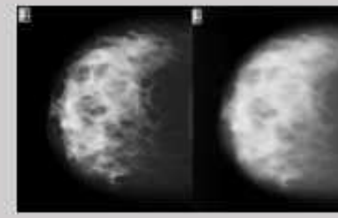
Sprawls

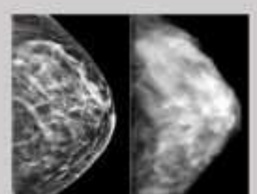
Forming Knowledge Structures

Physical Universe

Back Integrative Cortex

Sensory





Visible Physical Objects

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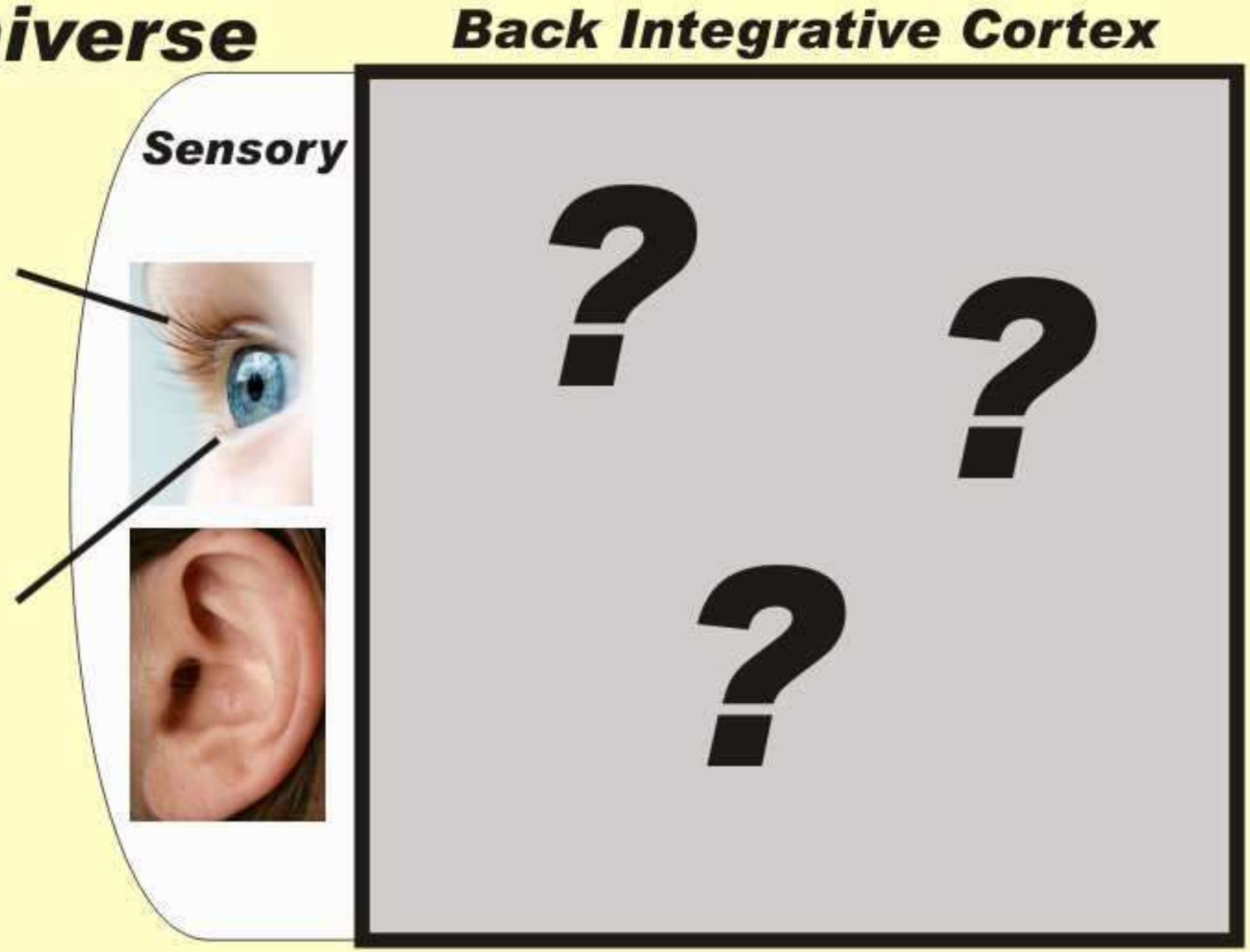
Forming Knowledge Structures

Physical Universe

Radiation
Electrons
Magnetic
Atomic
Nuclear



Invisible Physical Objects

Sprawls

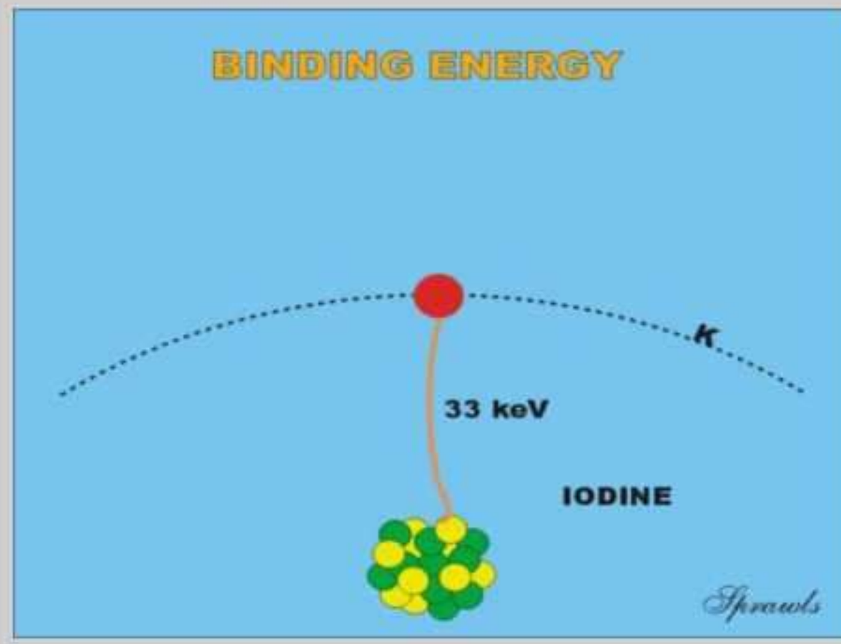
Forming Knowledge Structures

Physical Universe

Back Integrative Cortex

Sensory

Radiation
Electrons
Magnetic
Atomic
Nuclear

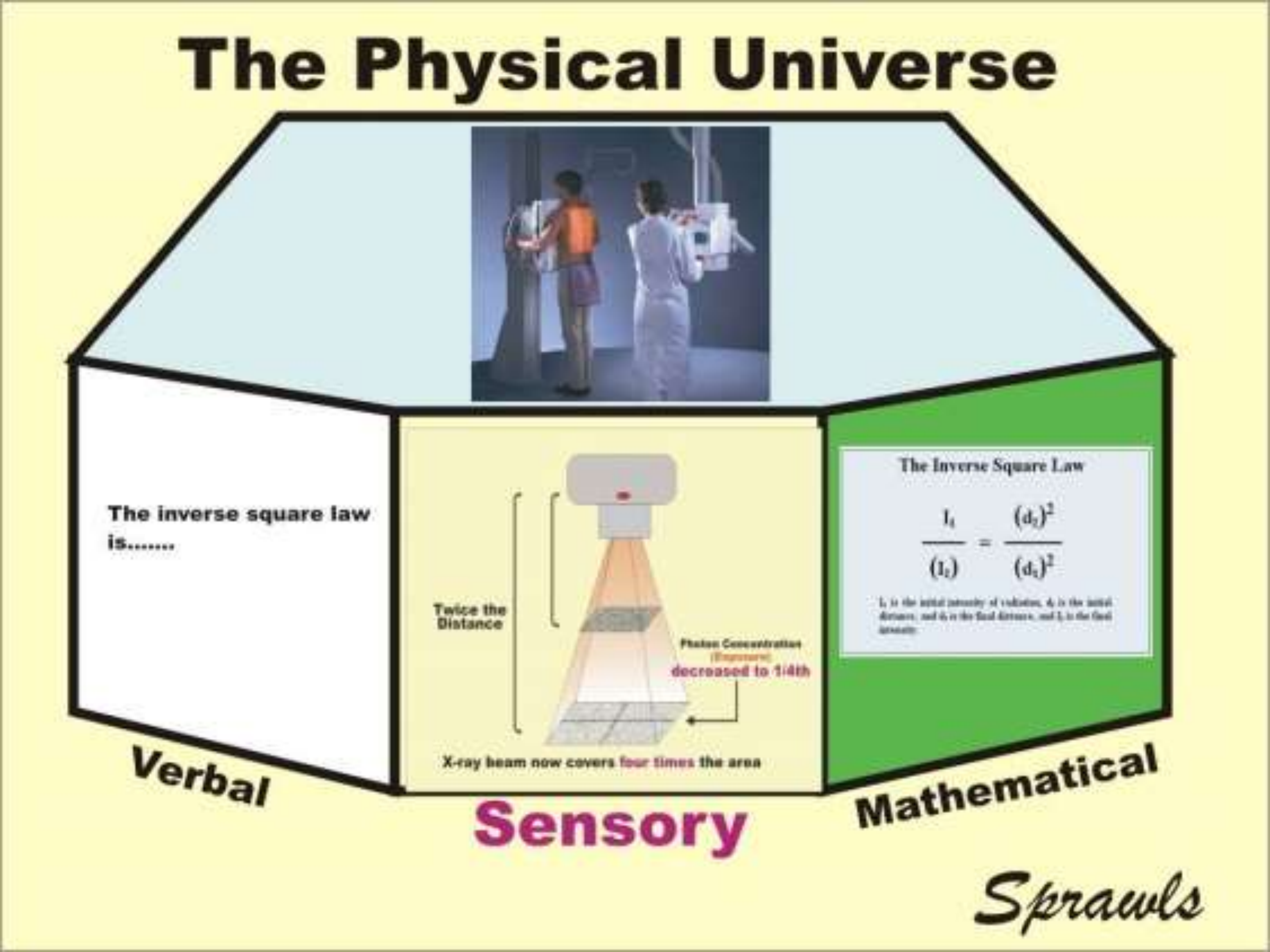


Invisible

Visuals

Physical Objects

Sprawls


The Physical Universe
The inverse square law is.......
Twice the Distance
Photon Concentration
decreased to 1/4th
X-ray beam now covers four times the area
The Inverse Square Law
$$\frac{I_1}{(I_2)} = \frac{(d_2)^2}{(d_1)^2}$$
Verbal
Sensory
Mathematical
Sprawls

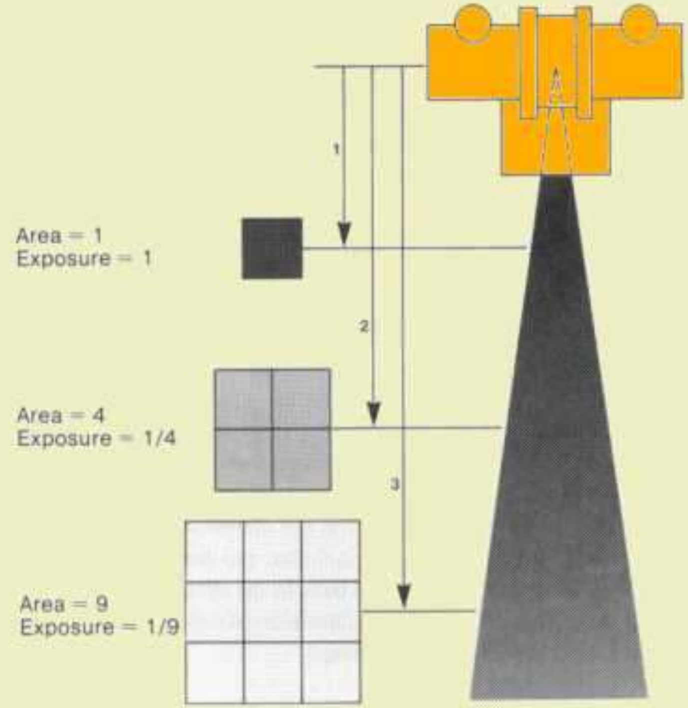
Forming Knowledge Structures

Physical Universe

Back Integrative Cortex

Inverse Square Effect

Sensory



Invisible

Concepts

Ideas

Visuals

Sprawls

The Barrier

Physics Education

Clinical Imaging

Efficiency

Location, Resources, Human Effort, Cost

Limited Experience

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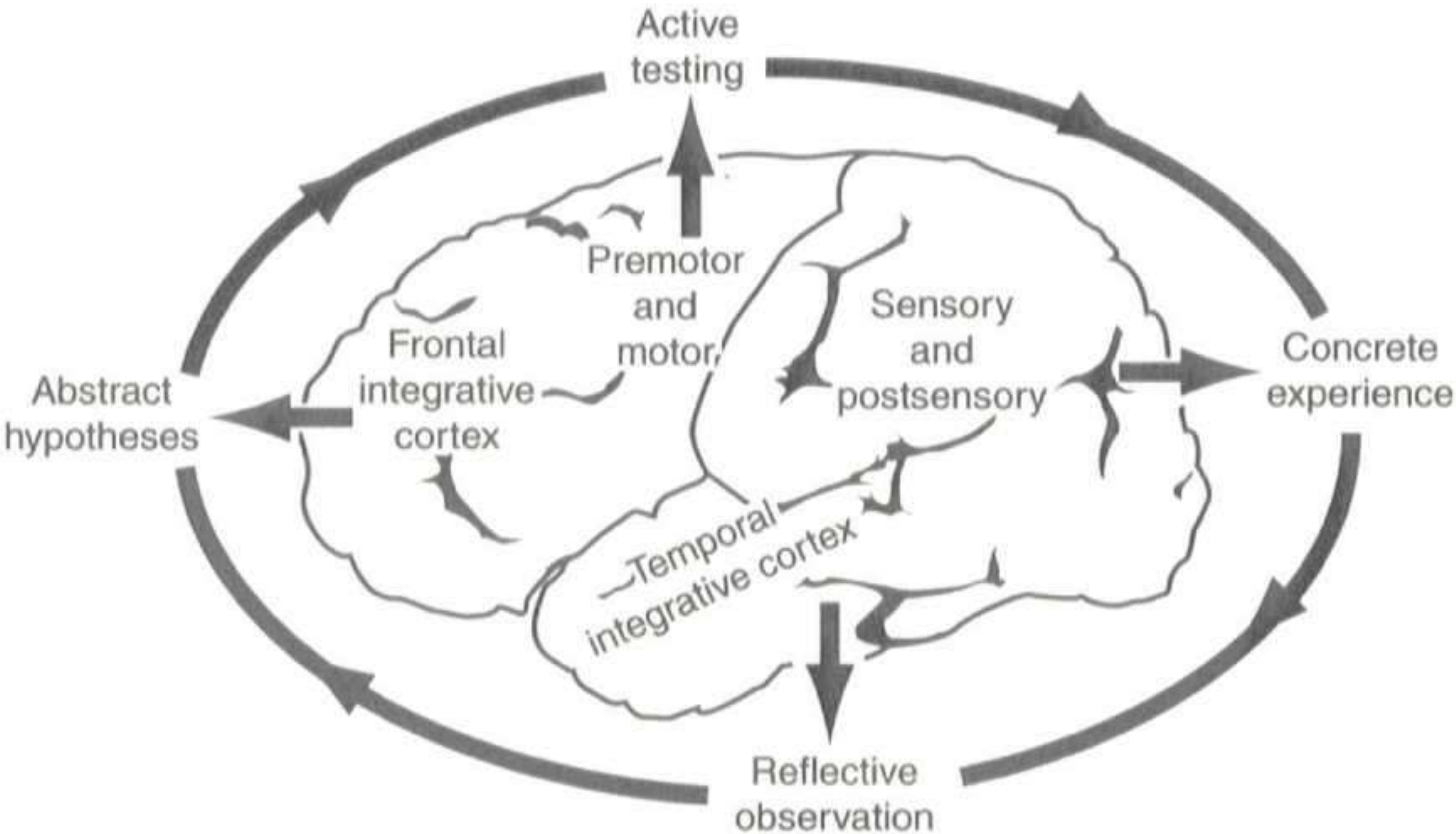
Zull's Model of Brain Function



Brain Functions for Learning Physics

Active Experimentation and Testing

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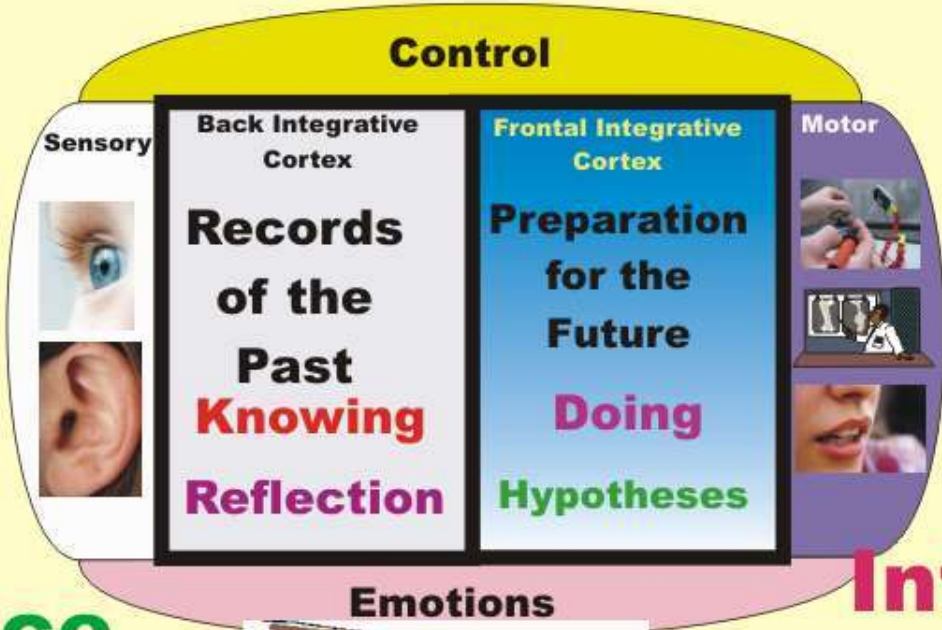
Brain Functions for Learning About

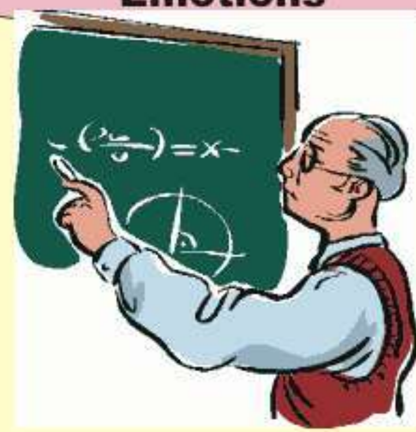
Learning Physics



Sense and Experience

Observe

Interact and Affect



Our Teaching

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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.

