NSF WORKSHOP

Development and Application of Online Medical Imaging Education

Sponsored by NSF Grant DUE1022750
Principal Investigator: Weizhao Zhao, Ph.D.

College of Engineering, University of Miami
1251 Memorial Drive, Coral Gables, FL 33146

August 16th, 2013

NSF 1022750 National Workshop

McArthur-Annex Building, Room 202
College of Engineering, University of Miami
1251 Memorial Drive, Coral Gables, FL 33146

August 16th, 2013 (8:30 am – 5:00 pm)

Final Program

8:00am	Breakfast
8:30 am	Registration, Introduction, Picture
9:00 am	Invited Presentation: Web-Based Interactive Computer Simulation and Animation for Engineering Education, Ning Fang, Utah State University
9:30 am	Medical Imaging Education by Online Animation and Simulation, Weizhao Zhao, University of Miami
10:00 am	Medical Imaging Teaching Software: Ultrasound Imaging and Image Processing, Ricardo Castellanos, Diego Pava, Nurgun Erdol and William Rhodes, Florida Atlantic University
10:20 am	Web Based Interactive Medical Imaging Application for Teaching Nuclear Medicine, Senait Debebe, Ruchir Bhatt, and Anthony McGoron, Florida International University
10:40 am	Evaluation STEM Initiatives, Ann Bessell, University of Miami
11:00 am	Discussion in THREE groups lead by PIs of FAU, FIU and UM, scribed by one participating scholar: Current medical imaging curriculum, teaching strategies, resources, and plans
12:15 pm	Summary presentation of each group presented by a participating scholar
12:30 pm	Lunch break
1:30 pm	Tutorial for the developed MITS/DATS system
5:00 pm	Conclusion

Table of Contents

Web-Based Interactive Computer Simulation and Animation for Engineering Education

Ning Fang
Department of Engineering Education
College of Engineering
Utah State University

August 16, 2013

Outline

1. My background
2. NSF TUES program
3. Web-based interactive computer simulation and animation (CSA) – a critical review
4. Demos of web-based interactive CSA learning modules
5. Concluding remarks

1. My Background

- Mechanical engineering (PhD in 1994, MS in 1988, BS in 1984)
- Research interest: technology-enhanced learning (clickers, tablet PCs, computer simulation and animation, intelligent tutoring systems, ……)
- Associate professor in the Department of Engineering Education at Utah State University

Department of Engineering Education at Utah State University

- Within the College of Engineering http://eed.usu.edu/
- Teach: 2nd year foundational engineering courses (Statics, Dynamics, Strength of Materials, Electrical Circuits, Computer-Aided Design, etc.)
- Research: Pedagogical research in engineering education
  - ✓ PhD in Engineering Education program: one of the only three programs in the nation
  - ✓ 12 PhD students (these students have MS/BS in engineering and are interested in educational research)

NSF/DUE STEM Programs That I Was Involved

- Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES) Program (formerly CCLI program) that aims to improve undergraduate education in STEM disciplines.
- Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) that aims to improve the recruitment and retention of STEM undergraduates.
- NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) Program that provides scholarships to STEM undergraduates.
- Advanced Technological Education (ATE) Program that aims to improve technology education in community colleges.

2. NSF TUES Program

The vision of the TUES program is excellent STEM education for all undergraduate students, especially providing "transformative" learning experiences for students.

TUES Program Solicitation NSF 10-544

Most Up-to-Date

CAUSE (Catalyzing Advances in Undergraduate STEM Education) is an NSF-wide investment that incorporates funding from established programs in the EHR directorate and other NSF directorates funded though the Research and Related Activities (R&RA) account. It is created by consolidating three Division of Undergraduate Education (DUE) programs: *STEM Talent Expansion Program (STEP), Widening Implementation and Demonstration of Evidence- based Reforms (WIDER)*, and *Transforming Undergraduate Education in STEM (TUES);* several R&RA programs: BIO's Transforming Undergraduate Biology Education (TUBE); ENG's Research in Engineering Education and Nanotechnology Undergraduate Education (NUE); GEO's Geosciences Education and Opportunities for Enhancing Diversity in the Geosciences (OEDG); and the cross-NSF program, Climate Change Education (CCE).

FY 2014 NSF Budget Request to Congress

TUES Program

- Creating Learning Materials and Strategies
  - ✓ Ex: web-based, interactive learning modules
  - ✓ Ex: learning materials for mobile learning (iphone, ipad,…)
- Implementing New Instructional Strategies
  - ✓ Ex: Peer-led guided inquiry
  - ✓ Ex: Collaborative problem-based learning
- Developing Faculty Expertise
  - ✓ Ex: faculty development workshops
  - ✓ Ex: virtual community of practices

TUES Program (Continued)

- Assessing and Evaluating Student Achievement
  - ✓ Ex: assessment of students' self-regulated learning skills
  - ✓ Ex: assessment of students' problem-solving skills
- Conducting Research on Undergraduate STEM Education
  - ✓ Ex: How do students learn foundational engineering concepts?
  - ✓ Ex: What factors critically affect student retention?
  - ✓ Ex: How to best design wed-based learning materials to optimize student learning outcomes, given diverse student populations (gender, learning styles, cultural background, …)

Three Types

- Type I: $200 K, 2-3 years, typically a single institution
- Type II: up to $600K, 2-4 years, multiple institutions
- Type III: up to $5M, over 5 years, multiple institutions

Key Points

In addition to excellent project ideas, implementation and evaluation plans, the project should:

- Provide "transformative" learning experiences for students.
- Broadly disseminate project results to facilitate the adoption /adaption at peer institutions.

3. Web-Based Interactive Computer Simulation and Animation (CSA) – A Critical Review

Advantages of Computer Simulation and Animation (CSA)

- Properly designed CSA helps improve students' spatial abstract thinking skills by enabling students to visualize various science and engineering phenomena.
- Particularly attractive to many contemporary tech-savvy students as it promotes active and collaborative learning, and can be easily and widely adopted at both formal and informal education sites with no requirement for expensive physical facilities and instrumentations.

Examples of NSF-Funded CSA Projects

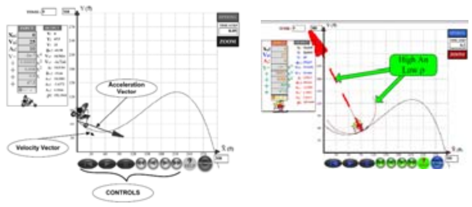
Project title	Institution
Development of Virtual CNC Machine Tools and Web-Based Machining Process Simulation and Learning	Missouri University of Science and Technology
An Inquiry-Based Simulation Learning Environment for the Ecology of Forest Growth	Hampshire College
Education Research Grant: Encouraging Students to Pursue Undergraduate Degrees in STEM Fields by Exposing them to Fundamental STEM Paradigms via Interactive Visual Arts Modules	Morehouse College
Introduction of Simulation Learning and Optimization to Support Engineering Design	University of Illinois at Urbana-Champaign
DIYModeling -- Do It Yourself Modeling and Simulation for STEM Learning	Texas Southern University
Modernizing the Undergraduate Power Engineering Curriculum with Real-Time Digital Simulation	Missouri University of Science and Technology
Interactive Simulation for Teaching Engineering Economics	Rowan University

Purpose of Literature Review

Purpose: understand the current status of design and implementation of computer simulation and animation (CSA) programs/modules

Scope: limited in foundational engineering mechanics courses: Statics, Dynamics, Engineering Mechanics, Strength of Materials; and several high school physics/mechanics

An Example Study



An animated motorcycle module (Stanley, 2008): Why does the acceleration vector change direction and magnitude as it moves along the trajectory?

