Developing Rich Learning Experiences for Medical Physics Education

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and
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Xhttp://www.sprawls.org

This Course Web Site
http://www.sprawls.org/learning
WELCOME TO EMORY
My name is Perry Sprawls
I am your teacher
LEARNING IS A NATURAL PROCESS
ENCOUNTER and EXPERIENCE
Learning is....

Building knowledge structures in the brain

Image: UCDavis
Learning Physics is by.. Encounter and Experience

Physical Universe  Brain

Images: BYU and Howstuff works
The Brain...

Structure and Function

Image: AMA
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:

The Art of Changing the Brain
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

- Active testing
- Premotor and motor
- Sensory and postsensory
- Temporal integrative cortex
- Reflective observation
- Concrete experience
- Abstract hypotheses
- Frontal integrative cortex
Brain Functions for Learning Physics

Control

Sensory
Back Integrative Cortex
- Where (Relationships)
- What (Characteristics)
- Language (Identification)

Motor
Frontal Integrative Cortex
- Making Plans
- Evaluating
- Problem Solving
- Language
- Assembly

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

Emotions

Frontal Integrative Cortex

Preparation for the Future
Doing

Motor

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
Forming Knowledge Structures

Physical Universe

Sensory

Back Integrative Cortex

Visible Physical Objects

Sprawls
Forming Knowledge Structures

Physical Universe

Visible Physical Objects

Sensory

Back Integrative Cortex

Sprawls
THE LEARNERS

WINDOW

or

BARRIER

PHYSICAL UNIVERSE
THE LEARNERS
or
BARRIER

WINDOW

PHYSICAL UNIVERSE

Distance
Availability
Time
Cost

Sprawls
Forming Knowledge Structures

Physical Universe

Radiation
Electrons
Magnetic
Atomic
Nuclear

Sensory

Back Integrative Cortex

Invisible Physical Objects

Sprawls
Forming Knowledge Structures

Physical Universe

Radiation
Electrons
Magnetic
Atomic
Nuclear

Invisible

Physical Objects

Sensory

Back Integrative Cortex

 BINDING ENERGY

33 keV
IODINE

Sprawls
Forming Knowledge Structures

Visual

Verbal and Symbolic

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:

\[
I = \frac{3P}{4\pi r^2}
\]

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

\[
I \sim \frac{1}{r^2}
\]
EFFECTIVE TEACHING
Requires....

TEACHER
to
GUIDE
and
EXPLAIN

Visual Representation of Reality (Media)
Interactive Group Learning Activity
(Classroom, Conference, Small Group)

Representation of Reality

Guide (Teacher)
Engage
Motivate
Provide Structure and Organization

Learners

Computed Tomography Quality Characteristics

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A MAGNETIC FIELD GRADIENT

GRADIENT COILS

ON

FIELD STRENGTH

GRADIENT COILS

OFF

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

**Spiral Scan**

- **Continuous**
- Distance per Revolution
- **Pitch** = \( \frac{D}{W} \) 
- Beam Width
Visibility of Low Contrast Anatomy Limited By

- **X-Ray Beam**
  - Receptor Exposure

- **Noise**
  - Electronic
  - Receptor/Display Structure

- **Reduced By**
  - Digital Processing
  - Blur (Pixel Size)
Forming Knowledge Structures

Physical Universe

NMR

Process

Back Integrative Cortex

Sensory

RF PULSE

MAGNETIC FIELD

LONGITUDINAL TRANSVERSE

NUCLEI

H-1 IS 42.56 MHz/T

MOLECULE STRUCTURE

FIELD STRENGTH

NUCLEID

ISOTOPIC ABUNDANCE

TISSUE CONCENTRATION

H-1 HAS HIGH RELATIVE SENSITIVITY

USED FOR SPECTROSCOPY

USED TO SUPPRESS FAT SIGNALS

CAN PRODUCE ARTIFACTS

IMAGE OF PROTONS (HYDROGEN)

RF SIGNAL

STRENGTH DETERMINED BY

SPINNING

Elements and Relationships

Visuals

Mindmaps

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Mind Map of the NMR Process

MAGNETIC FIELD
- LONGITUDINAL
- TRANSVERSE

RF SIGNAL STRENGTH DETERMINED BY

MAGNETIC NUCLEI
- SPIN

RF PULSE

MOLecule STRUCTURE
- CHEMICAL SHIFT

 Behavioral
- FIELD STRENGTH

NUCLEIDE
- ISOTOPIC ABUNDANCE
- TISSUE CONCENTRATION

IMAGE OF PROTONS (HYDROGEN)
- H-1 HAS HIGH RELATIVE SENSITIVITY
- H-1 IS 42.58 MHz/T

*USED FOR SPECTROSCOPY
*USED TO SUPPRESS FAT SIGNALS
*CAN PRODUCE ARTIFACTS

Spawrlls
IMAGE QUALITY CHARACTERISTICS

THAT AFFECT VISIBILITY

- Spatial
- Spatial
- Spatial
- Detail (blurring)
- Artifacts
- Noise
- Contrast sensitivity
COMPUTED TOMOGRAPHY QUALITY CHARACTERISTICS

SPATIAL SPATIAL SPATIAL

ARTIFACTS

DETAIL (BLurring)

CONTRAST SENSITIVITY

NOISE

PROTOCOL FACTORS

SLICE TH.