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Gagne's Hierarchy of Learning

PROBLEM SOLVING

RULE LEARNING

CONCEPT LEARNING

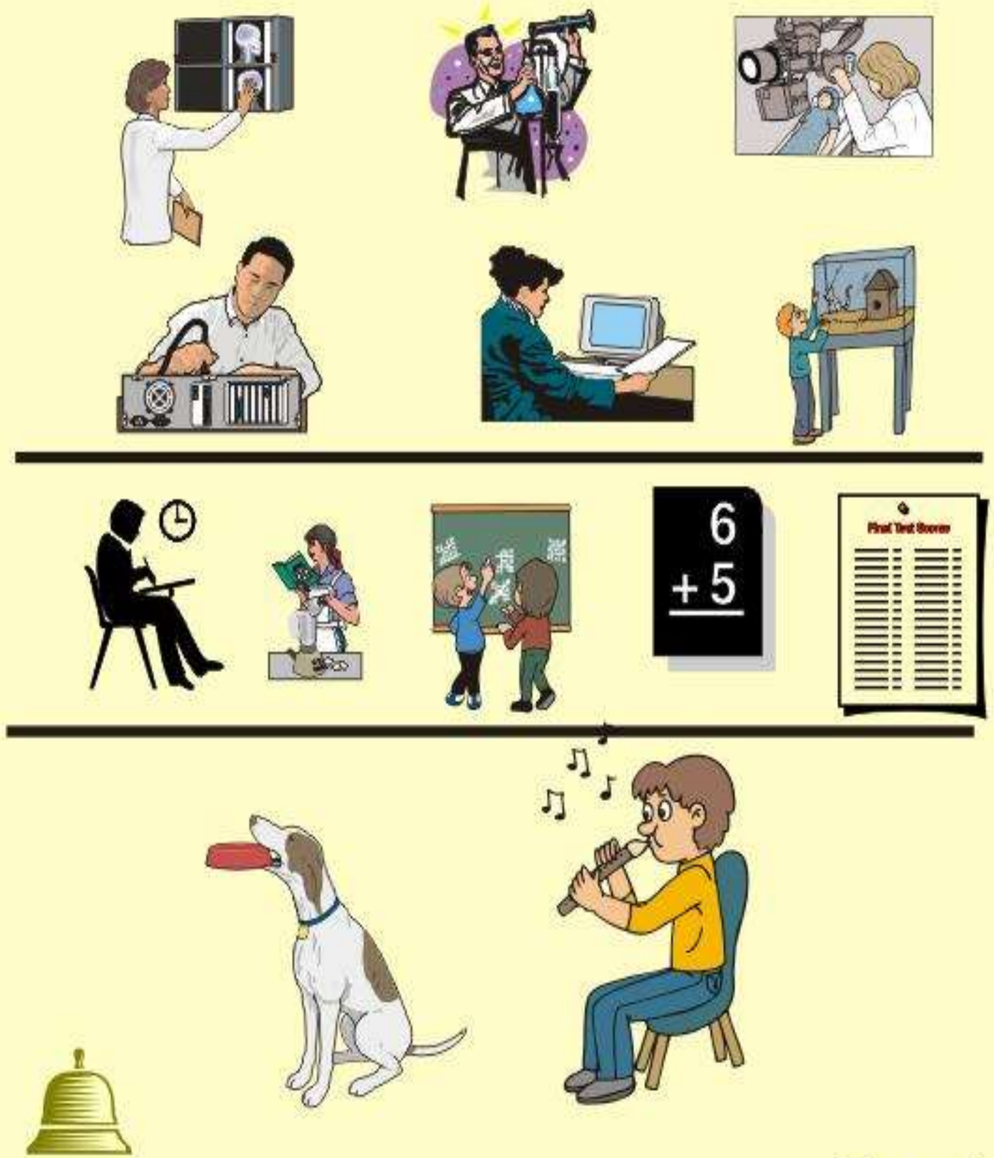
DISCRIMINATION LEARNING

VERBAL ASSOCIATION

CHAINING

STIMULUS RESPONSE

SIGNAL LEARNING



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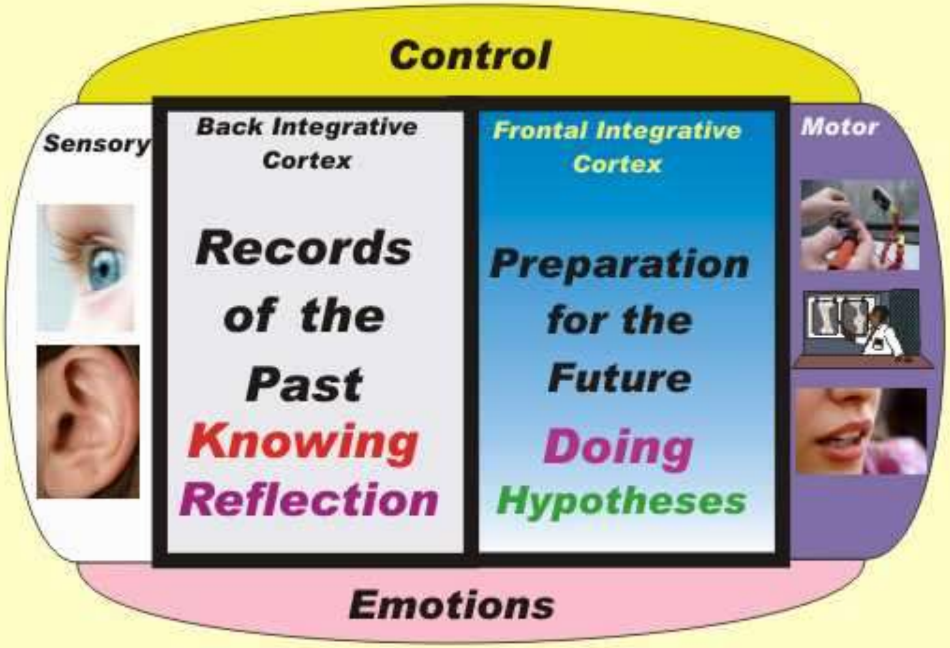
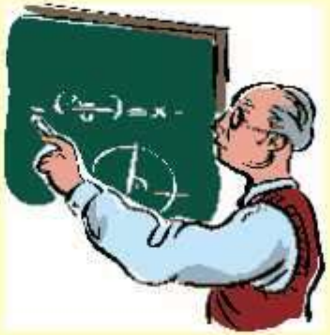
Challenging Learning Environments





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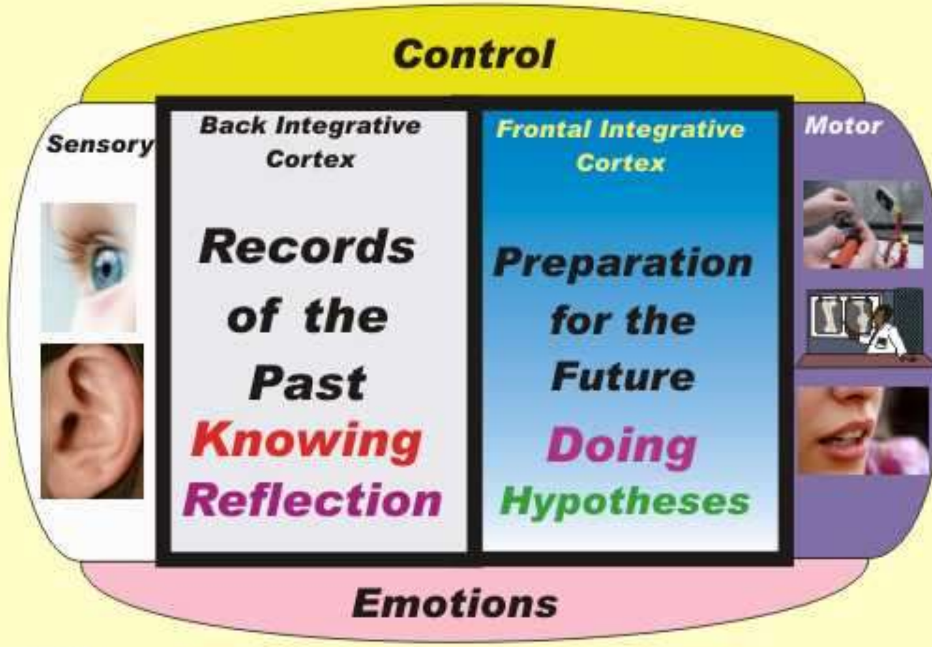
Rich Learning Environments



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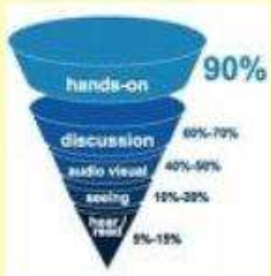
Edgar Dale (1900-1985)