Study Characteristics

- Student learning outcomes
- Sample size of study
- Area of study
- Authoring software
- Proprietary
- Mathematical equations
- User controls
- Other media
- Experimental design
- Data collection

Results

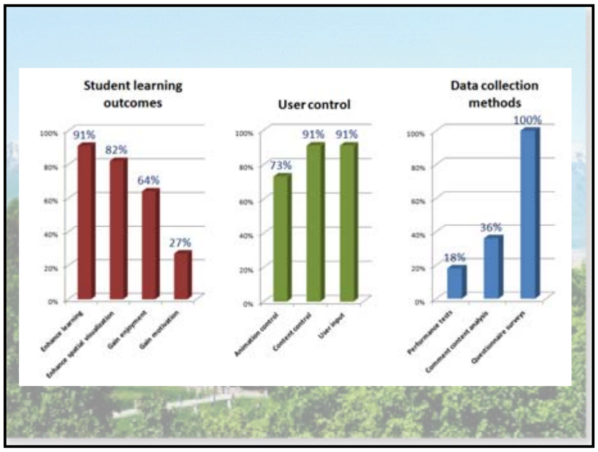
Study	Learning outcomes	Sample size	Area of study	Authoring software	Proprietary	Mathematical equations	User controls	Other media	Experiment design	Data collection
Fiori et al. (1996)	* Enhance learning * Enhance spatial visualization * Gain Enjoyment * Gain Motivation	50 (1994) 85 (1995)	Dynamics	Macromedia Flash	N	Y	* Animation control * Content Control * User inputs	None	One-Shot Case Study	* Questionnaire
Cornwell (2000)	* Enhance learning * Enhance spatial visualization * Gain Enjoyment * Gain Motivation	Other	Dynamics	Working Model	Y	N	* Animation control * Content Control	None	One-Shot Case Study	* Questionnaire
Hubing et al. (2002)	* Enhance learning * Enhance spatial visualization * Gain Motivation	51	Statics	Adobe Flash	N	Y	* Animation control * Content Control * User inputs	None	Static Group Comparison Design	* Comment content analysis * Performance Test * Questionnaire
Mazzei (2003)	* Enhance learning * Enhance spatial visualization * Gain Enjoyment	100	Dynamics	MSC Adams	Y	Y	* Content Control * User inputs	None	One-Shot Case Study	* Questionnaire
Sidhu, Ramesh, & Selvanathan (2005)	* Enhance learning * Enhance spatial visualization * Gain Enjoyment	Other	Dynamics	Macromedia Director	N	Y	* Animation control * Content Control * User inputs	None	One-Shot Case Study	* Questionnaire

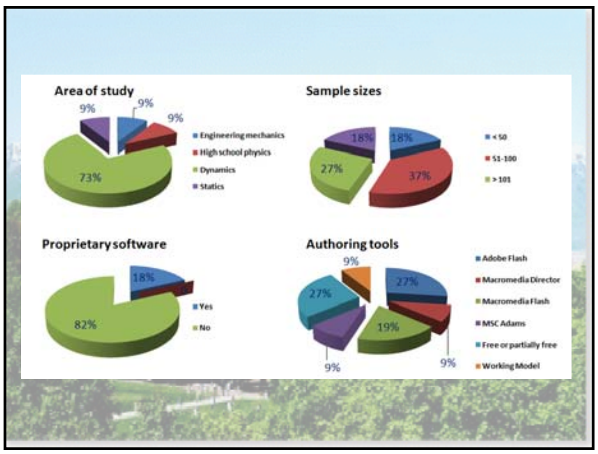
Results (Continued)

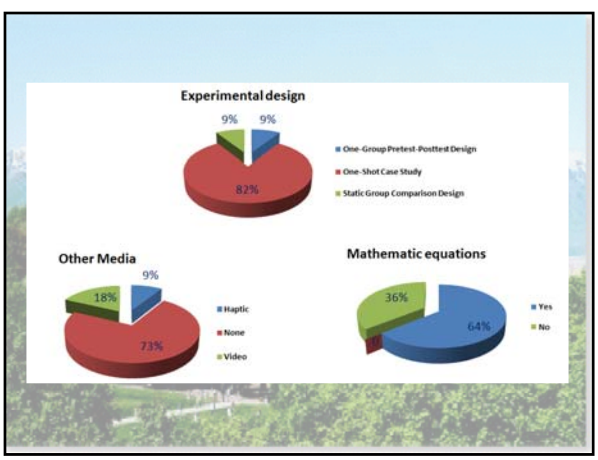
Study	Learning outcomes	Sample size	Area of study	Authoring software	Proprietary	Mathematic equations	User controls	Other media	Experiment design	Data collection
William et al. (2007)	* Enhance learning	26	High school Physics	Free or partially free (HTML, C++, DirectX, and OpenGL)	N	N	* Animation control * Content Control * User inputs	Haptic	One-Shot Case Study	* Comment content analysis * Questionnaire
Ariz et al. (2007)	* Enhance learning * Enhance spatial visualization * Gain Enjoyment	16	Dynamics	Free or partially free (VRML, Java, and Jython)	N	Y	* Animation control * Content Control * User inputs	Video	One-Shot Case Study	* Questionnaire
Fong (2008)		94	Dynamics	Free or partially free (C++ and GDI+)	N	N	* User inputs	None	One-Shot Case Study	* Comment content analysis * Questionnaire
Stanley (2008, 2009)	* Enhance learning * Enhance spatial visualization * Gain Enjoyment	70	Dynamics	Adobe Flash	N	N	* Animation control * Content Control * User inputs	None	One-Shot Case Study	* Questionnaire
Deliktas (2011)	* Enhance learning * Enhance spatial visualization * Gain Enjoyment	383	Engineering Mechanics	Macromedia Flash	N	Y	* Animation control * Content Control * User inputs	Video	One-Shot Case Study	* Questionnaire
Fang (2012)	* Enhance learning * Enhance spatial visualization	304	Dynamics	Adobe Flash	N	Y	* Content Control * User inputs	None	One-Group Pretest-Posttest Design	* Comment content analysis * Performance Test * Questionnaire

Study	Learning outcomes	Sample Size	Area of study	Authoring Software	Proprietary
Hubing et al. (2002)	* Enhance learning * Enhance visualization * Gain Motivation	51	Statics	Adobe Flash	N
Mazzei (2003)	* Enhance learning * Enhance visualization * Gain Enjoyment	100	Dynamics	MSC Adams	Y
William et al. (2007)	* Enhance learning	26	High school Physics	Free or partially free (HTML, C++, DirectX, and OpenGL)	N
Stanley (2008, 2009)	* Enhance learning * Enhance visualization * Gain Enjoyment	70	Dynamics	Adobe Flash	N
Deliktas (2011)	* Enhance learning * Enhance visualization * Gain Enjoyment	383	Engineering Mechanics	Macromedia Flash	N

Study	Math equation	User Controls	Other media	Experiment Design	Data collection Methods
Hubing et al. (2002)	Y	* Animation control * Content Control * User inputs	None	Static Group Comparison Design	* Comment content analysis * Performance Test * Questionnaire
Mazzei (2003)	Y	* Content Control * User inputs	None	One-Shot Case Study	* Questionnaire
William et al. (2007)	N	* Animation control * Content Control * User inputs	Haptic	One-Shot Case Study	* Comment content analysis * Questionnaire
Stanley (2008, 2009)	N	* Animation control * Content Control * User inputs	None	One-Shot Case Study	* Questionnaire
Deliktas (2011)	Y	* Animation control * Content Control * User inputs	Video	One-Shot Case Study	* Questionnaire


Student learning outcomes
91%
82%
64%
27%
Enhance learning
Enhance spatial visualization
Gain enjoyment
Gain motivation
User control
73%
91%
91%
Animation control
Content control
User input
Data collection methods
18%
36%
100%
Performance tests
Comment content analysis
Questionnaire surveys


Area of study
9%
9%
9%
73%
Engineering mechanics
High school physics
Dynamics
Statics
Sample sizes
18%
18%
27%
37%
< 50
51-100
> 101
Proprietary software
18%
82%
Yes
No
Authoring tools
9%
27%
27%
19%
9%
9%
Adobe Flash
Macromedia Director
Macromedia Flash
MSC Adams
Free or partially free
Working Model


Experimental design
9%
9%
82%
One-Group Pretest-Posttest Design
One-Shot Case Study
Static Group Comparison Design
Other Media
9%
18%
73%
Haptic
None
Video
Mathematic equations
36%
64%
Yes
No

Suggestions

Design of CSA programs/modules:

- More animation controls
- Diverse representations of information
- Free web browser plug-ins
- Mathematic equations
- "Copy & Paste"

Assessment of student learning outcomes:

- Random assignments
- Control group, pre and post tests
- Diverse methods of data collection and more performance tests

4. Demos of Web-Based Interactive CSA Learning Modules

- TUES Type 2 project "Improving Students' Problem-Solving in Engineering Dynamics Through Interactive Web-based Simulation and Animation Modules" (2011-2015)

- Phase I (1.5 years): Develop a unique set of CSA modules for both particle and rigid-body dynamics
- Phase II (2.5 years): Assess the effectiveness of the developed CSA modules using the quasi-experimental research design method: control group and treatment group.

Engineering Dynamics

- High-enrollment and high-impact, core engineering course that nearly all mechanical, civil, and aerospace engineering students are required to take.
- Covering a broad spectrum of foundational concepts and principles, such as motion, force and acceleration, work and energy, impulse and momentum, and vibration.
- One of the most difficult engineering courses to succeed in. In the Fundamentals of Engineering examination in 2009, the national average score for the Engineering Dynamics exam was only 53%.