MAS

Matrix

OPERATION
Forming Knowledge Structures

Physical Universe

Inverse Square Effect

Back Integrative Cortex

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:

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Verbal and Symbolic

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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
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.
Gagne’s Hierarchy of Learning

- Problem Solving
- Rule Learning
- Concept Learning
- Discrimination Learning
- Verbal Association
- Chaining
- Stimulus Response
- Signal Learning
Edgar Dale (1900-1985)
Educationalist who developed the famous Cone of Experience theory
Cone of Experience for Medical Imaging Education

- Verbal
- Symbols
- Equations
- Sketches
- Visuals (Clinical Images and Graphics)
- Visuals (With Expert Guidance)
- Simulation
- Physical Reality
Technology Enhanced Learning and Teaching

Experience Learning Level

- Physical Reality
- Simulation
- Visuals with Expert Guidance
- Sketches
- Symbols and Equations
- Verbal
Zull’s Model of Brain Function

Active testing → Premotor and motor → Sensory and postsensory → Concrete experience

Abstract hypotheses ← Frontal integrative cortex ← Temporal integrative cortex ← Reflective observation
Brain Functions for Learning Physics
Active Experimentation and Testing

Control

Back Integrative Cortex
Records of the Past
Knowing Reflection

Frontal Integrative Cortex
Preparation for the Future
Doing Hypotheses

Sense and Experience
Observe

Interact and Affect

Physical Universe

Sprawls
Brain Functions for Learning Physics
Active Experimentation and Testing

Control

Emotions

Records of the Past
Knowing Reflection

Preparation for the Future
Doing Hypotheses

Sensory

Motor

Sense and Experience
Observe

Interact and Affect

Physical Universe
The Learning Environment

Control

Sensory

Back Integrative Cortex

Records of the Past

Knowing Reflection

Frontal Integrative Cortex

Preparation for the Future

Doing Hypotheses

Emotions

Motor

Sprawls
Challenging Learning Environments

Control

Sensory

Back Integrative Cortex

Records of the Past

Knowing Reflection

Emotions

Frontal Integrative Cortex

Preparation for the Future

Doing Hypotheses

Motor

Sprawls
Rich Learning Environments

Control

Sensory

Back Integrative Cortex

Records of the Past
Knowing Reflection

Frontal Integrative Cortex

Preparation for the Future
Doing Hypotheses

Emotions

Sprawls
Brain Functions for Learning Physics

Motivation

Interest

Organization

Emotions

Control

Sensory

Back Integrative Cortex

Records of the Past

Knowing Reflection

Frontal Integrative Cortex

Preparation for the Future

Doing Hypotheses

Hate

Joy

Sprawls
Interactive Group Learning Activity
(Classroom, Conference, Small Group)

Representation of Reality

Guide (Teacher)
Engage
Motivate
Provide Structure and Organization

Learners
Why:
1. Is Medical Imaging Physics Education Changing?
2. Do we have Evolving Models?

Educational Capabilities

Educational Needs

1958

2008

Technology

Scope
And Complexity
Of Medical Imaging Technology and Procedures
Digital Technology

Tools for:

Developing High Quality Educational Resources

Organizing and Managing Resources

Distributing and Sharing Resources
Enriched Learning Environments

Learners

Learning Facilitators

Scientists with Experience

Digital Shared Resources

The Physical Universe

Sprawls
Technology Enhanced Learning

Learning Guide

Learner

COMPTON SCATTER INTERACTIONS

X-RAY PHOTON

ENERGY

WEAK

NUCLEUS

Visuals for Classroom

Notes and Text

Online Resources

Sprawls
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.
Interactive Group Learning Activity
(Classroom, Conference, Small Group)

Representation of Reality

Guide (Teacher)
Engage
Motivate

Provide Structure and Organization

Learners
Brain Functions for Learning About Learning Physics

Control
- Sensory
- Back Integrative Cortex
  - Records of the Past
  - Knowing
  - Reflection
- Frontal Integrative Cortex
  - Preparation for the Future
  - Doing
  - Hypotheses
- Motor

Emotions

Interact and Affect

Sense and Experience Observe

Our Teaching

Sprawls
Developing Rich Learning Experiences for Medical Physics Education

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