Educationalist who developed the famous

Cone of Experience theory



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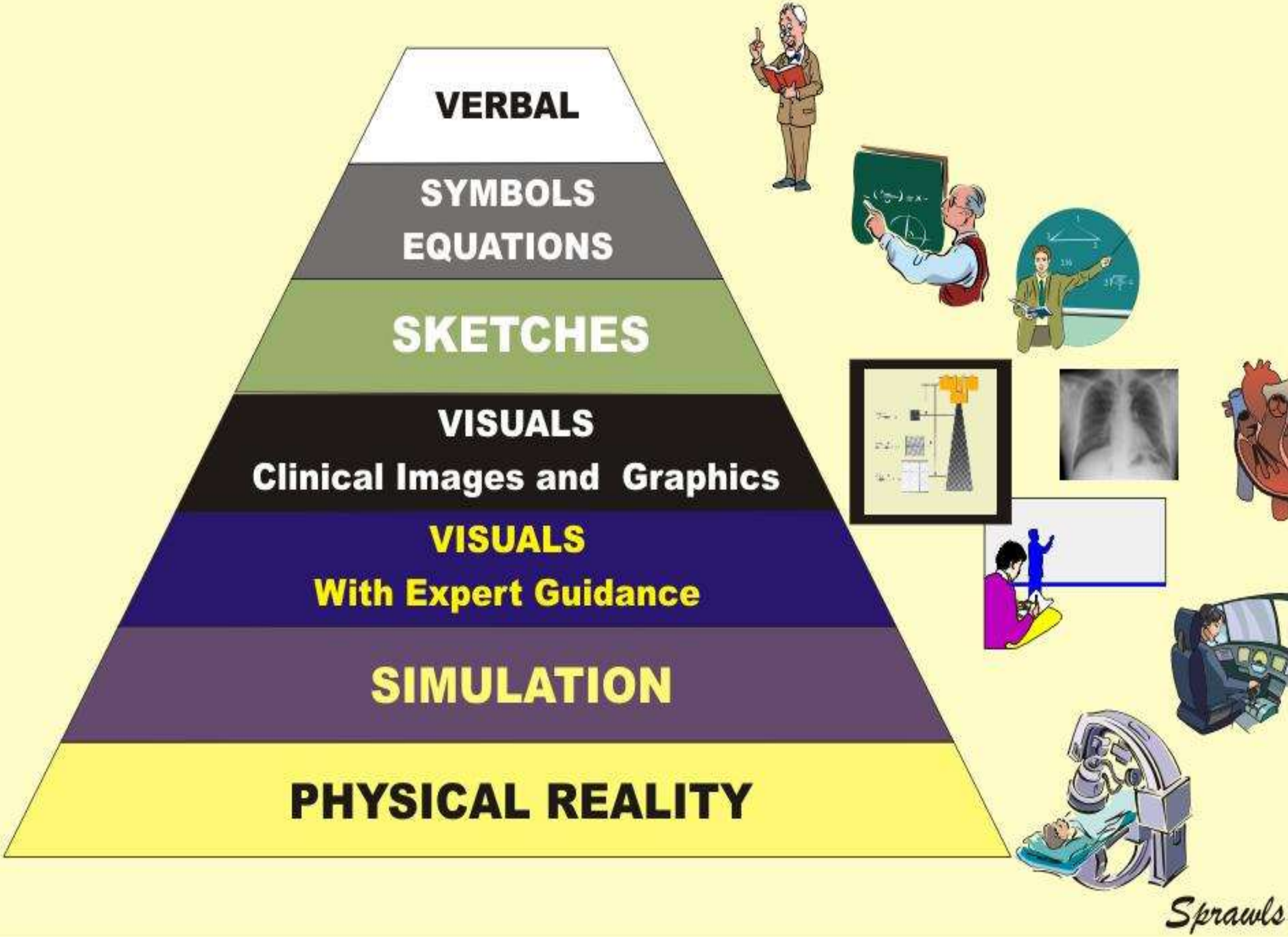
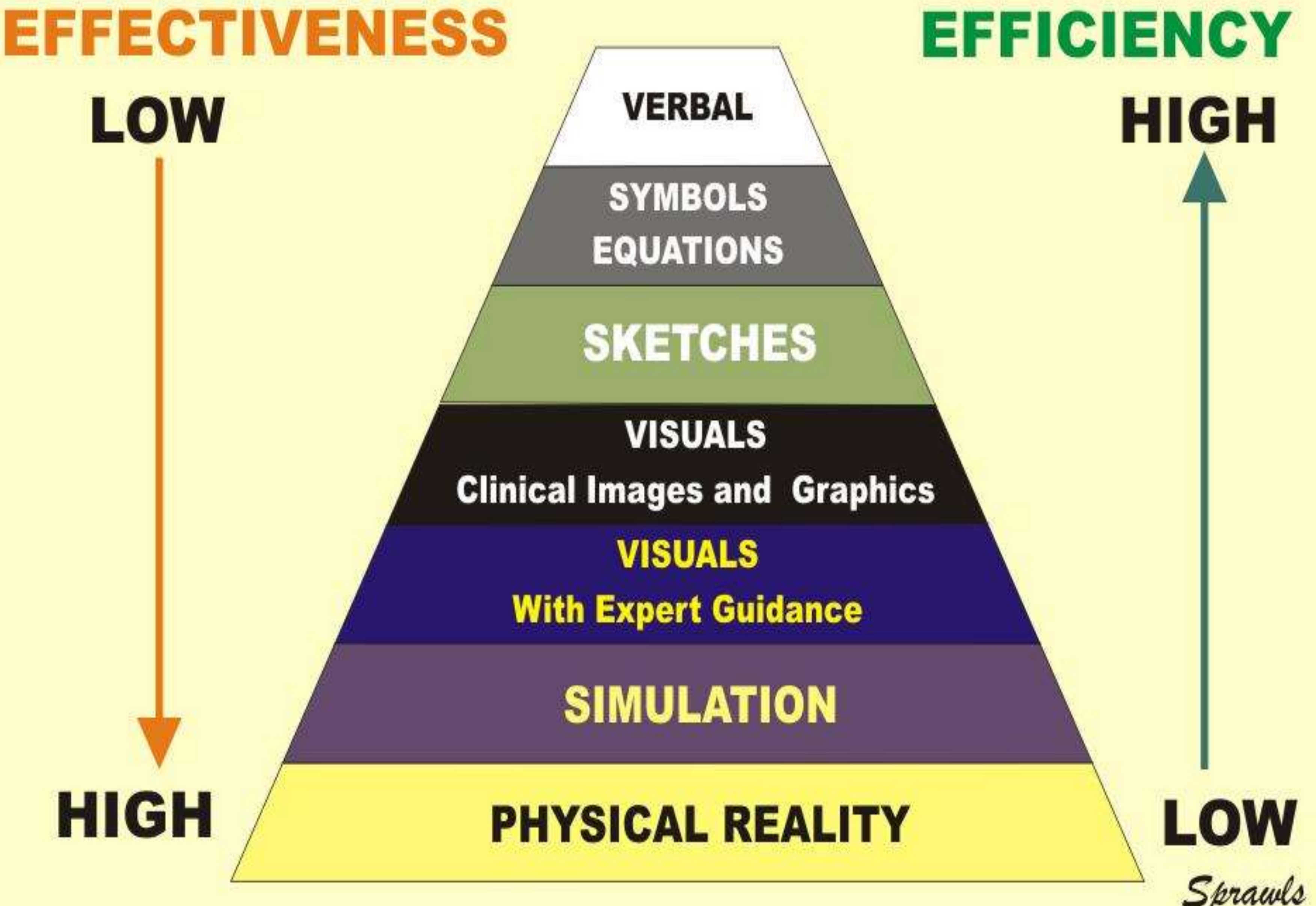
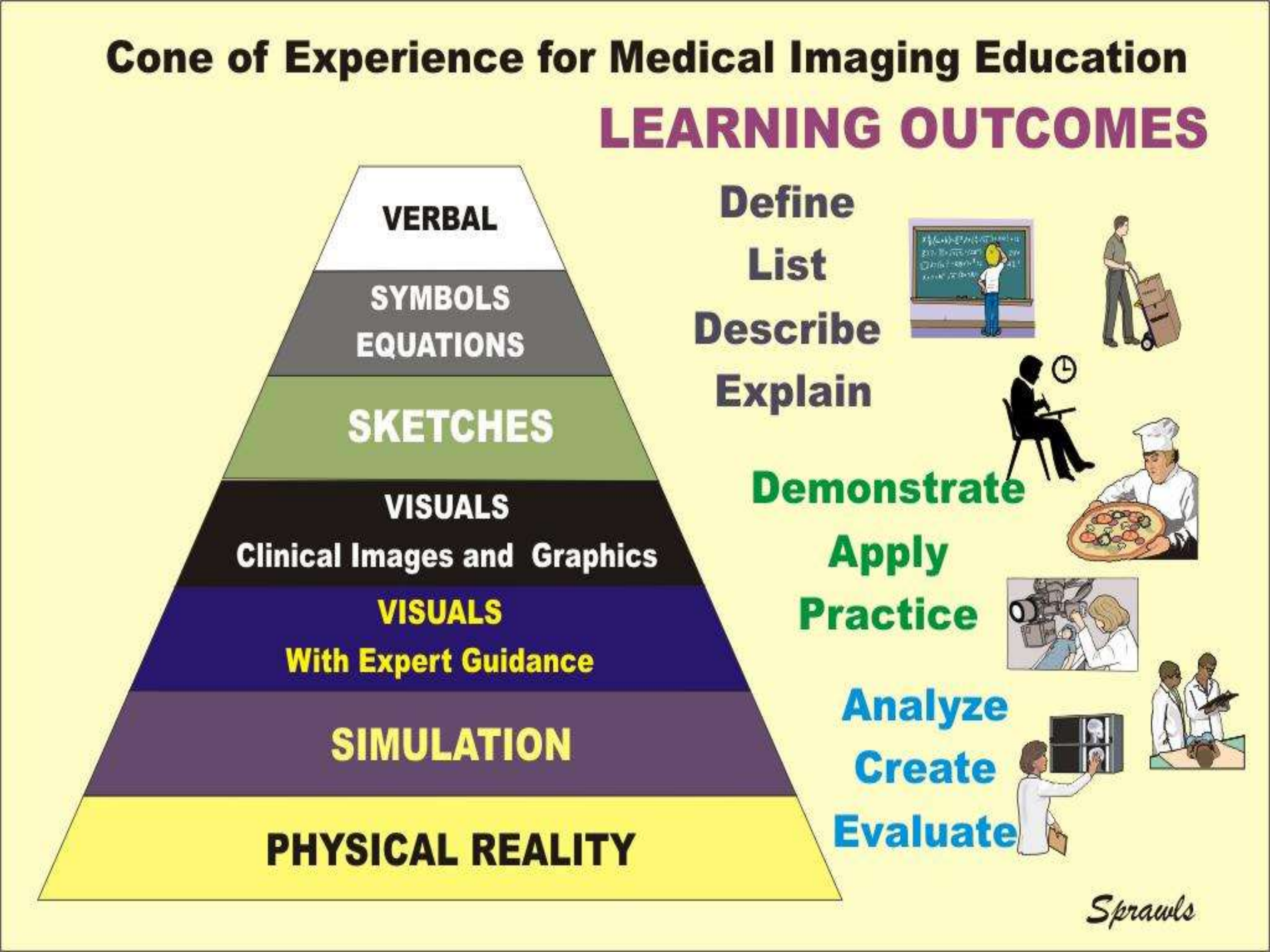
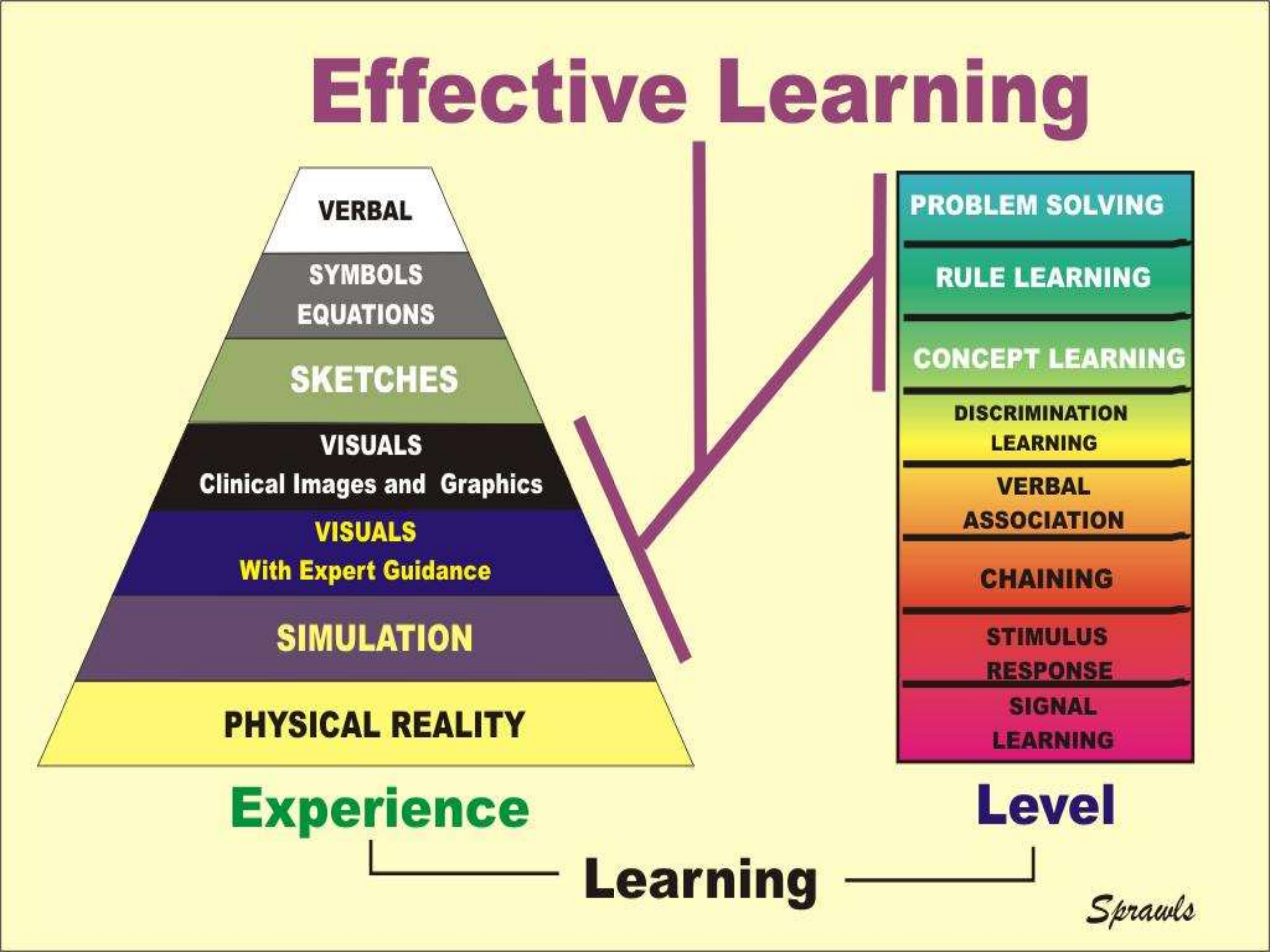
Cone of Experience for Medical Imaging Education



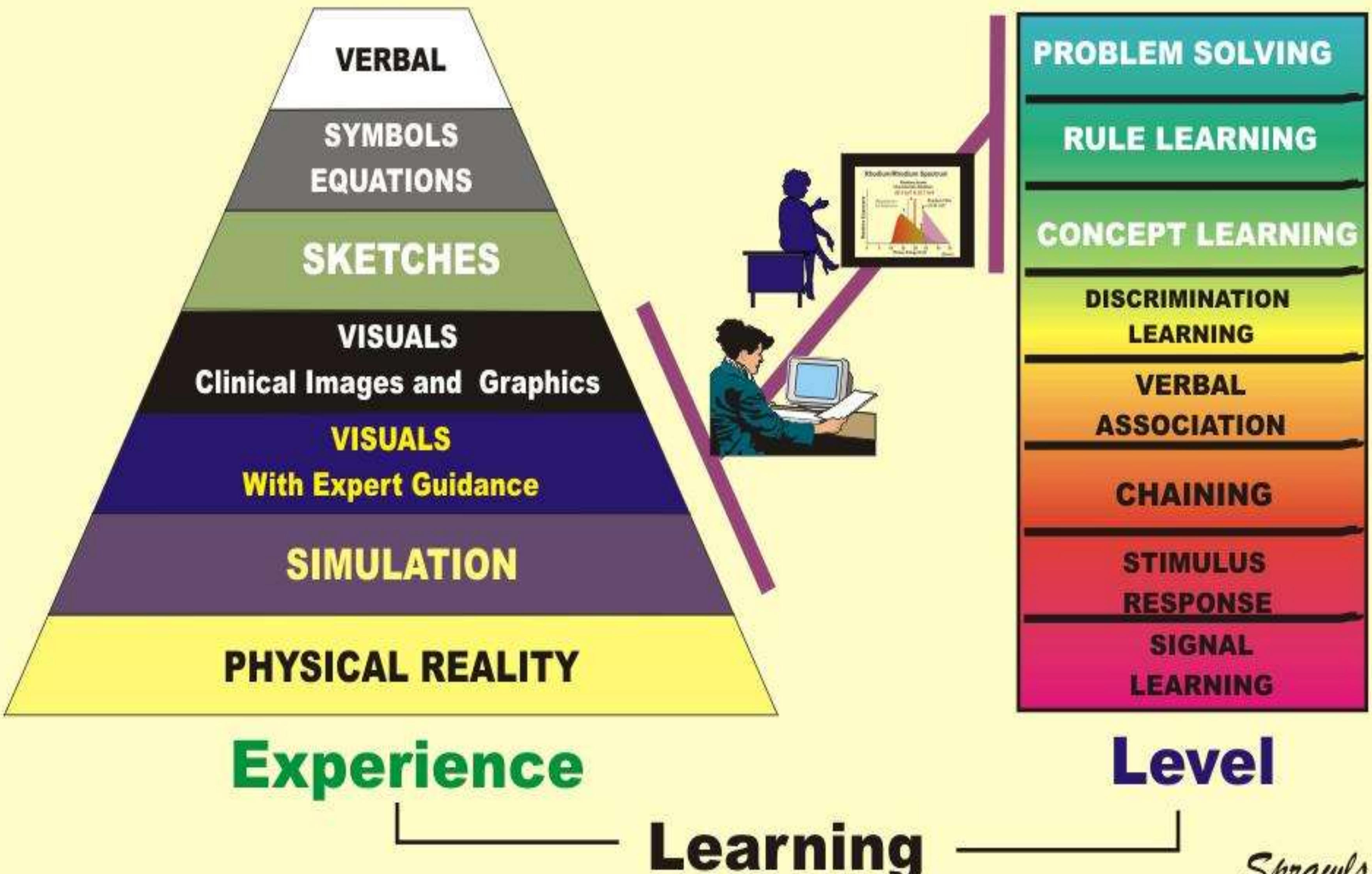
Cone of Experience for Medical Imaging Education




Cone of Experience for Medical Imaging Education
LEARNING OUTCOMES
VERBAL
SYMBOLS
EQUATIONS
SKETCHES
VISUALS
Clinical Images and Graphics
VISUALS
With Expert Guidance
SIMULATION
PHYSICAL REALITY
Define
List
Describe
Explain
Demonstrate
Apply
Practice
Analyze
Create
Evaluate
Sprawls


Effective Learning
VERBAL
SYMBOLS
EQUATIONS
SKETCHES
VISUALS
Clinical Images and Graphics
VISUALS
With Expert Guidance
SIMULATION
PHYSICAL REALITY
Experience
PROBLEM SOLVING
RULE LEARNING
CONCEPT LEARNING
DISCRIMINATION
LEARNING
VERBAL
ASSOCIATION
CHAINING
STIMULUS
RESPONSE
SIGNAL
LEARNING
Level
Learning
Sprawls

Technology Enhanced Learning and Teaching



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

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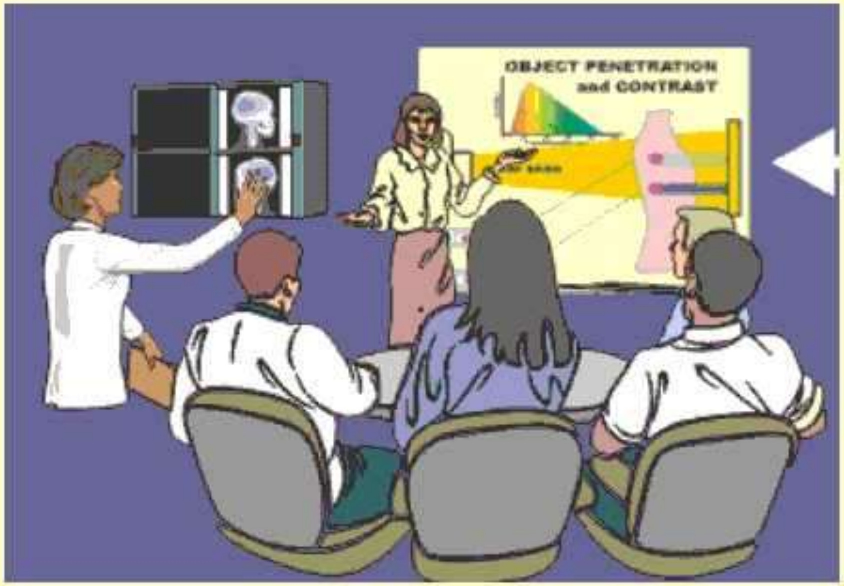
Rich Classroom and Conference Learning Activities