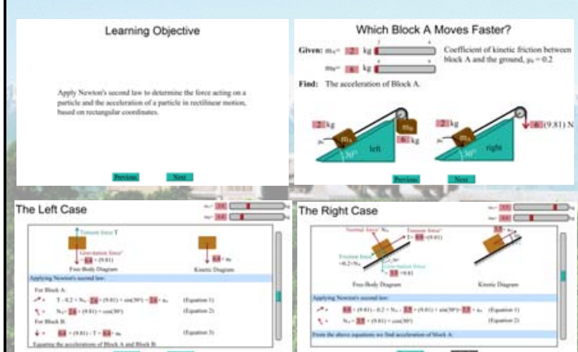
Challenges of Student Learning in Dynamics

- Spatial abstract thinking and reasoning skills to correctly understand *what* physically happens in a dynamics phenomenon and to identify correct dynamics concepts and principles associated with that particular phenomenon.
- Analytical and mathematical modeling skills to help students translate their physical understanding into mathematical equations that accurately explain and describe *why* that particular dynamics phenomenon occurs and *how* it evolves.

Features of the New CSA Learning Modules

- Integrates visualization with mathematical modeling
- Interactive computer graphical user interface allows students to vary inputs and see how the numerical numbers in mathematical equations change, simultaneously and dynamically, as a physical object moves in a space
- Web-based and stand-alone computer software program.

Examples of the CSA Learning Modules



Demos of web-based interactive CSA learning modules

Research Question

To what extent the developed CSA modules improve students' conceptual as well as procedural knowledge (skills) of engineering dynamics?

Research Design

Quasi-experimental research design, surveys, and interviews

Student groups	Pretests	Treatment	Pos-tests
Control group (i.e., **comparison group**)	o		o
Quasi-experimental (i.e., treatment group)	o	x	o

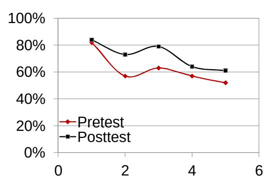
$$\text{Learning gain} = \frac{\text{Post-test score (\%) - Pre-test score (\%)}}{\text{100 (\%) - Pre-test score (\%)}}$$

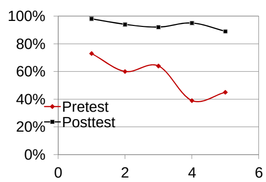
Student Participants

Control semester: 86 students from three departments: mechanical and aerospace engineering, civil and environmental engineering, biological engineering

Treatment semester: 94 students from the above three engineering departments

Preliminary Results

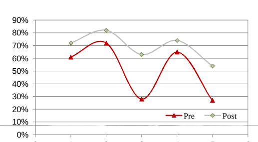


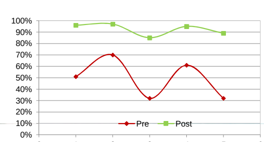


CSA Module 2

- Control semester: Class-average learning gain 16%
- Treatment semester: Class-average learning gain 62%

Continued





CSA Module 4

- Control semester: Class-average learning gain 21%
- Treatment semester: Class-average learning gain 69%

Student Comments

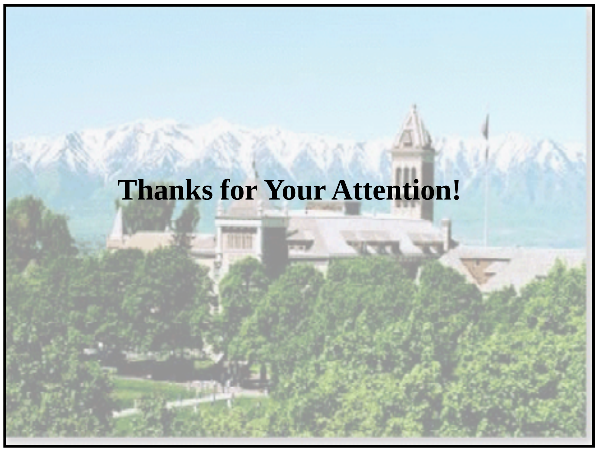
- "When visual and math come together, see and understand much better."
- "I was able to see the math laid out in front of me. Then I can see the physics as it moves in real life. This links the two."
- "They helped me see that happens and see why."
- "I could see how different factors changed the simulation and in what way."
- "They helped me visualize the relationships of how the mathematics changes when the calculations are altered."

Student Comments

- "Seeing physical demonstrations definitely helps to understand what the math is describing."
- "They help me connect what is happening conceptually to mathematically."
- "It helped me visualize what was happening & see how the physics and mathematics were related."
- "The computer simulation made it possible to visualize some concepts that were not as easy to see just on paper."
- "It was nice to "instantly" see if my intuition was correct or not."
- "For some of the problems my institution was incorrect and the computer simulations helped illustrate the mathematical proof of the problem."

5. Concluding Remarks

- If designed properly, web-based interactive computer simulation and animation (CSA) programs/modules can improve student learning.
- When designing CSA programs/modules, it is suggested to consider:
  - ✓ More animation controls
  - ✓ Diverse representations of information
  - ✓ Free web browser plug-ins
  - ✓ Mathematic equations


Thanks for Your Attention!

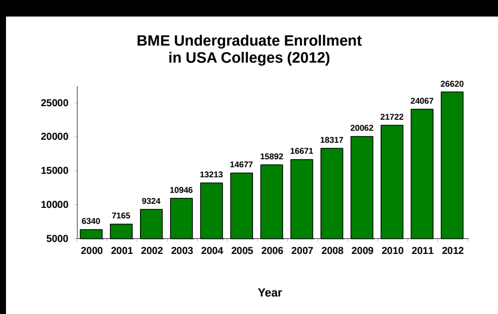
Medical Imaging Education by Online Animation and Simulation

Weizhao Zhao, Ph.D.
Department of Biomedical Engineering
University of Miami, Coral Gables, Florida

Background: Facts

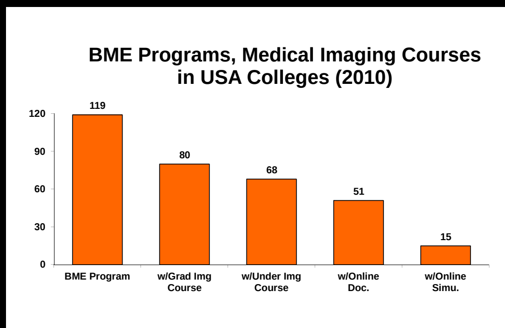
- BME education has developed as an interdisciplinary engineering training area in the last 30 years.
- Medical Imaging is a required training area in BME and almost any health care related major, e.g., medical physics, health science.
- Medical Imaging techniques are applied in clinical and research laboratories on a daily basis.
- Medical Imaging instrument is usually unavailable (even available, it is usually not accessible).

Background: Facts



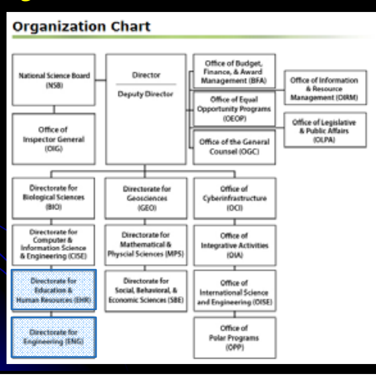
http://www.asee.org/papers-and-publications/publications/11-47.pdf

Background: Facts



http://mis.eng.miami.edu/survey

Background: Resource



Background: Resource

EHR Directorate

Graduate Education (DGE)
Research on Learning in Formal and Informal Settings (DRL)
Undergraduate Education (DUE)
Human Resource Development (HRD)

ENG Directorate

Chemical, Bioengineering
Environmental, and Transport Systems (CBET)
Civil, Mechanical and Manufacturing Innovation (CMMI)
Electrical, Communications and Cyber Systems (ECCS)
Engineering Education and Centers (EEC)
Emerging Frontiers in Research and Innovation (EFRI)
Industrial Innovation and Partnerships (IIP)

History: Success

NSF CCLI DUE0127290 (2001-2004)
"Proof of Concept"

NSF CCLI DUE0632752 (2006-2009)
"Build a Prototype"

NSF TUES DUE1022750 (2010-2014, Current)
"Expansion Development"

NSF DUE 1022750

Florida Atlantic University
Florida International University
University of Miami

Collaborative Development and Application of Distributable, Internet Accessible, Interactive Medical Imaging Teaching Software (MITS) and Dynamic Assessment Tracking System (DATS)

Motivation

- You hear, you forget.
- You see, you remember.
- You do, you understand.
- **What do you see and what do you do?**
- A picture is worth a thousand words: you see!
- A moving picture is even better: you see more!
- An interactive moving picture is better than a simple moving pictures: you do too!