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**

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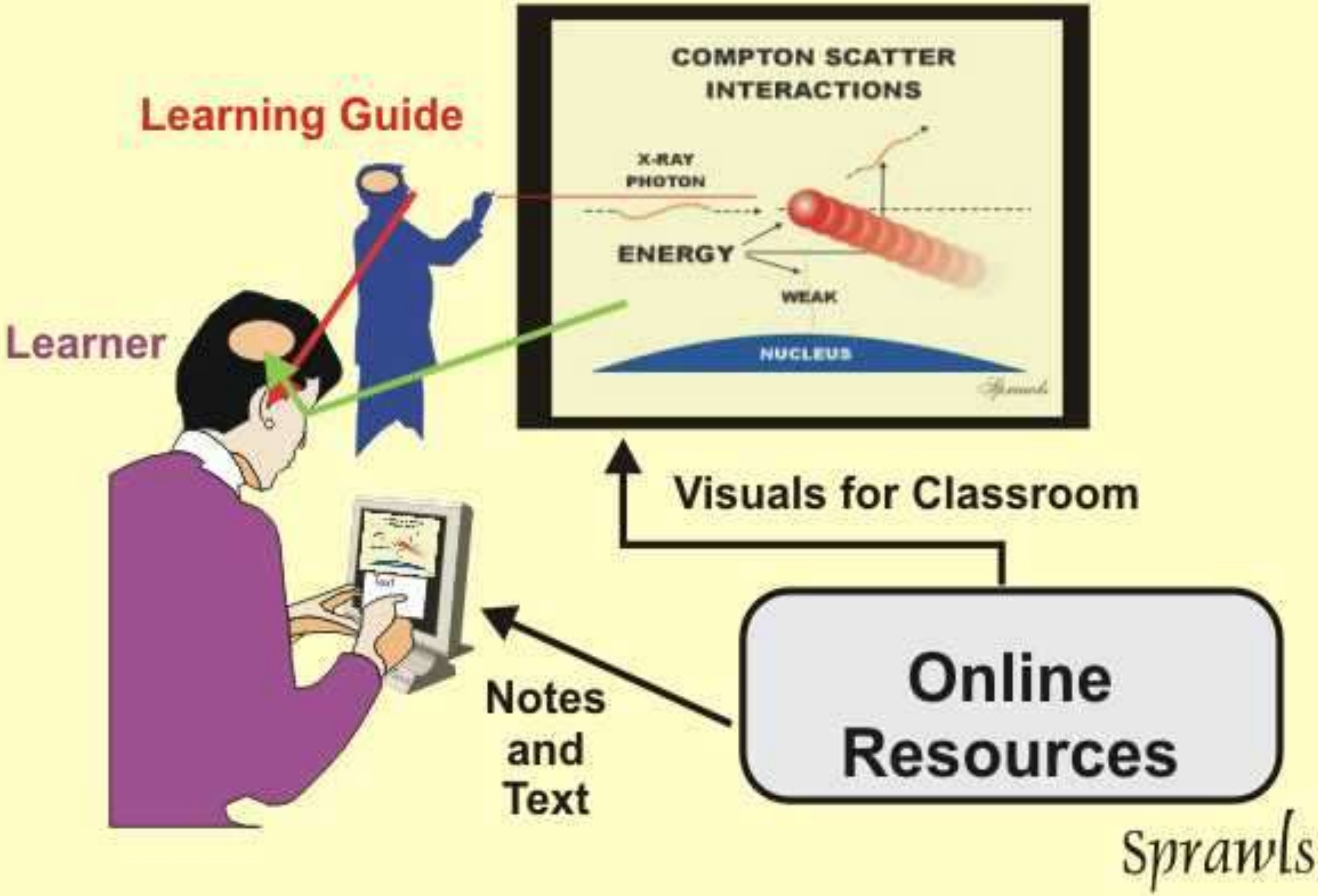
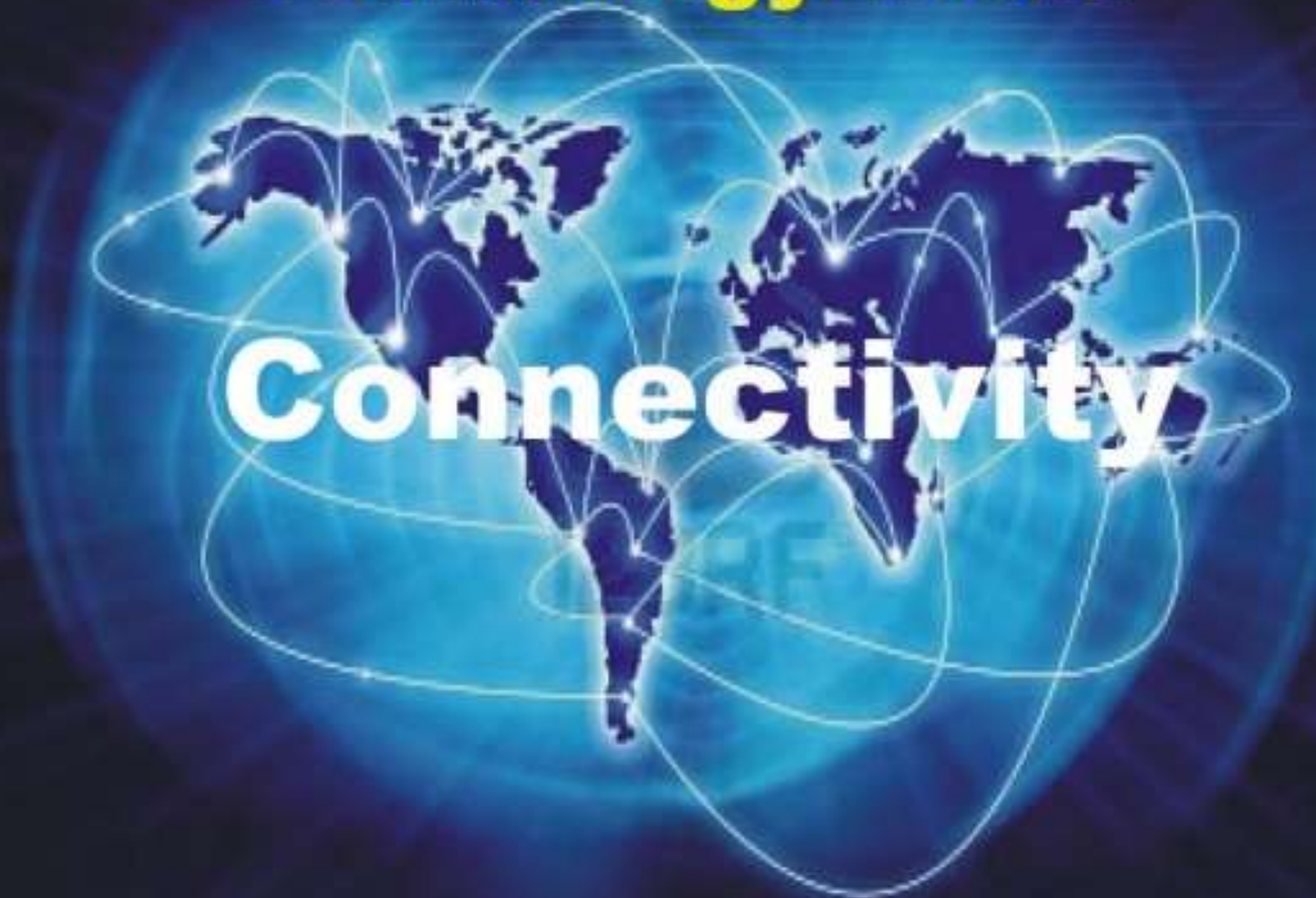
Technology Enhanced Learning



Technology Tools




Technology Tools
Digitizing


Technology Tools
Video

Technology Tools
Handheld Devices

Technology Tools

Developing Digital Images

Technology Tools

Developing Digital Images

"Paint" | **"Draw"**

Bitmaps

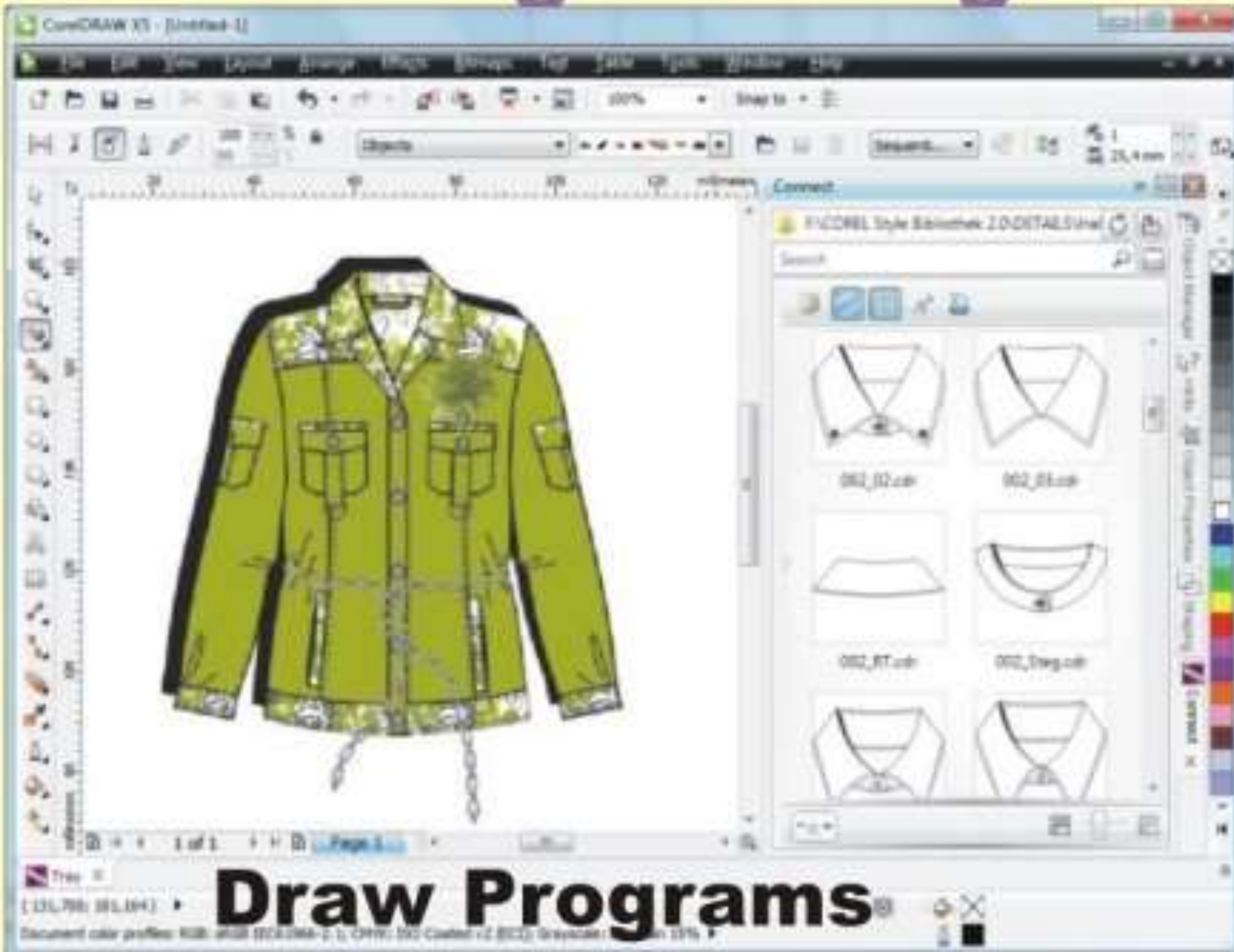
This illustration is a raster file, made up of pixels.

Vectors

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

Technology Tools

Vector Digital Images

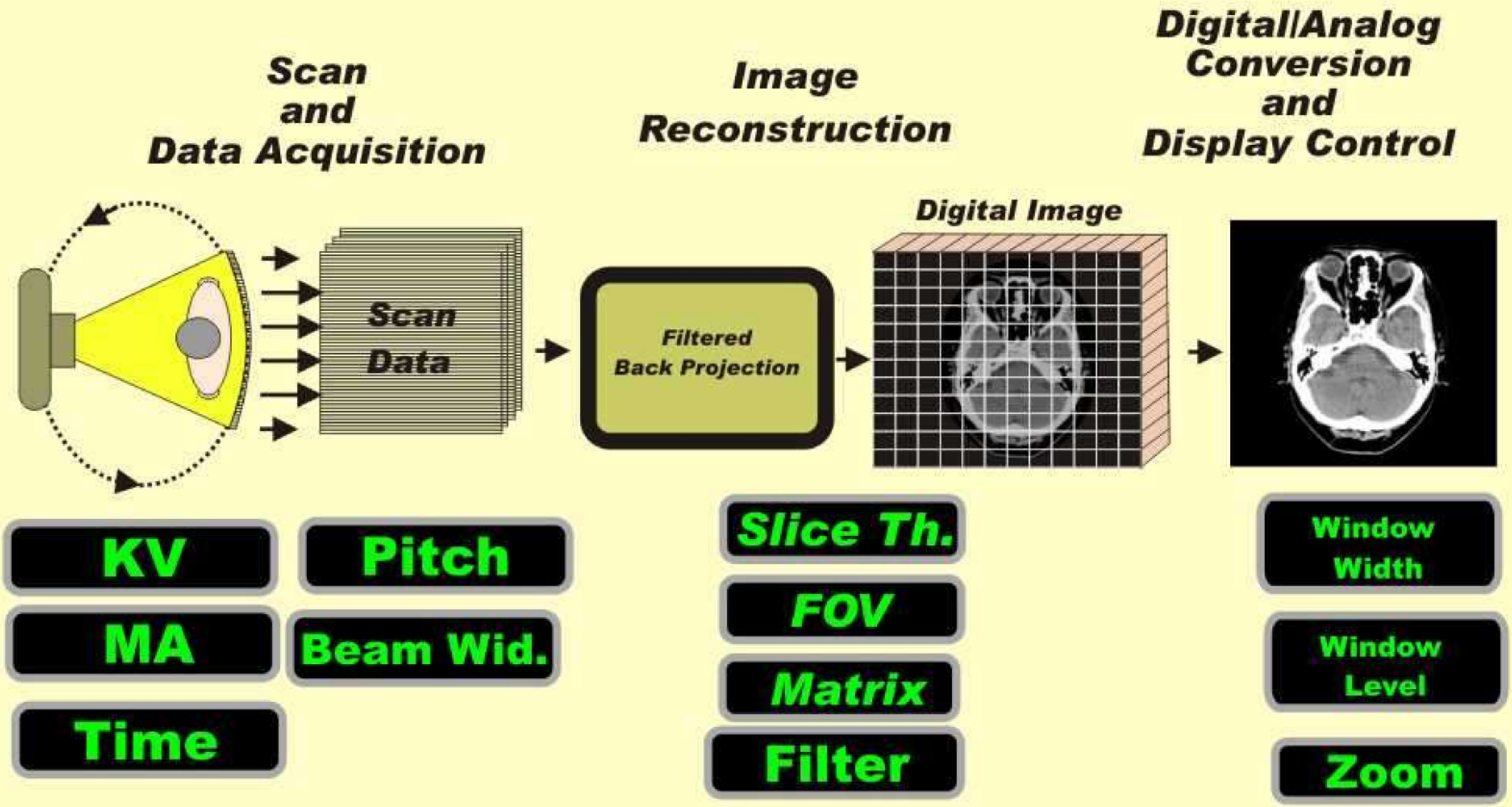


Draw Programs

Technology Tools

Bitmap Digital Images

The Three Phases of CT Image Formation



Major Protocol Factors

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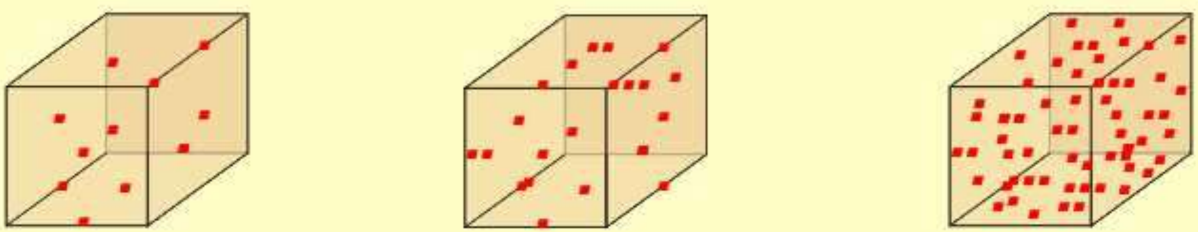
Decreasing Noise

Requires Increased Photons Absorbed Per Voxel



Produces Increasing Dose

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Technology Tools
Course Management

Technology Tools
Web Conferencing

WebEx

Use in “share desktop” mode.

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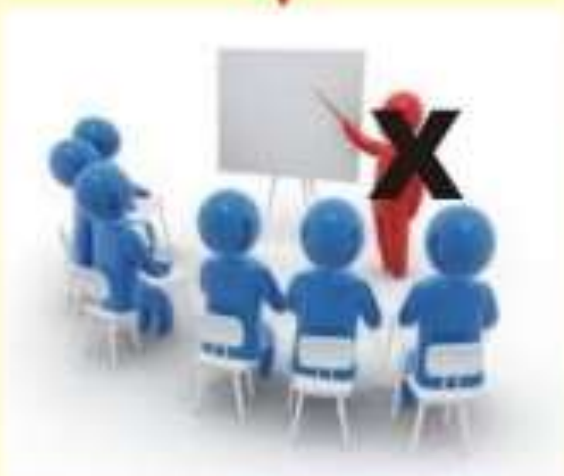
The Model

Online Courses

Modular Courses **MOOC**

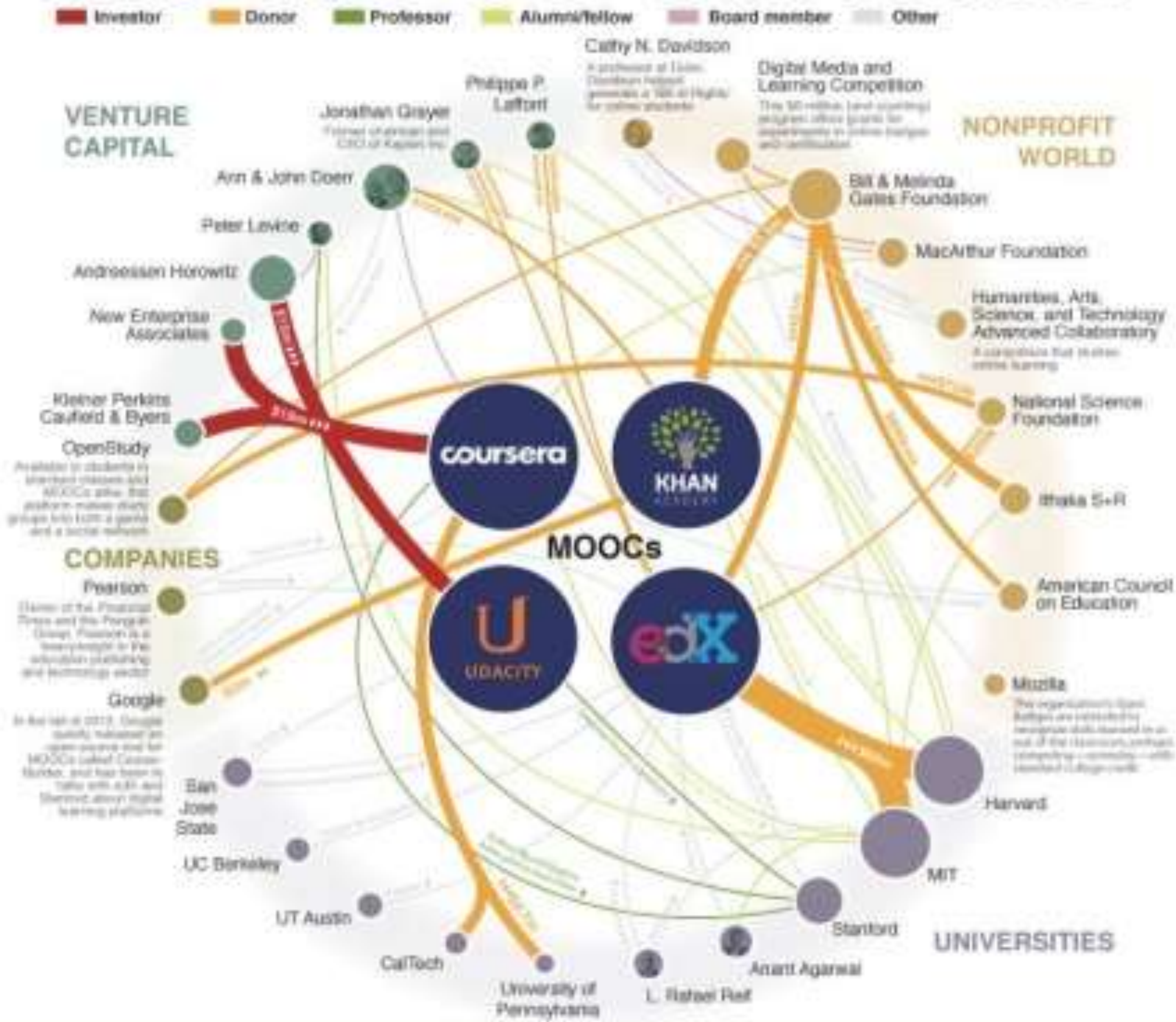


Reduce the need and opportunity for local faculty

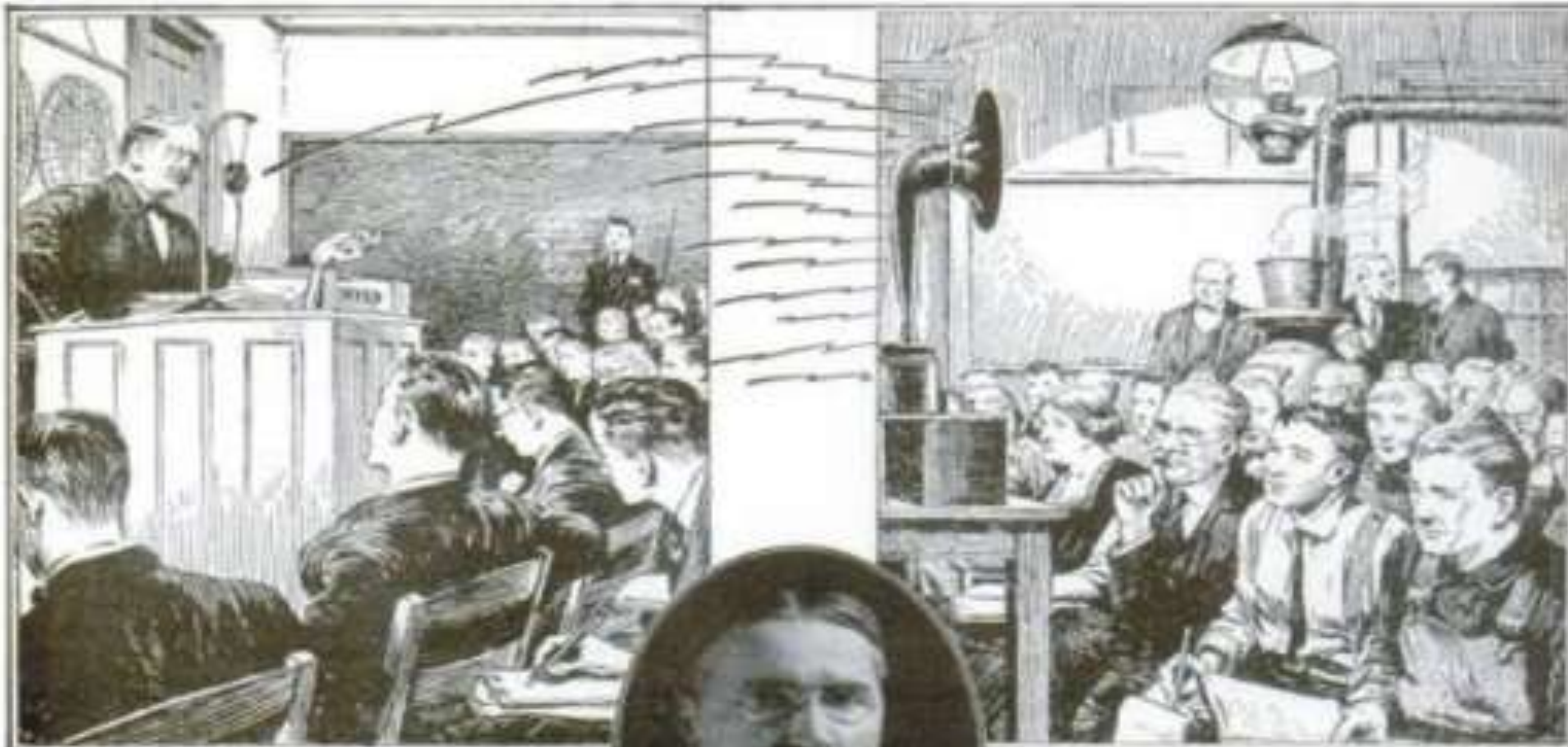
Local Universities

Sprawls

The MOOC Universe



Professor-Inventor Predicts "Radio Universities"



The "radio university" that Prof. Michael Pupin, of Columbia University, believes is sure to come with the further development of the loudspeaker. From the classroom where the university professor lectures to a group of his students—

Radio will carry a wealth of authoritative information and scientific knowledge to hundreds of town halls, factories, and firesides, offering a higher education to thousands of men and women to whom such training has hitherto been denied

Prof. Michael Pupin

Professor of physics; head of the Phoenix Research Laboratory at Columbia University, and inventor of the Pupin coil, which made possible transcontinental telephony

A COLLEGE education for every one who wants it.

A university in the home, in the factory and mill, and in the public hall.

An "aerial soapbox" for the forces of economic progress and right.

A complete course in practically any of the subjects now named in the college curriculum—for five dollars; an elementary course in those subjects for one dollar, and

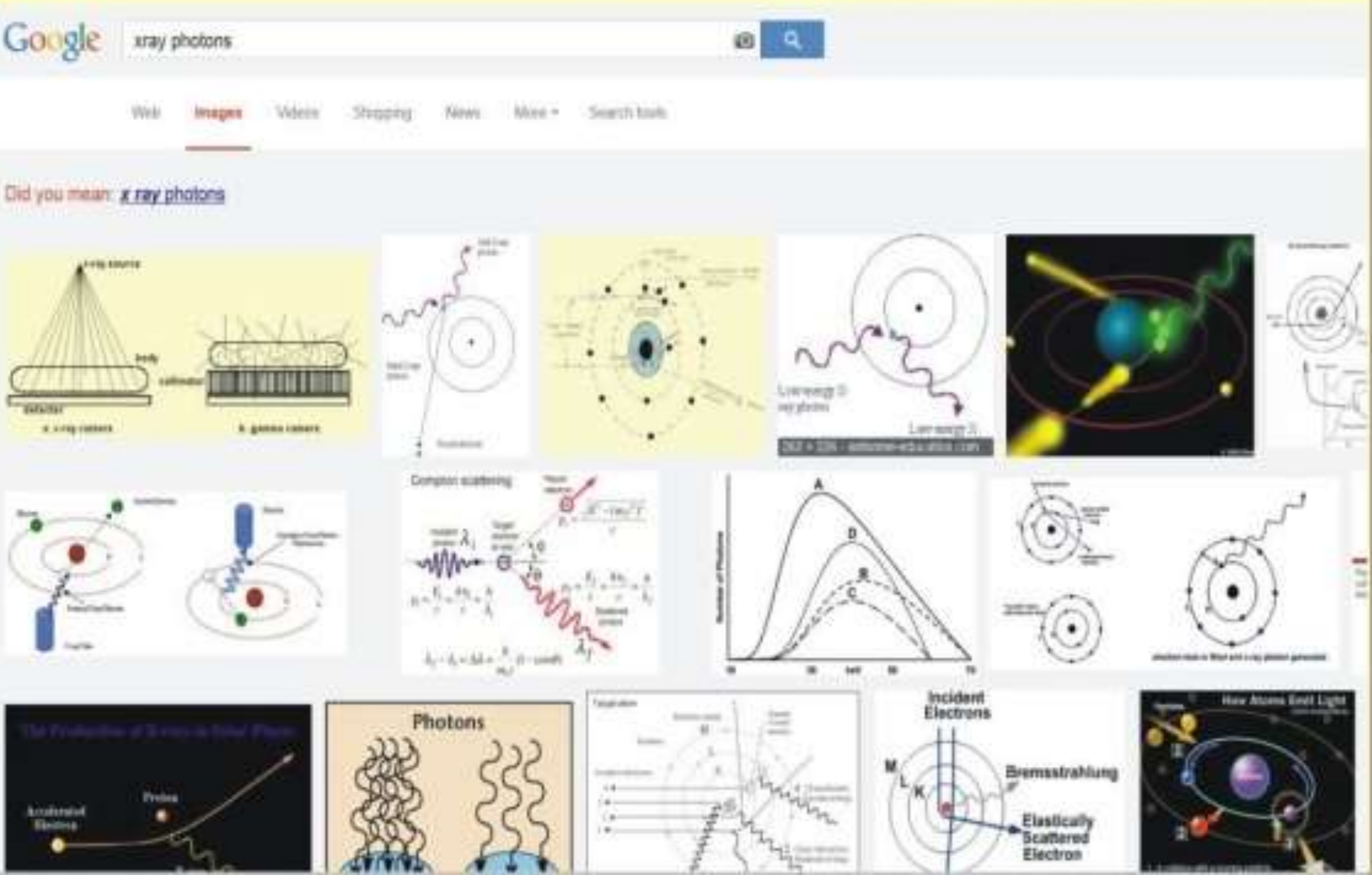
"In each of the 100 halls 1000 persons—100,000 persons in all—are receiving an education without even leaving the limits of their own neighborhoods!

"Such a picture represents, to my mind, what radio may mean soon as a broadcaster of useful knowledge and as a disseminator of vital information.

"Go a step further. Enter a factory or mill of the future. It is lunchtime and,

Open Courseware

Google Images



Google Images

The Collaborative Teaching Model

Online Resources

Modules Books Visuals

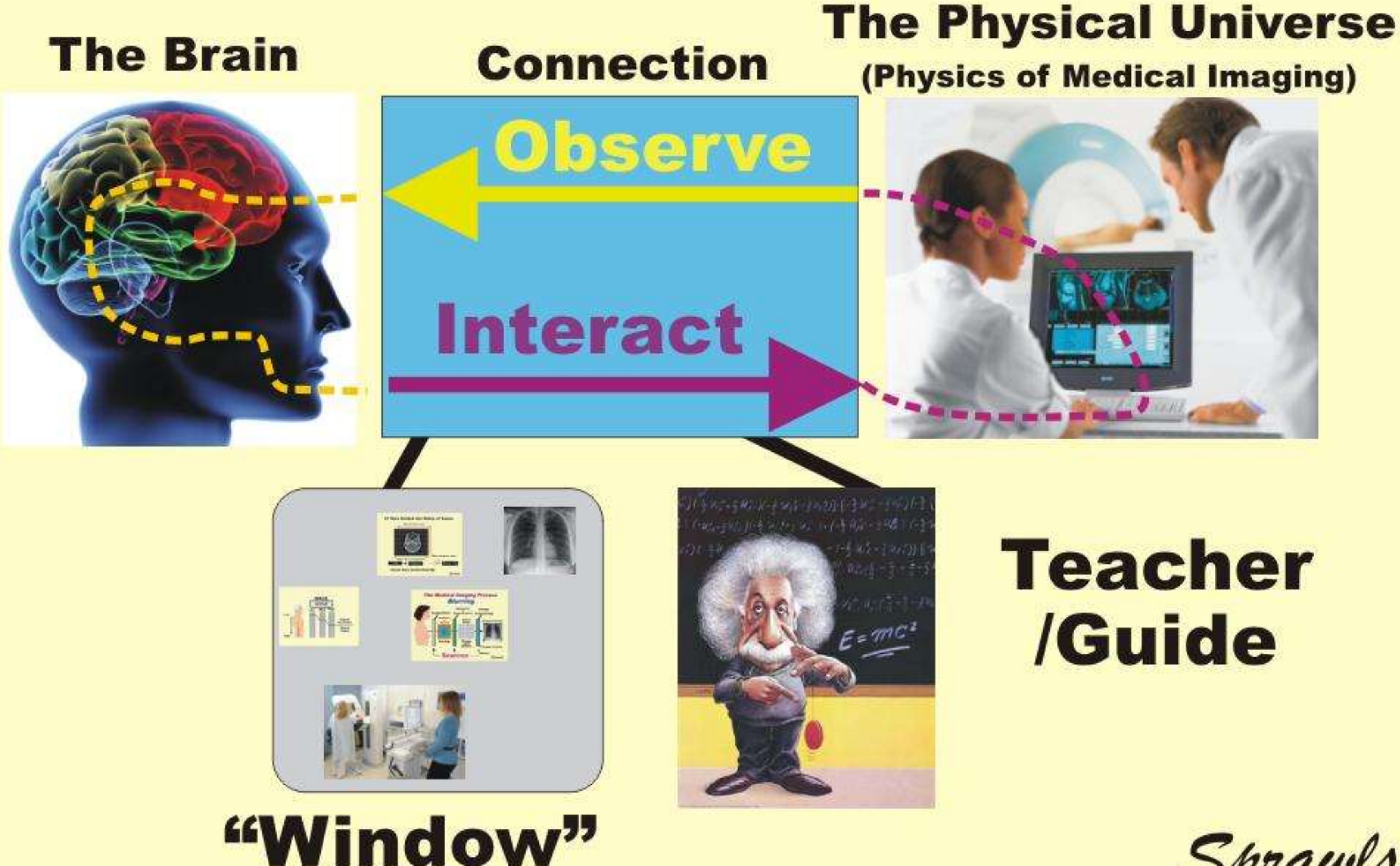
Enhance the performance of physics faculty