Hypothesis

Web-based interactive teaching model increases student learning gain in the field of medical imaging education, particularly for biomedical engineering students.

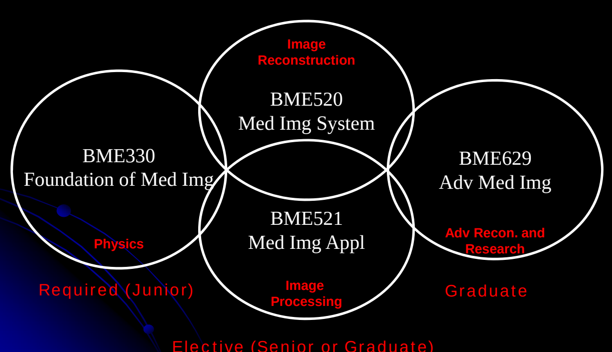
Objective

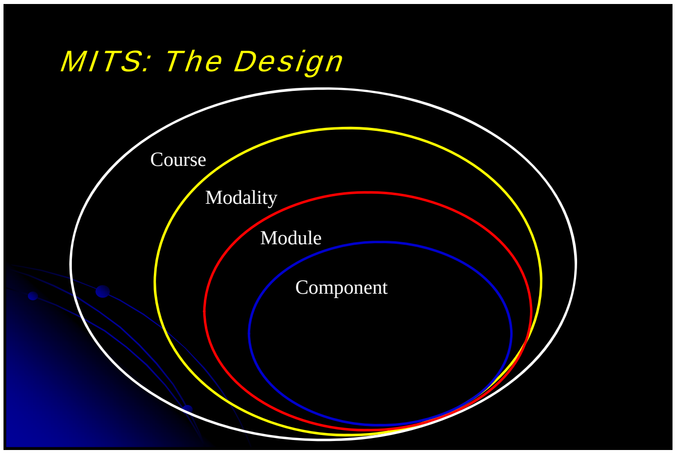
- Develop an online learning environment to help successfully deliver medical imaging curriculum

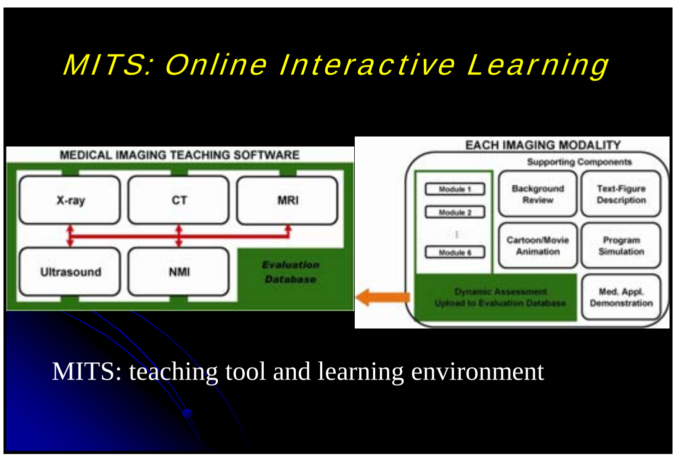
  MITS: Medical Imaging Teaching Software
- Develop an online tracking platform to evaluate teaching effectiveness and assess student learning gain

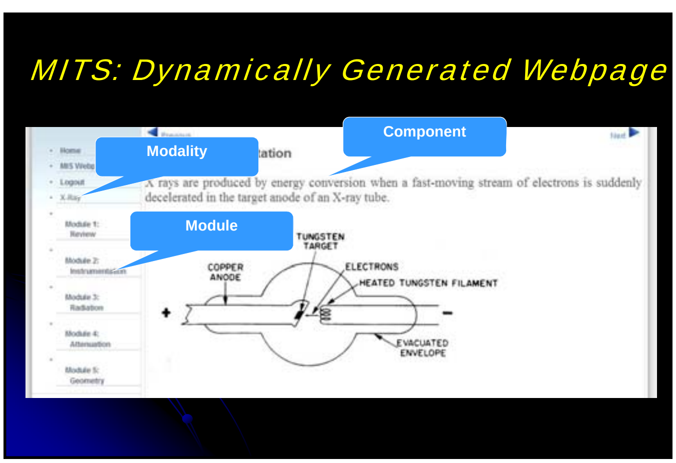
  DATS: Dynamic Assessment Tracking System

Curriculum in UM's BME

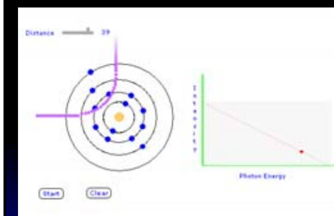



MITS: The Design
Course
Modality
Module
Component

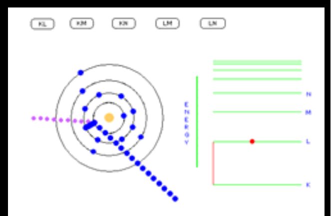

MITS: Online Interactive Learning
MEDICAL IMAGING TEACHING SOFTWARE
X-ray
CT
MRI
Ultrasound
NMI
Evaluation Database
EACH IMAGING MODALITY
Supporting Components
Module 1
Module 2
Module 6
Background Review
Text-Figure Description
Cartoon/Movie Animation
Program Simulation
Dynamic Assessment Upload to Evaluation Database
Med. Appl. Demonstration
MITS: teaching tool and learning environment


MITS: Dynamically Generated Webpage
Modality
Component
Module
X rays are produced by energy conversion when a fast-moving stream of electrons is suddenly decelerated in the target anode of an X-ray tube.
TUNGSTEN TARGET
COPPER ANODE
ELECTRONS
HEATED TUNGSTEN FILAMENT
EVACUATED ENVELOPE

Animation and Simulation



General Radiation



Characteristic Radiation

Animation and Simulation

Animation Example

Either you can explain the following equation and ask student to write codes to simulate CT projection…

$$p(x',\theta) = \sum_{\text{verticle axis}} f\left(x\cdot\cos\theta + y\cdot\sin\theta, -x\cdot\sin\theta + y\cdot\cos\theta\right)$$

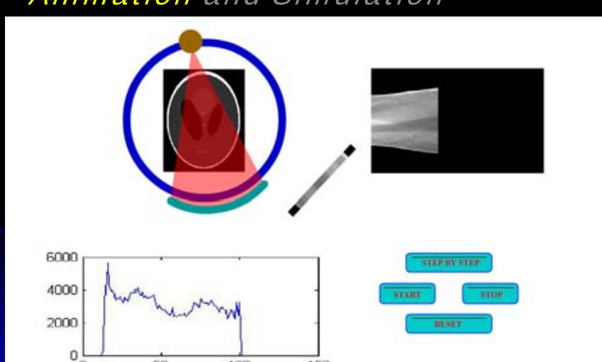
$$= \sum_{y'} f\left(x\cdot\cos\theta + y\cdot\sin\theta, y'\right) \qquad \forall\theta$$

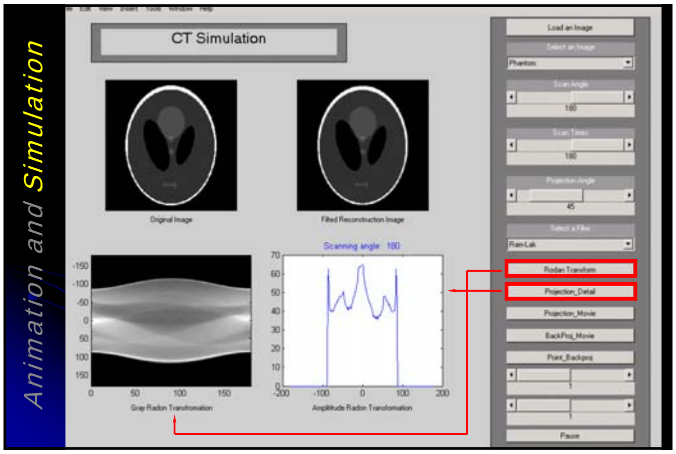
OR

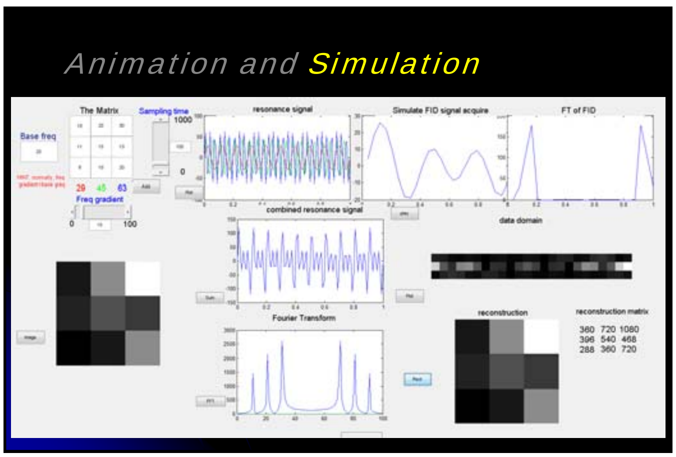
And explain the following equation and ask students to write codes to simulate CT reconstruction…

$$g(x,y) = \sum_{\theta} p(x',\theta) = \sum_{\theta} p(x\cdot\cos\theta + y\cdot\sin\theta, \theta) \qquad \forall\theta$$

Animation and Simulation







DATS: Online Assessment Database

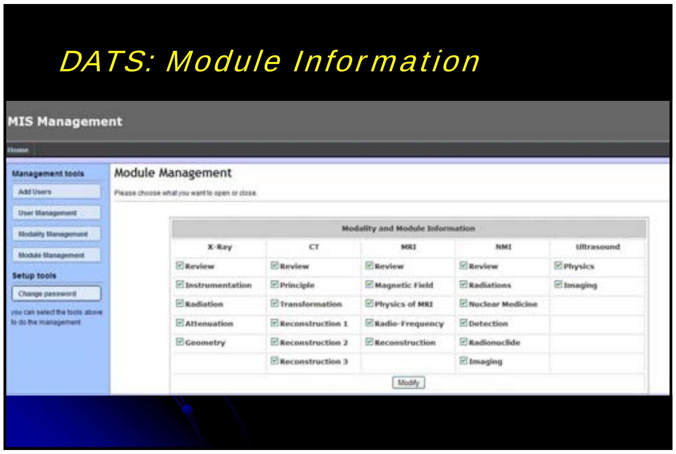
Pre-Modality Test (4~5 concept questions)

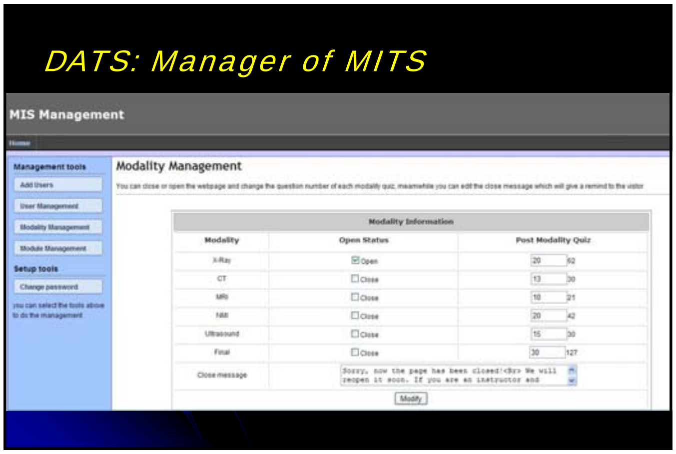
- Pre-Module Test (1~2 concept questions)
- **Module 1**
- Post-Module Test (1~2 concept questions) — Web-based Module Assessment
- Pre-Module Test (1~2 concept questions)
- **Module 2**
- Post-Module Test (1~2 concept questions)

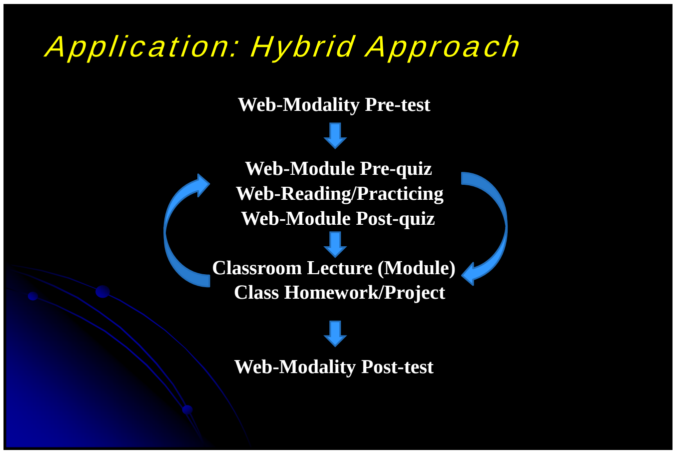
MODALITY 1 — Modality Teaching Learning Assessment

Post-Modality Test (10~20 questions) — Course Teaching Learning Evaluation

Final Review Test (40~50 questions)


DATS: Module Information
MIS Management
Home
Management tools
Add Users
User Management
Modality Management
Module Management
Setup tools
Change password
you can select the tools above to do the management
Module Management
Please choose what you want to open or close.
Modality and Module Information
X-Ray
CT
MRI
NMI
Ultrasound
Review
Instrumentation
Radiation
Attenuation
Geometry
Review
Principle
Transformation
Reconstruction 1
Reconstruction 2
Reconstruction 3
Review
Magnetic Field
Physics of MRI
Radio-Frequency
Reconstruction
Review
Radiations
Nuclear Medicine
Detection
Radionuclide
Imaging
Physics
Imaging
Modify


DATS: Manager of MITS
MIS Management
Home
Management tools
Add Users
User Management
Modality Management
Module Management
Setup tools
Change password
you can select the tools above to do the management
Modality Management
Modality Information
Modality
Open Status
Post Modality Quiz
X-Ray
Open
20
62
CT
Close
13
30
MRI
Close
10
21
NMI
Close
20
42
Ultrasound
Close
15
30
Final
Close
30
127
Close message
Sorry, now the page has been closed!
 We will reopen it soon. If you are an instructor and
Modify


Application: Hybrid Approach
Web-Modality Pre-test
Web-Module Pre-quiz
Web-Reading/Practicing
Web-Module Post-quiz
Classroom Lecture (Module)
Class Homework/Project
Web-Modality Post-test

Animation and Simulation:

X-ray Modality:

- X-Ray Tube's working principle
- X-Ray Tube's emission spectrum
- Inner shell ionization
- Bremsstrahlung radiation
- Compton Scattering
- Half Value Layer
- Attenuation
- X-ray Geometry

Animation and Simulation:

CT Modality:

- Pen-beam projection
- Fan-beam projection
- Back projection by degree in Radon domain
- Back projection by Cartesian coordinate
- Downloadable CT Simulation
- Numerical reconstruction

Animation and Simulation:

MRI Modality:

- Precession
- Larmor frequency and RF pulse
- MRI Relaxation
- Downloadable FID Simulation
- Downloadable Reconstruction Simulation

Animation and Simulation:

Nuclear Medicine Modalities:

- **Radioactive decay through materials**
- **How PET works**
- **How SPECT works**
- **Radionuclide half-life**
- **Coincidence Sampling**
- **PET demonstration**
- **Reconstruction demonstration**
- **To be uploaded animations by FIU**
- **To be uploaded simulations by FIU**

Animation and Simulation:

Ultrasound Imaging Modality:

- **A-mode Ultrasound**
- **M-mode Ultrasound**
- **B-mode Ultrasound**
- **Doppler Effect**
- **To be uploaded animations by FAU**
- **To be uploaded simulations by FAU**

Collaboration: "Users"

- **Contacted:**
  - **University of Valencia (EE), Spain**
  - **University Pompeu Fabra in Barcelona (BME), Spain**
  - **IIT Roorkee (ECE), India**
  - **Ariel University (MP), Isaerel**
  - University of Western Ontario (ECE), Canada
  - **Medical School Athens, Greece**
  - Università degli Studi di Milano (Rad), Italy
  - **Baylor College of Medicine (MI), TX**
  - **Duke University (CoE), NC**
  - **DeVry University (BMET), CA**
  - **Rose-Hulman Institute of Technology (MP), NJ**
  - **Wentworth Institute of Technology (BME), MA**
  - **Catholic University of America (ECE/BME), DC**
  - **Prairie View A&M University (PHY/BME), TX**
  - **University of North Carolina (BME), NC**
  - **Broward College (HS), FL**
- **Participating**
  - **Florida Atlantic University**
  - **Florida International University**
  - **University of Miami**

Application: "Protocols"

BME330: Foundation of Medical Imaging

- **Primary teaching material:** Textbook, Instructor's handout
- **MITS/DATS system:** Reference material, volunteer
- **Pre/Post test/quiz:** Extra credits