Knowledge
Experience
Guidance
Role Model

Local Universities

Sprawls

The Elements of A Highly Effective Educational Session



Sprawls

The Collaborative Teaching Model

Sprawls Online Resources

Modules Books Visuals

Enhance the performance of physics faculty

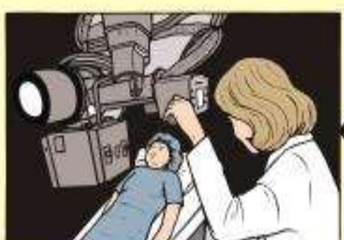
Residents & Radiologists

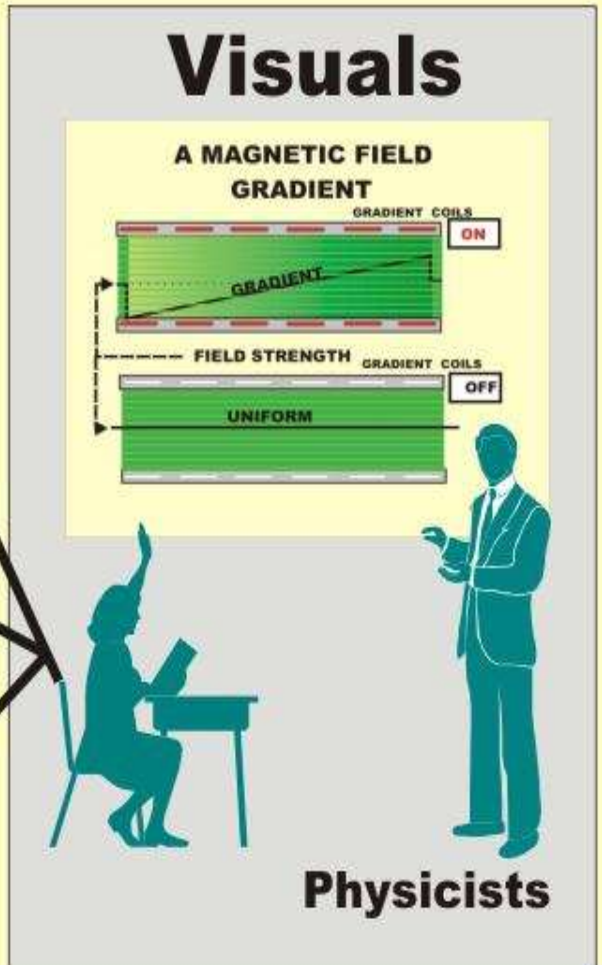
Local Universities

Sprawls

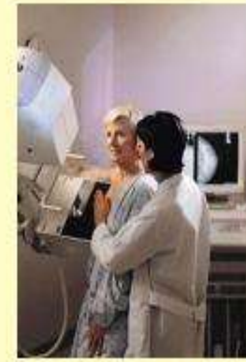
WINDOW or BARRIER

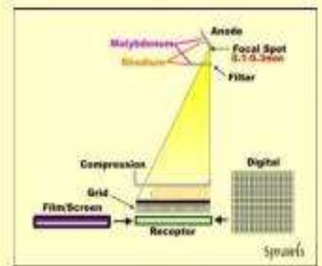
THE LEARNERS

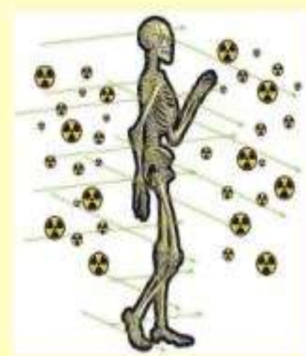


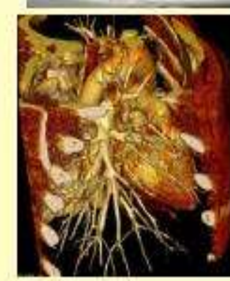


PHYSICAL UNIVERSE









Sprawls

Visuals
to be used by
Physicists in Classroom and Conference Discussions

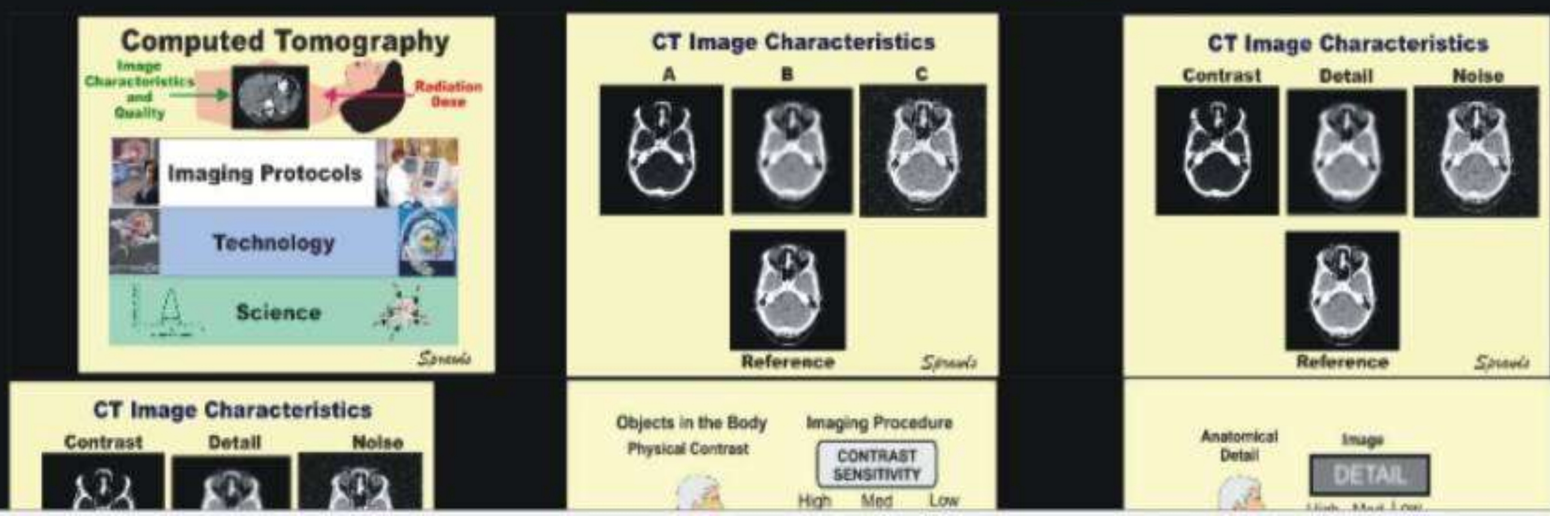
SPRAWLS EDUCATIONAL FOUNDATION
Open Resources
for
Learning and Teaching
The Physical Principles of Medical Imaging

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

Effective Medical Imaging Physics Learning
...In The Clinic

The Real World Motivating Interactive Collaborative

The Physicist Provides:
Learning Modules & Collaboration

Sprawls

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

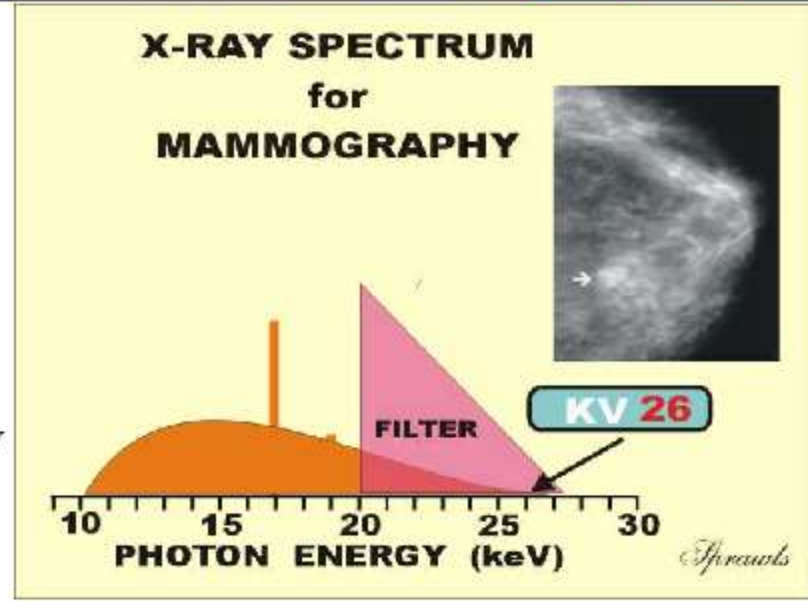
Edit View History Bookmarks Tools Help

The Physics and Technology of M...

KV Values for Mammography

BACK NEXT

e x-ray beam spectrum is one of the most critical factors that must be justed to optimize a procedure with respect to contrast sensitivity and dose.

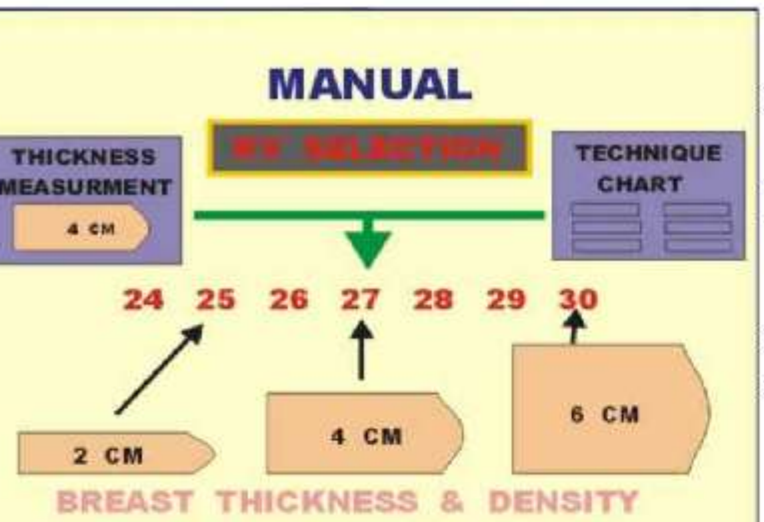


e can think of it as a three-step procedure:

1. Select the appropriate anode (moly or rhodium)
2. Select the appropriate filter (moly or rhodium)
3. Select the appropriate KV (In the range 24 kV to 32 kV)

reasing the KV has two effects on the x-ray beam. It increases the efficiency d output for a specific MAS value and it shifts the photon energy spectrum ward so that the beam becomes more penetrating.

nile a more penetrating beam does reduce contrast sensitivity it is necessary nen imaging thicker and more dense breast. Therefore compressed breast thickness is the principal factor that determines the optimum V.

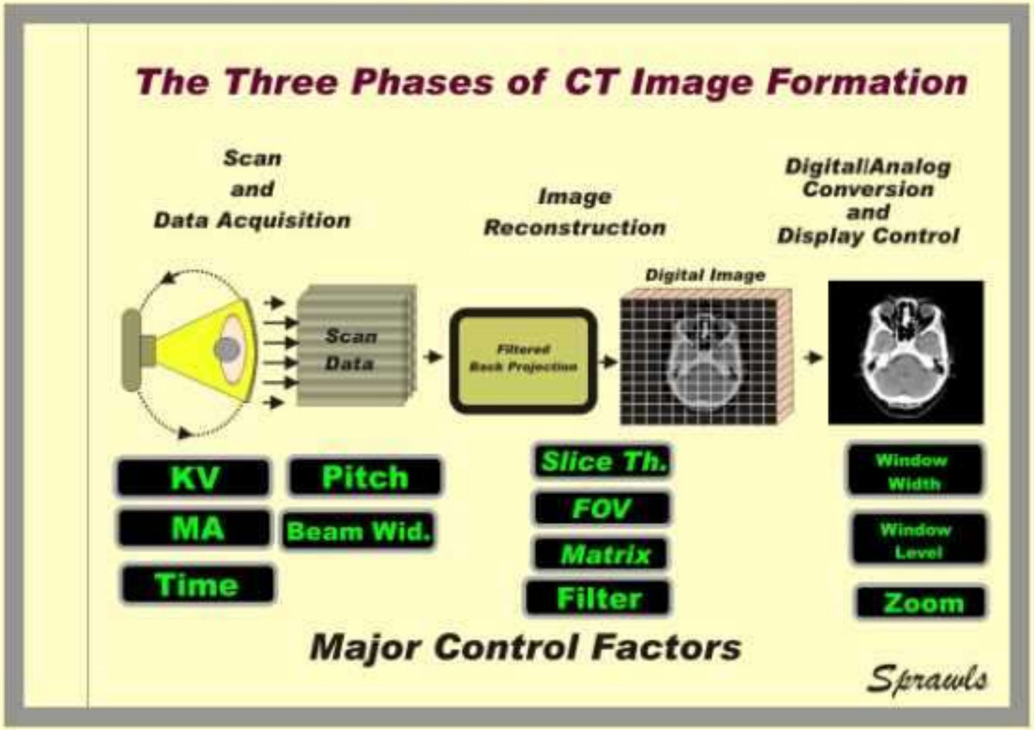


Mammography systems have indicators that display the thickness of the compressed breast. This along with a general assessment of breast density is used to manually select an optimum KV either from experience or an established technique chart.

The general goal is to increase the KV as necessary to keep the exposure time, MAS, and dose to the breast within reasonable limits as breast thickness increases.

Visuals for Learning and Teaching

The Imaging Process



Clinical Images

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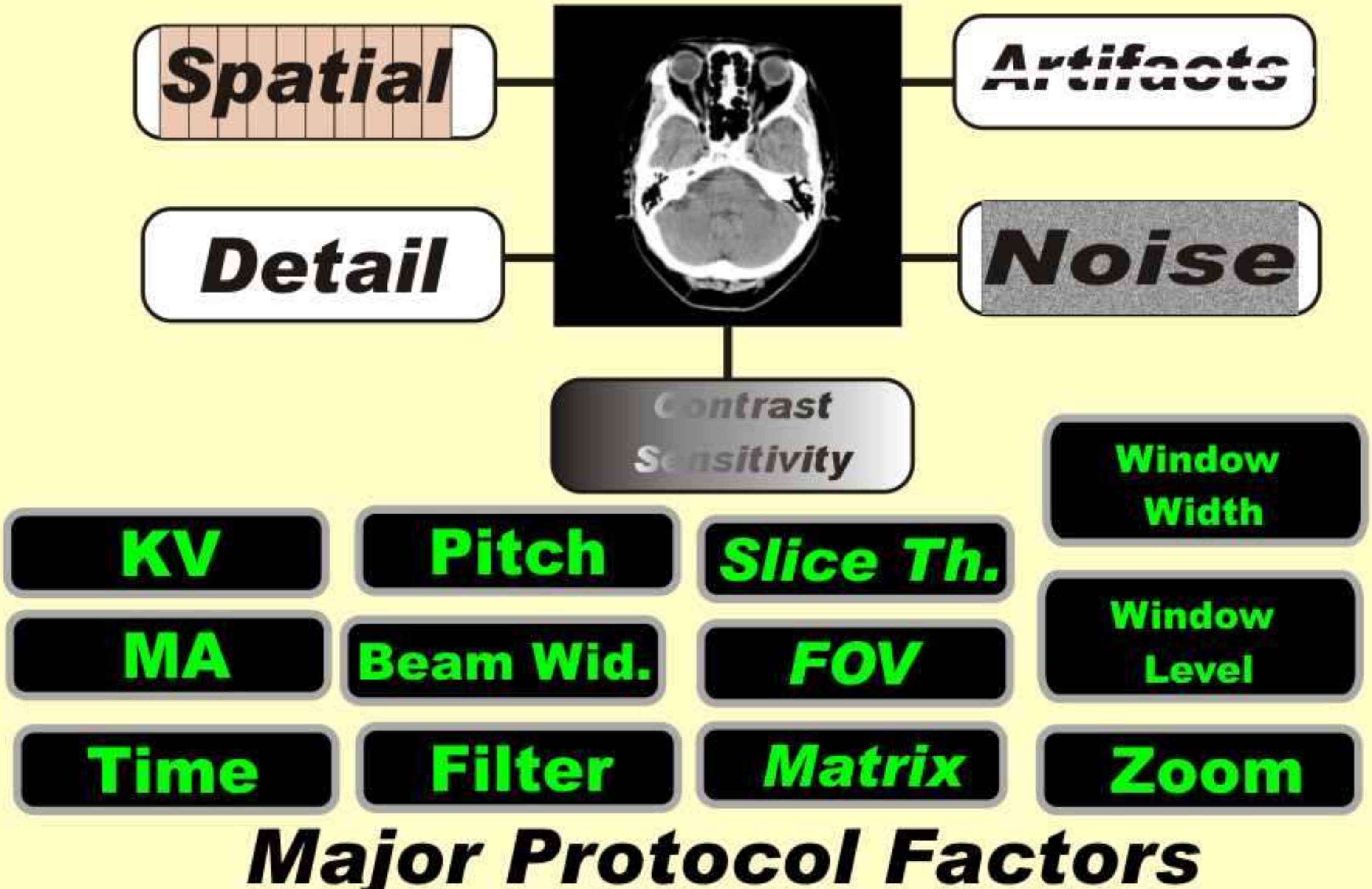
CT Image Characteristics