BME520: Medical Imaging System

- **Primary teaching material:** Textbook, No handout
- **MITS/DATS system:** Hybrid with textbook to serve as handout material, volunteer
- **Pre/Post test/quiz:** for review only, NO extra credits

Results Subjective perception information

21 student responses Rating 5:strongly agree – 1:strongly disagree	5 – 4	3	2 – 1
1. The simulation protocol is well organized (*)	18	3	0
2. The interface of the protocol is user-friendly (*)	16	5	0
3. The protocol provides you ample opportunities to gain knowledge, skill and technique that traditional lecture or textbook cannot provide (*, #)	20	1	0
4. The visual feature stimulates your interest of learning a subject (*)	21	0	0
5. The physics and mathematics concepts link closely the engineering implementation (*, #)	18	3	0
6. Simulation exercises enhance your understanding to a particular modality (*, #)	21	0	0
7. Overall usefulness of the simulation protocol to current course (*, #)	20	1	0

Results Factual information

214 students (154 undergraduates) took medical imaging courses

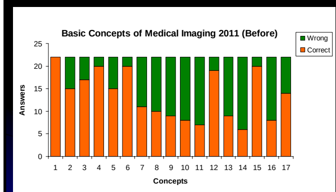
For modality X-ray and CT (pre/post test)

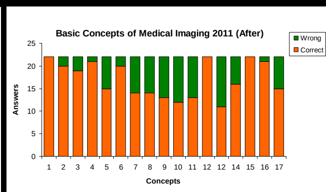
	GPA	All Prob.	Concept Prob.	Projects
Pre (n=23)	3.42±0.34	82±9%	76±5%	82±5%
Post (n=21)	[1]3.46±0.44	[2]89±8%	[3]91±6%	[3]90±6%

1: $p < 0.7$ 2: $p < 0.1$ 3: $p < 0.05$

Results Learning Gain

Result: Concept understanding quiz (BME520)

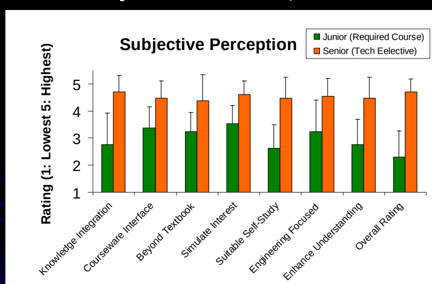




Learning Gain (2011):
LG = (post-pre)/(100-pre) = 0.36 ± 0.28

Results Subjective perception

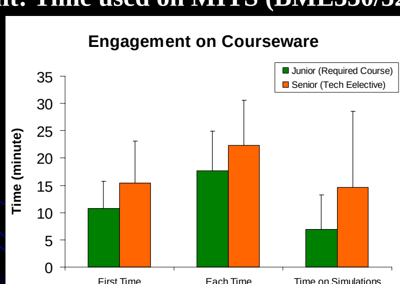
Result: Survey from classes (BME330/520)



Apparent subjective perception "disparity" between classes

Results Engagement

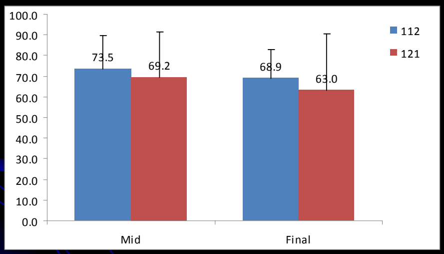
Result: Time used on MITS (BME330/520)



Apparent subjective perception "disparity" between classes

Results Grade Impact

Result: Midterm/Final exam (BME330)



112: 73.5+/-16 and 68.9+/-14 (N=12), lowest grade B (n=4)
121: 69.2+/-22 and 63.0+/-27 (N=24), lowest grade F (n=1), D (n=1), C (n=3)

Results Comments

Result: Open end survey (BME330/520)

Summary:

- Animations of the underlying physics behind modalities…
- Organized well and provided visualization…
- Good summary for class review…
- Remote accessible, self-paced…
- Practice test/quiz help review…
- Format is not consistent…
- Index is not clear…
- Pre/post quiz does not match content/class material…
- Class test questions are too difficult and some not relevant…
- Too much text…
- Can you put the website on Blackboard…

Conclusion

- MITS provides an Internet accessible, interactive, module based teaching tool and learning environment
- DATS manages MITS through a database platform, provides quick feedback for teaching efficiency and assesses student learning gain dynamically

Future Work

- Seeking for collaboration to apply the system under different settings, such as BME, ECE, HS, PHY, or other curricula.
- Seeking for NSF proposal collaborators: Medical Imaging through CyberLearning
- Seeking for collaborative research on Integration of Medical Imaging into Special Applications, e.g., Medical Physics program, Health Science program

Acknowledgement

NSF CCLI DUE0127290 (2002-2004), "Proof of a Concept"
NSF CCLI DUE0632752 (2006-2009), "Build a Prototype"
NSF CCLI DUE1022750 (2010-2014), "Expansion Development"

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Dept. of Mechanical Engineering, University of South Florida

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Qian Shen, Xiping Li, Decho Surangsrirat, Wupeng Yin, Hairong Chen

NSF CCLI/TUES Program Directors
Dr. Russell L. Pimmel, Dr. Don L. Millard

http://mis.eng.miami.edu

Questions?
http://mis.eng.miami.edu

NSF National Workshop on Medical Imaging Teaching Software

University of Miami – 16 August 2013

FLORIDA ATLANTIC UNIVERSITY

1

Florida Atlantic University Modules

Ultrasound Imaging
Image Processing

Ricardo Castellanos
Diego Pava
Prof. Nurgun Erdol
Prof. William Rhodes

2

Medical Imaging Course Testbeds

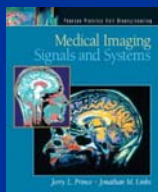
- Fa10 Florida Atlantic University - 10 students
- Sp12 Florida Atlantic University - 12 students
- Sp12 Universidad Javeriana - 30 students
- Sp13 Universidad Javeriana - 26 students

Total of 78 students (all from engineering)

3

Course Text:

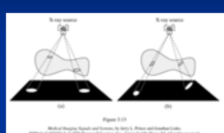
Medical Imaging Signals and Systems by Prince & Links

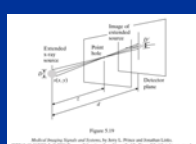


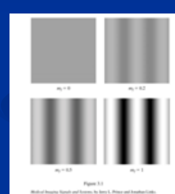
An excellent text for students with background in engineering and physics, but short on figures in certain areas: a good candidate for augmentation with animations.

4

Representative Examples

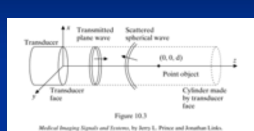


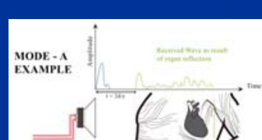




5

Ultrasound Imaging





- Presentation by Ricardo Castellanos (Ph.D. candidate in electrical engineering)

6

Image Processing for Medical Imaging

Image Processing Innotool
For Medical Imaging

A Matlab-based teaching software package and tutorial

Diego F. Pava
Florida Atlantic University

- Presentation by Diego Pava (Ph.D. candidate in electrical engineering)

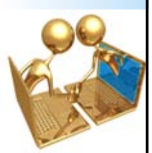
7

Web Based Interactive Medical Imaging Applications for Teaching Nuclear Medicine

Senait A. Debebe, Ruchir Bhatt, Anthony J. McGoron

Department of Biomedical Engineering , Florida International University, Miami, FL, U.S.A.

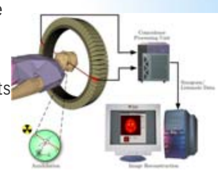
Our Goal



- Develop interactive medical imaging applications focused in Nuclear medicine
- Establish internet accessible applications
- Sharable, distributable and upgradable applications
- Increase students learning gain by conveying dynamic explanations.
- Flexible learning schedule to fit into the available class hours.

2

I. PET Simulation



- MATLAB® was used to simulate PET image reconstruction mechanism.
- Scattering and random coincidence effects were simulated by adding Gaussian and/or Poison noise.
- Radon transform was performed to generate *sinogram* of an image.
- Filtered Back Projection algorithm was used to reconstruct the original image

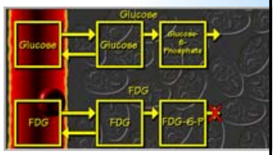
3

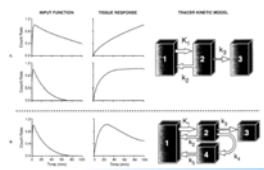
II. Tracer Kinetics Model

- The relationship among Input function (Plasma activity), Tissue response, model structure and rate constants was Illustrated using 3-compartmental models.
- MATLAB® GUIDE has been used to develop a user interface.
- Background MATLAB program has been used to implement:

$A_i = (\int \mathit{Input\ Function}) \otimes \mathit{Tissue\ Response}$

Where A_i is the measured data by PET

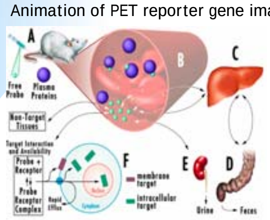


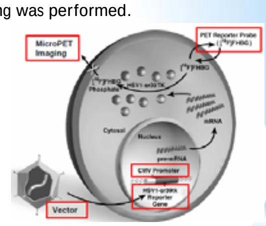


4

III. Reporter Gene Imaging

- Animation of PET reporter gene imaging was performed.



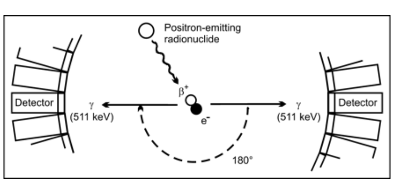


- Adobe® Flash® Professional CS5 was used together with ActionScript 3.0 to apply codes .

5

IV. Coincidence detection

- Circuitry of PET coincidence detection, generation of single and multiple incidences are animated.



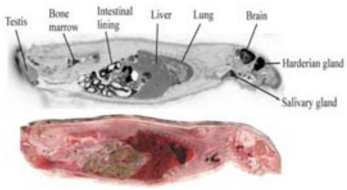
- Adobe® Flash® Professional CS5 was used.

6

Courtesy of : 'The promise of Immuno-PET in Radioimmunotheraphy' , *J Nucl Med January 1, 2005 vol. 46 no. 1*

V. Autoradiography

- Procedures and materials required to do Autoradiography is animated which is used determine the distribution of radioactivity.

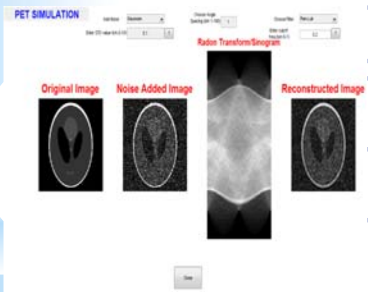


- Adobe® Flash® Professional CS5 was used.

7

Results

1.



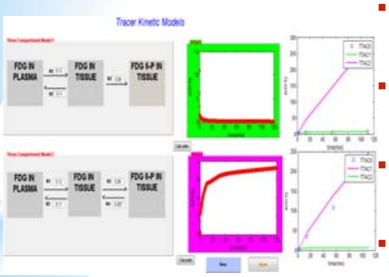
Activities

- Choose to add Gaussian and/or Poison noise
- Set STD value;
- Enter angle spacing between projection angle of Radon transform
- Adjust image reconstruction parameters ; filter type & cutoff frequency
- Help files provided

8

Results Cont.

2.



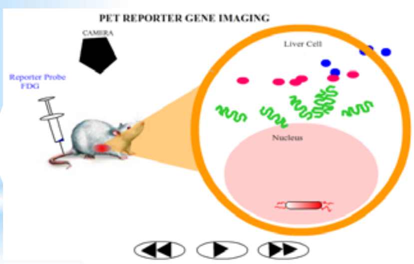
Activities

- Choose between models
- Click on input functions (PTACs)
- Enter estimated rate constant values (Ki)
- Observe the resulting TTACs

9

Results Cont.

3.

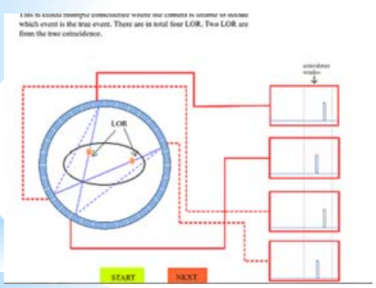


Activities
- Step by step procedures are animated.
- Reporter gene injection and its route inside a liver cell is elaborated.
- Reporter probe interaction with expressed proteins/enzymes/receptors is shown.
- Start, forward and backward buttons are provided.

10

Results Cont.

4.

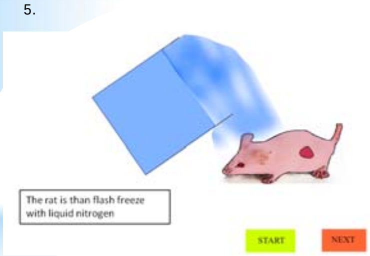


Activities
- Start button to start the animation
- Coincidence detection circuitry is animated
- Step by step explanation of signal generation
- Next button to go to the next step

11

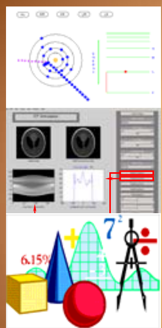
Results Cont.

5.



Activities
- Start button to start the animation
- Injection and distribution of radioisotope, and technique of autoradiograph is animated
- Step by step explanation materials and methods applied
- Next button to go to the next step

12



EVALUATING STEM INITIATIVES

Ann G. Bessell, Ph.D.

UNIVERSITY OF MIAMI
SCHOOL of EDUCATION & HUMAN DEVELOPMENT

WHAT IS

Beyond **S**cience, **T**echnology, **E**ngineering and **M**ath

STEM education attempts to transform the typical professor-centered classroom by encouraging a curriculum that is driven by problem-solving, discovery, exploratory learning, and requires students to actively engage a situation in order to find its solution.

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STEM PIPELINE FROM 9TH GRADE TO BACHELOR'S DEGREE FOR LOW-INCOME STUDENTS IN THE U.S.

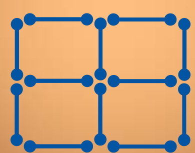
10,000 Students in the Bottom Income Quartile Start the 9th Grade	6,600 of 10,000 Students Earn a High School Diploma (8,200 total)	3,860 of 10,000 Students Go to College 76 are Declared STEM Majors vs 800 total	710 of 10,000 Students Earn a Bachelor's Degree 30 BA/BS in STEM Fields vs 400

THINK OUTSIDE THE BOX: PROBLEMS

1. Convert the following figure into a six by adding only one line.

IX

2. Leave two squares in the following figure by removing just two lines.



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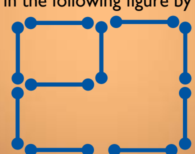
8/15/2013

THINK OUTSIDE THE BOX: SOLUTIONS

1. Convert the following figure into a six by adding only one line.

SIX

2. Leave two squares in the following figure by removing just two lines.



8/15/2013

10 ESSENTIAL STEM TEACHING PRACTICES

- **1. Believe in your students.** Set high expectations for your students, challenge them to succeed, and believe that they will.
- **2. Transfer control of the learning process to the students.** Develop new roles and rules that stress student responsibility. Then guide from the sidelines while keeping students on target with their direction and purpose.
- **3. Foster curiosity.** Pose problems rather than answers and send students on a search for solutions. Use discrepant events to intrigue students and draw them into the problem.
- **4. Provide hands-on, experiential learning.** Don't be the old-fashioned sage on the stage. Learning through reflection and doing is compelling. When your students have their imagination piqued, give them opportunities to actually investigate multiple possible solutions to a problem, or to solve a mystery.

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- **5. Increase collaboration among students.** Get comfortable with teamwork.
- **6. Accept failure – both yours and the students – as a necessary part of learning and growing.** That is, accept failure that accompanies taking a risk and experimenting, knowing that they might not get it right.
- **7. Be an inspiring leader and role model for your students.** Be positive and enthusiastic about what students are learning and how they are learning it.
- **8. Accept some drawbacks.** STEM education will improve student engagement, critical thinking skills, and workforce skills. But you'll need to be flexible and ready to make some quick shifts in your thinking.
- **9. Evolve and grow as a learner.** Develop your skills in facilitating (as opposed to dictating) so that students focus on learning how to think like a STEM professional.
- **10. Learn in community.** Work with your colleagues to study effective ways of teaching STEM lessons.