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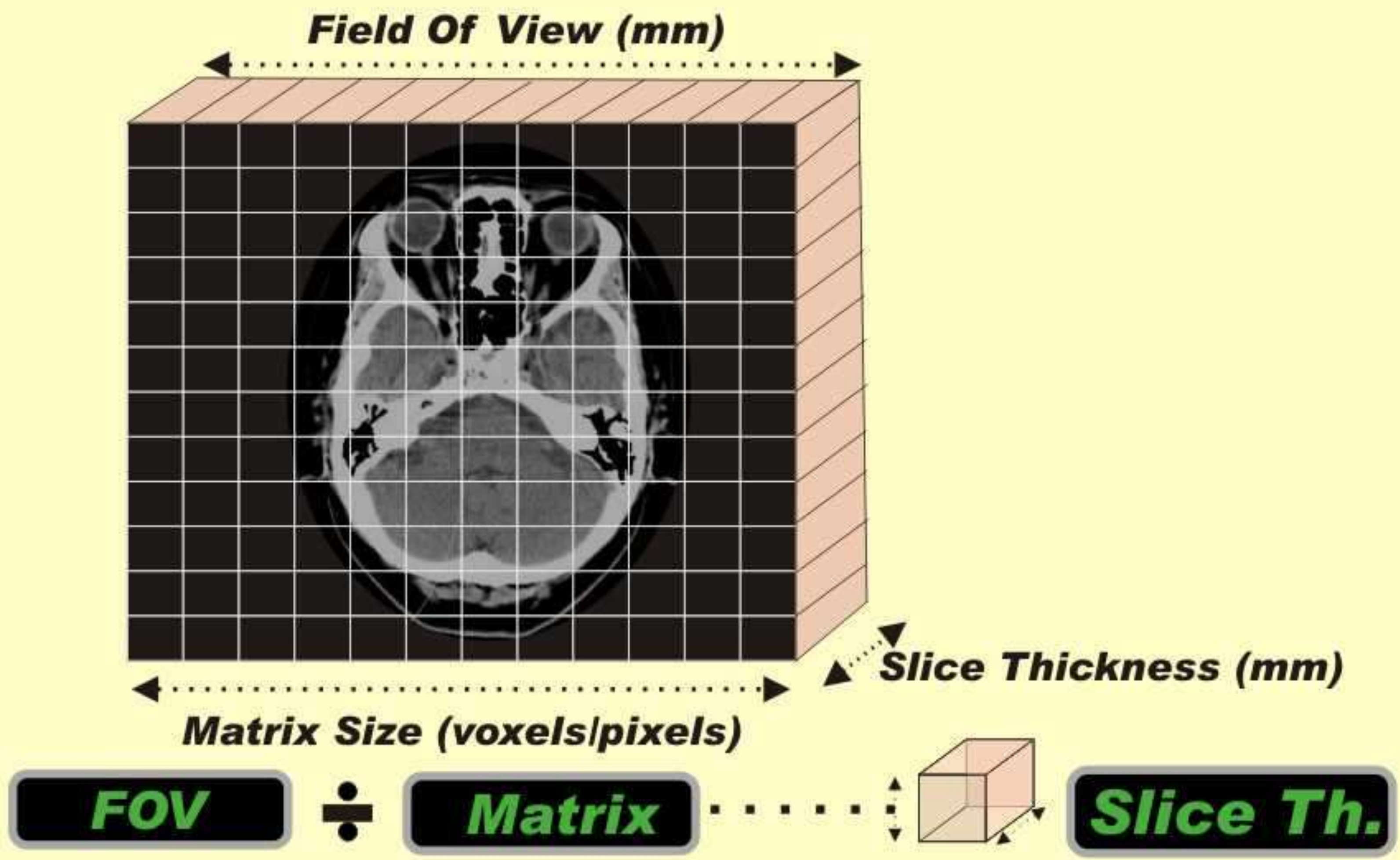
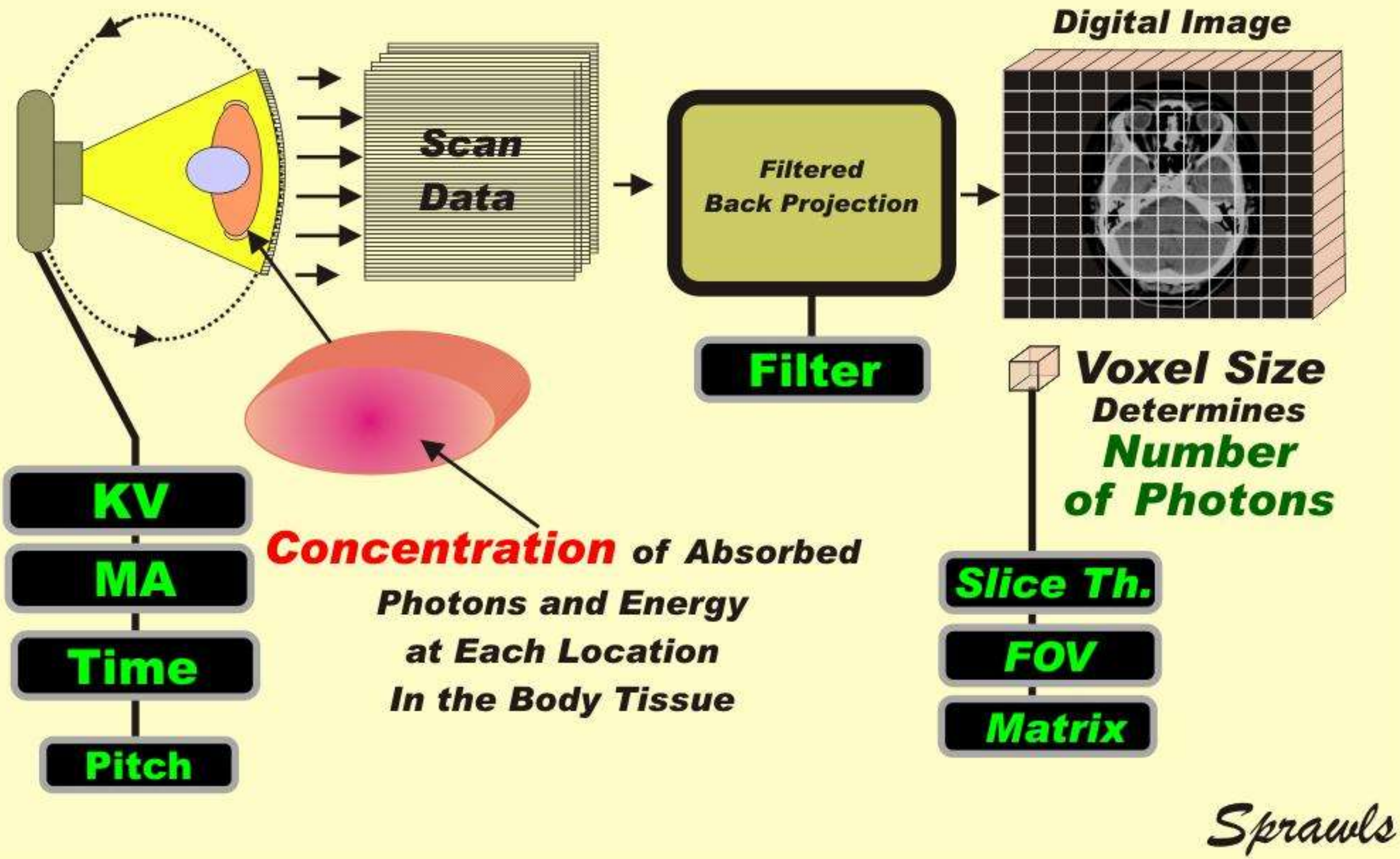
CT Slice Divided into Matrix of Voxels



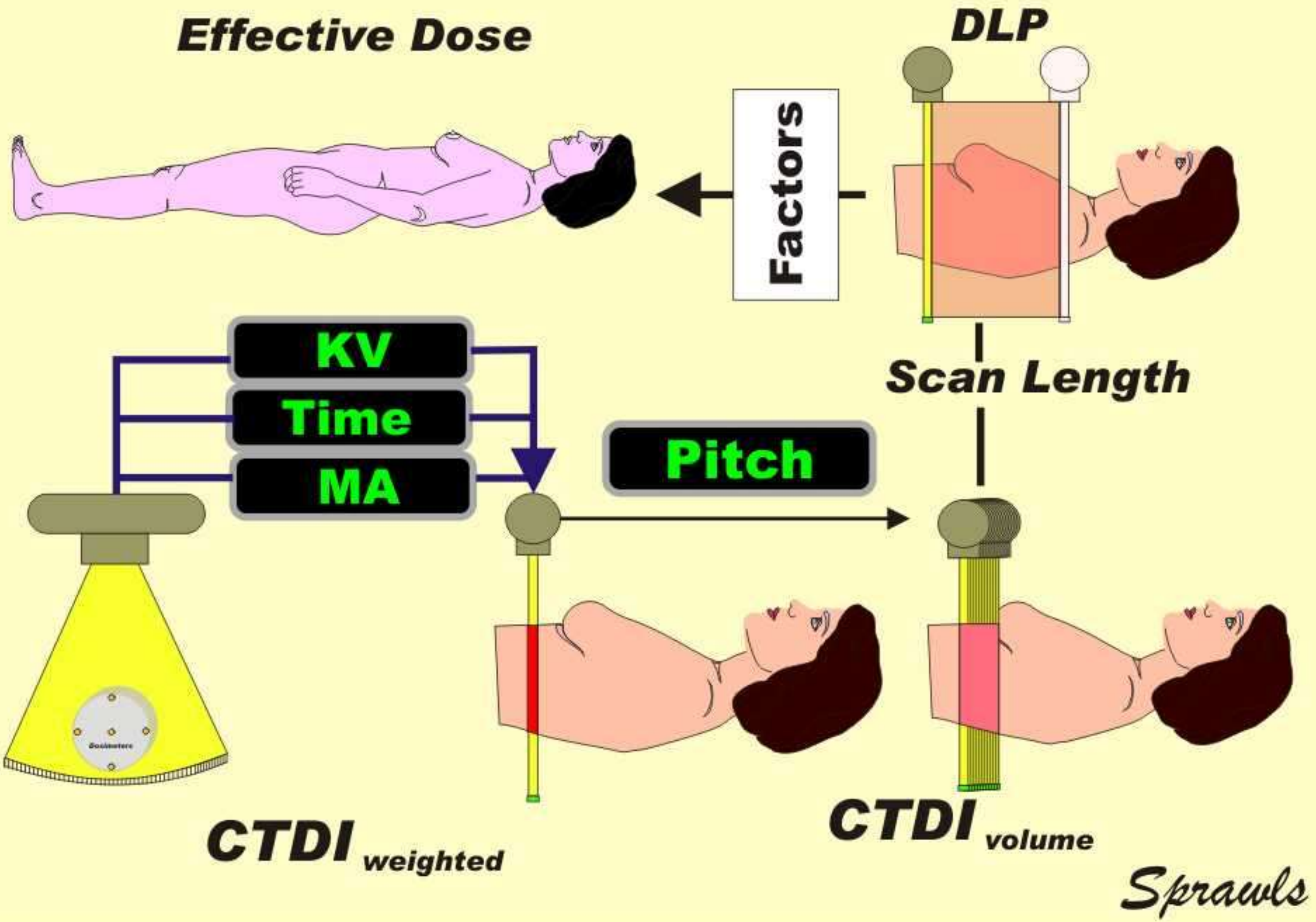
Voxel Size Controlled By

Sprawls

Factors That Determine Image Noise

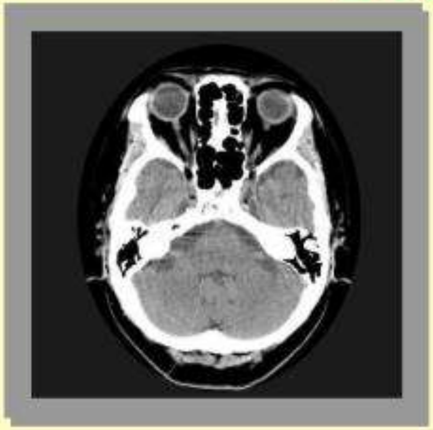


CT Dose Quantities

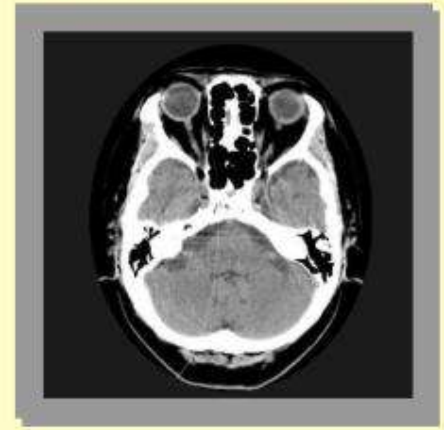


Relationship of Radiation Dose to Image Detail

Lower Dose



Higher Dose



When detail is increased by

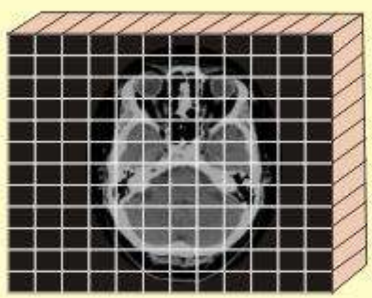
Decreasing Slice Th.

Increasing Matrix

Decreasing FOV

Noise Increases

Because of decreased voxel size



Dose must be **increased** to **reduce noise.**

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The Sprawls Resources

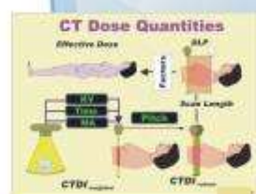
Sharing the Emory Experience with the World
With Emphasis on the Developing Countries

Emory

www.sprawls.org/resources

Open Access

Educational Resources

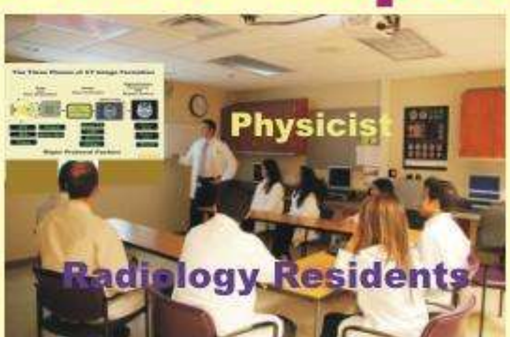


Visuals

Books

Modules

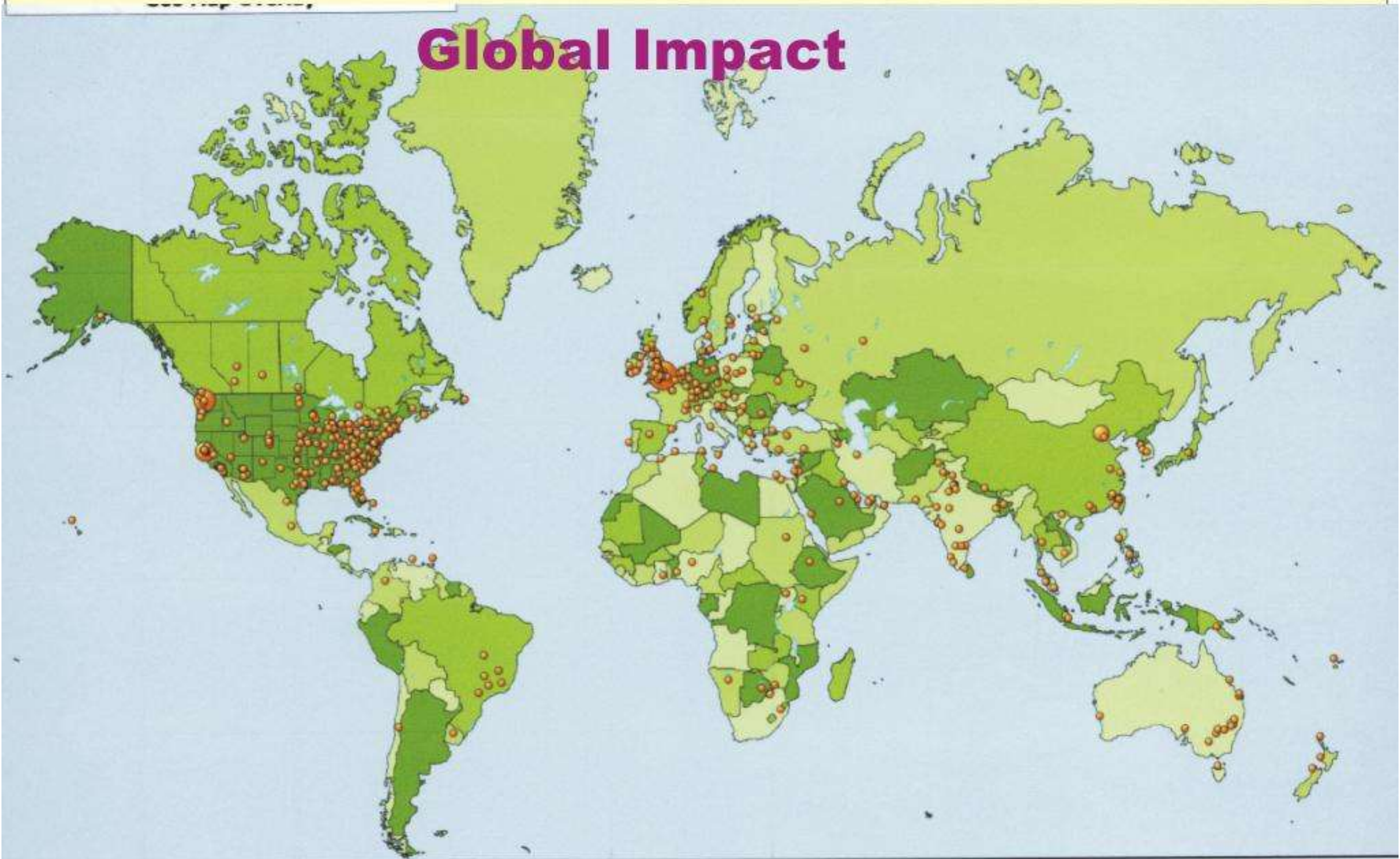
Global Impact



Enhancing Radiology Education in Every Country of the World

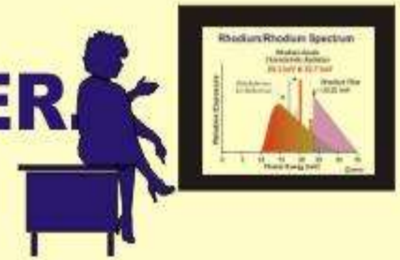
The Sprawls Resources

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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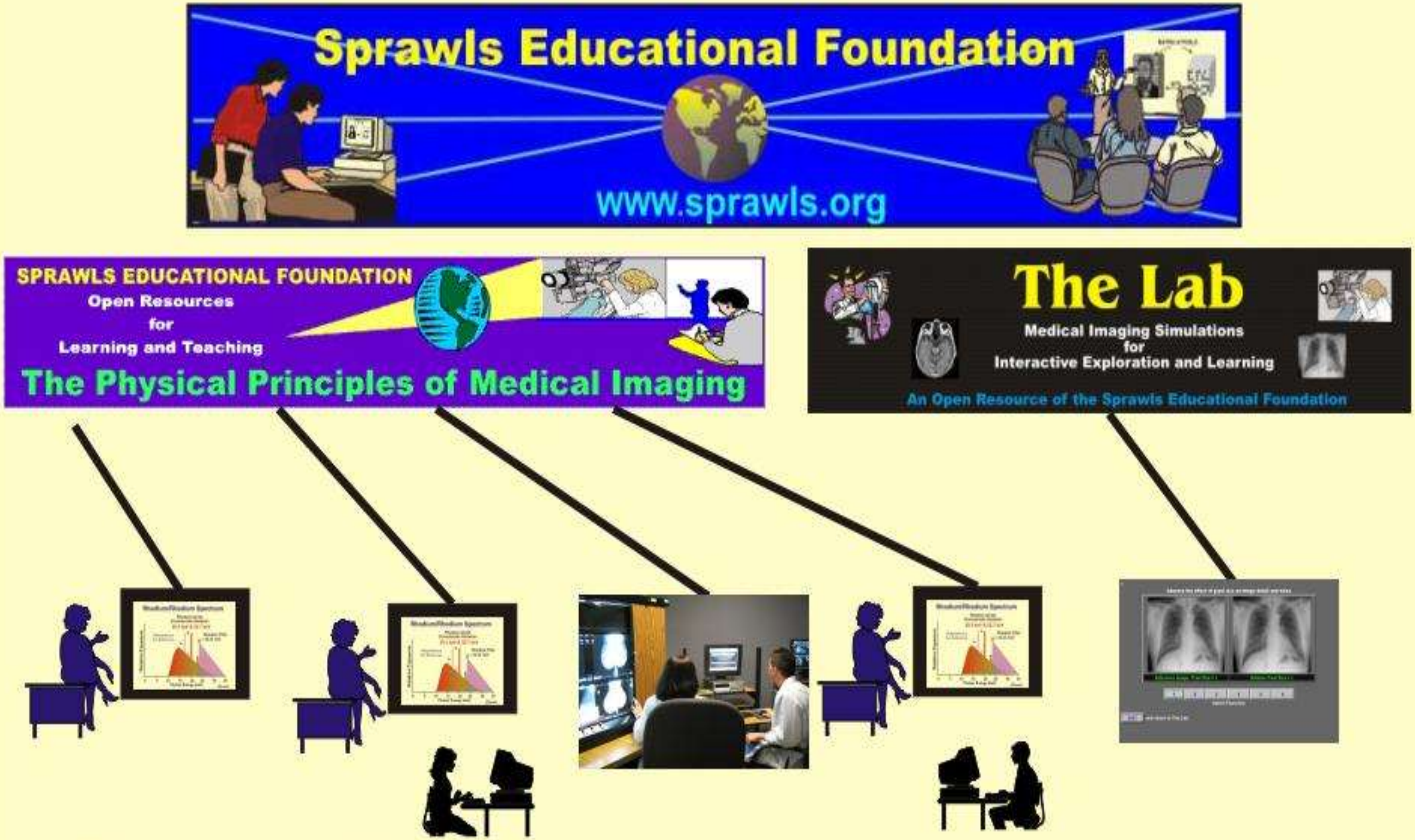


In **Partnership** with Other Medical Physics Teachers

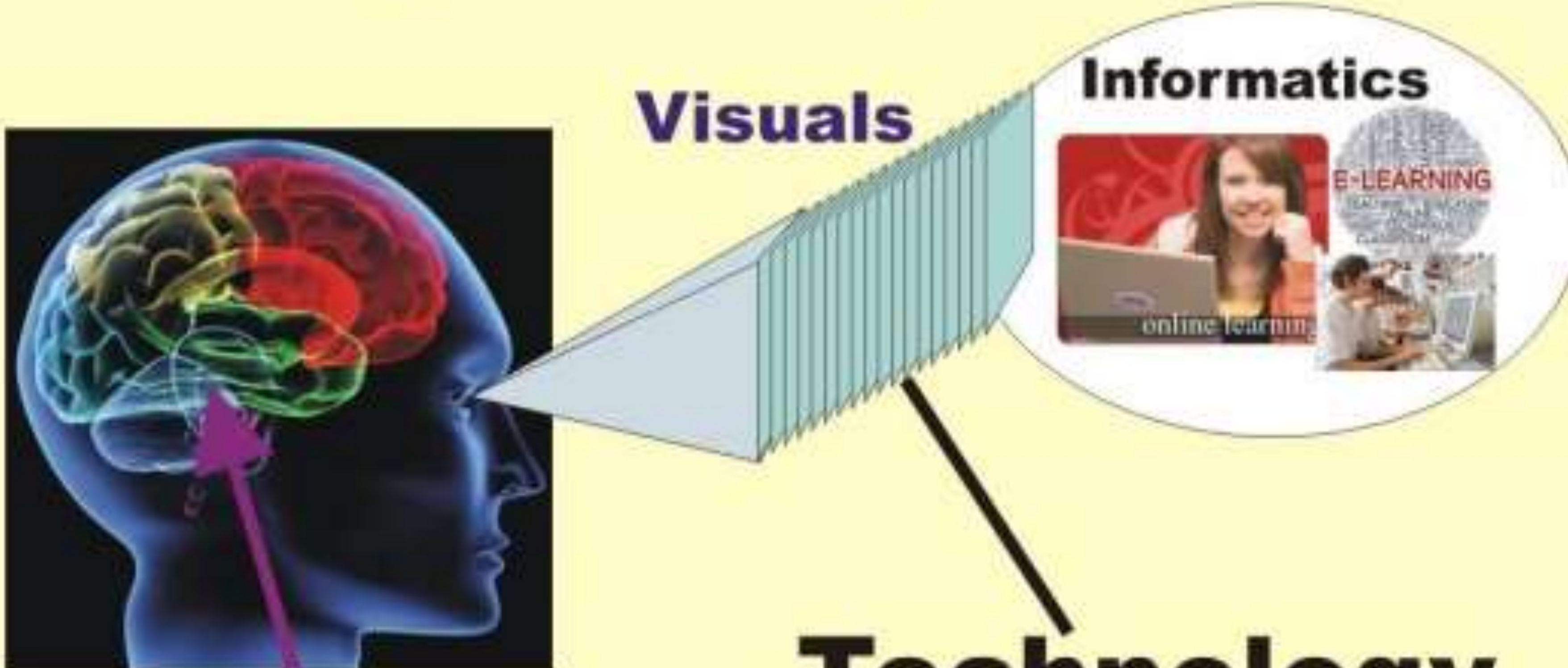
to be More **Effective** and **Efficient** in Providing

Medical Imaging Education

Conclusion

In This Session

Building Knowledge Structures



Technology

Human
(Teacher)

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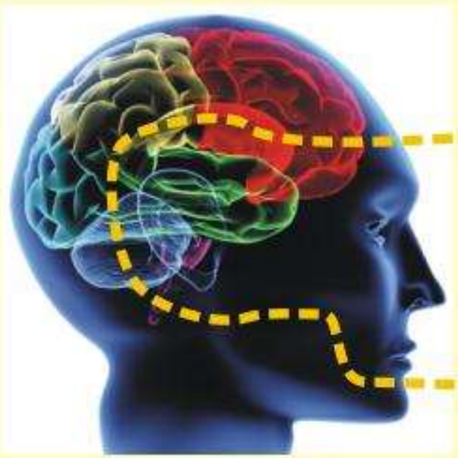
The Elements of
A Highly Effective Educational Session

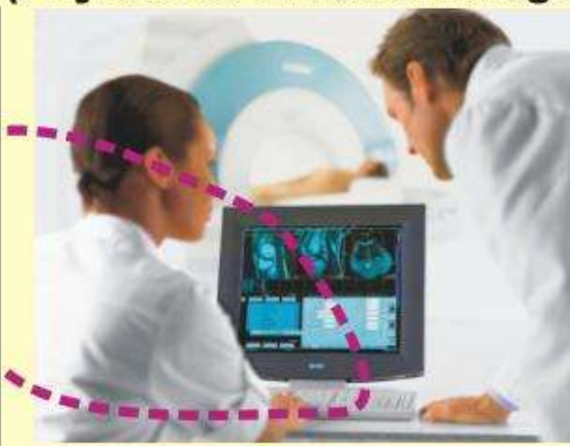
The Brain



Follow Up

- **R**eview
- **R**efresh
- **R**eflect
- **R**ecall
- **R**emember
- **R**e-inforce

The Physical Universe
(Physics of Medical Imaging)



Web-based Resources
(www.sprawls.org/ipad)

Sprawls

Conclusion

After This Session

Enhancing Knowledge Structures

Review
&
Refresh

Technology

Create

Sprawls

Sprawls References for Additional Viewing

AAPM Virtual Library Presentations

1. The Elements of a Highly Effective Educational Session
2. Medical Physics and Technology Education for Society: Adults, Teenagers, and Elementary Students
3. Effective Medical Imaging Physics Education
4. Clinically Focused Physics Education
5. Education Council Symposium - Effective Use of Web-Based Resources to Enrich Classroom and Collaborative Learning Activities
6. Models and Resources for Intergrated Teaching and Learning of Medical Imaging Physics and Technology
7. Radiology Resident Education: A Resource Model for Integrated Learning

Published in Medical Physics International (www.mpijournal.org)

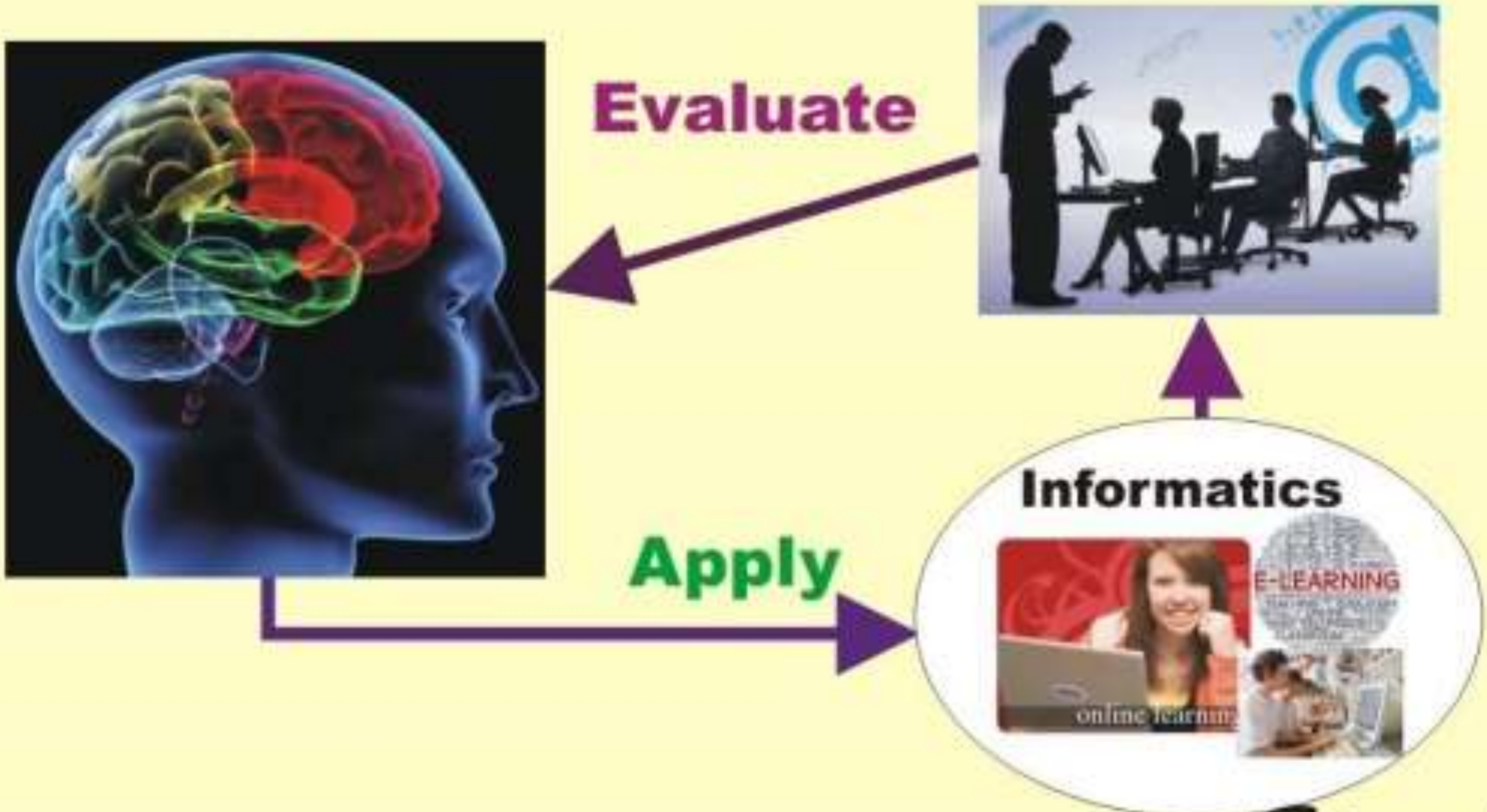
PHYSICS EDUCATION FOR THE OPTIMIZATION OF MRI CLINICAL PROCEDURES: VISUALIZING THE INVISIBLE AND COLLABORATIVE TEACHING

EFFECTIVE PHYSICS EDUCATION FOR OPTIMIZING CT IMAGE QUALITY AND DOSE MANAGEMENT WITH OPEN ACCESS RESOURCES

Conclusion

Using Knowledge For

More Effective & Efficient Learning Activities



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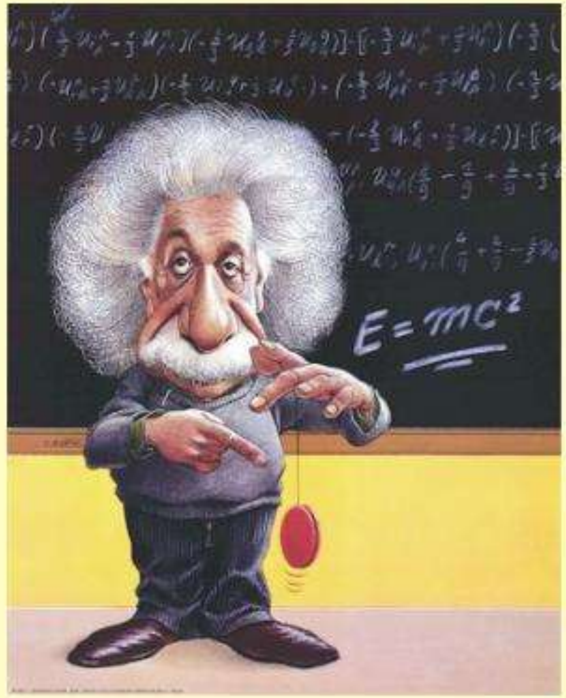
The Physicist as an Educator and Teacher

Our Objectives

Provide more EFFECTIVE learning activities.



Be EFFICIENT in our teaching

Challenges Opportunities

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Informatics for Medical Physics Education

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&
Sprawls Educational Foundation
www.sprawls.org

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