University of Miami
School of Education & Human Development

REASONS FOR EVALUATION

- Performance improvement
- Outcome assessment
- Program justification
- Accountability
- Program clarification
- Cost-effectiveness

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School of Education & Human Development

RESULTS-BASED ACCOUNTABILITY™

- **Results (or outcomes or goals)** as "A condition of success for students, professors, program of study, or school." This can include some of the major junctures in a student's education where they can continue on a trajectory toward success or fall back/fall through the cracks.
- **Indicators (or benchmarks)** which are the "what" that can be measured to help quantify the achievement of an outcome. Each program needs to identify the appropriate indicators for their program by answering the question "How would we recognize these outcomes in measureable terms?"
- **Performance Measures.** These are the metrics that will be used to measure how well a program, course, or career path is working. Each program needs to identify the appropriate metrics for their program by answering questions like "How much did we do?, How well did we do it?, What are the effects/gains for the participants?"

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EVALUATION PLANNING

Most STEM evaluation proposals ask for three elements but use different language:

- "Fidelity of Implementation" or just "fidelity" measures the extent to which the program activities have been accomplished.
- "Formative" or "process" evaluation provides mid-course corrections to Pis.
- "Summative" or "impact" evaluation summarizes the programs merit and worth.

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THEORY OF PROGRAM CHANGE:

- "…a static, fixed, and mechanical cause-effect model where inputs lead to outputs, which produce outcomes and impacts…
- "Works well in simple situations of high certainty and high agreement about what to do. But such modeling has significant downsides and distorting effects in complex and dynamic situations where the [program] is emerging, evolving, and adapting." MQP 2011

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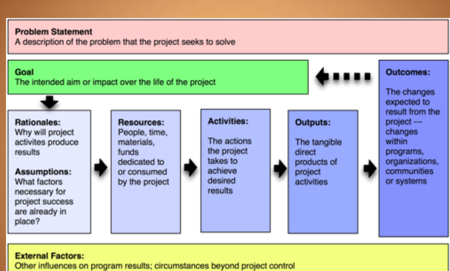
BASIC LOGIC MODEL



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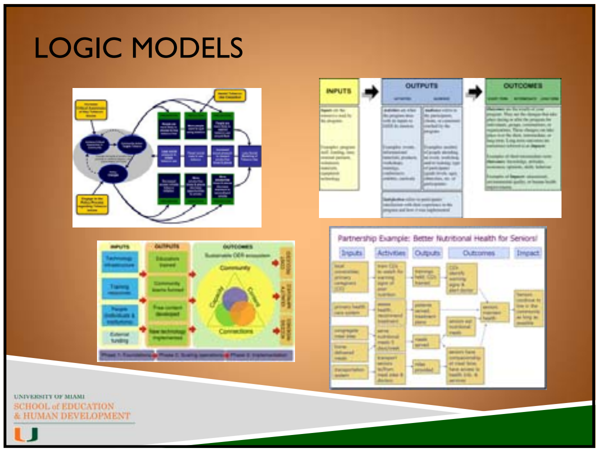
& HUMAN DEVELOPMENT


LOGIC MODELS
INPUTS
OUTPUTS
OUTCOMES
Partnership Example: Better Nutritional Health for Seniors!
Inputs
Activities
Outputs
Outcomes
Impact
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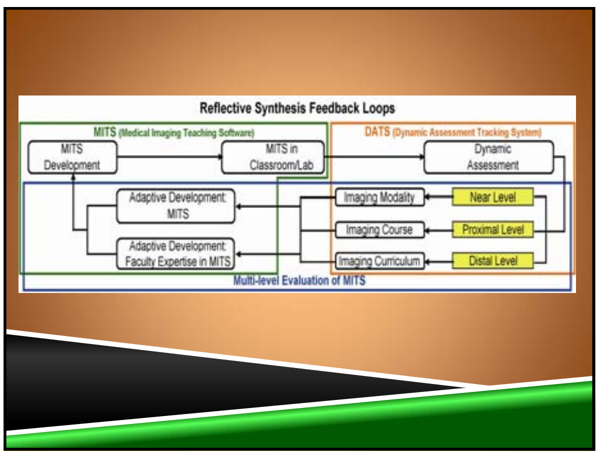
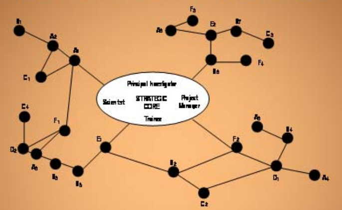

Reflective Synthesis Feedback Loops
MITS (Medical Imaging Teaching Software)
DATS (Dynamic Assessment Tracking System)
MITS Development
MITS in Classroom/Lab
Dynamic Assessment
Adaptive Development: MITS
Adaptive Development: Faculty Expertise in MITS
Imaging Modality
Imaging Course
Imaging Curriculum
Near Level
Proximal Level
Distal Level
Multi-level Evaluation of MITS

STRUCTURE OF A *COLLABORATIVE*



Proposed structural design illustrating the dynamic relationship between a multidisciplinary teams and network collaborators. A = external universities, B = external research centers, C = independent researchers/labs, D = pharmaceutical companies/labs, E = governmental agencies/labs, F = clinical research support (bio-repositories, biostatistics, clinical research units, etc.)

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INPUTS

Resources, contributions, investments that go into the project. Input indicators measure resources, contributions and investments such as:

- Staff
- Volunteers
- Funding
- Materials
- Facilities

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OUTPUTS

Output indicators measure things such as the scope/size of activities, services, events, and products reaching the target population:

- Numbers of students served
- Number of simulations completed
- Number of courses
- Numbers of workshops

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PROCESS

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UNPACKING THE BLACK TUBE

- Usability methods
  - Cognitive interviews "Think Alouds"
- Focus Groups
  - Satisfactions
  - Challenges
  - Successes
- Observations
- Surveys

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OUTCOMES

Things project hopes to achieve; actual benefits, impact, or changes. Outcomes are expressed in terms of changes for individuals, groups, communities, institutions, and system :

- ❑ Knowledge, attitude, and skill changes
- ❑ Behavior changes
- ❑ Value changes
- ❑ Policy, procedural, and practice changes

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CONSIDERING BP SUCCESS AT MULTIPLE LEVELS

Level 1: Having access to the *benefits* of STEM knowledge

Level 2: Having access to STEM knowledge

Level 3: Studying STEM

Level 4: Working in STEM areas

Level 5: Generating STEM knowledge

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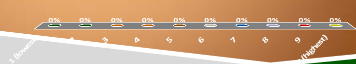
11. ON A SCALE OF 1 TO 10, HOW SATISFIED ARE YOU WITH YOUR SIMULATION EXPERIENCE?

1. 1 (lowest)
2. 2
3. 3
4. 4
5. 5
6. 6
7. 7
8. 8
9. 9
10. 10 (highest)



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BRIEFS AS A WAY TO DISSEMINATE

BUSINESS PARTNERSHIPS TO ADVANCE STEM EDUCATION:

Building a Bridge to Homegrown STEM Talent

Focus on Teachers

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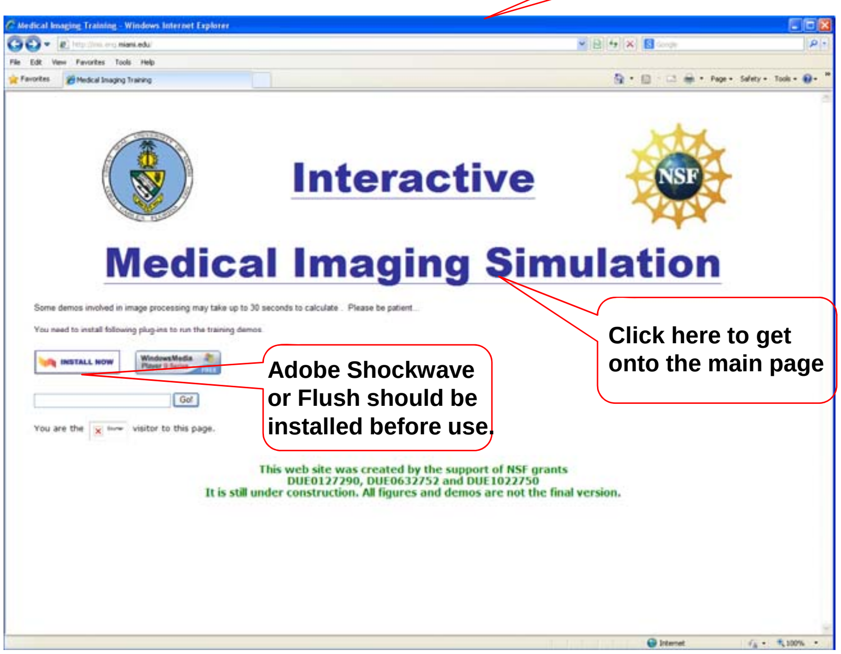
MITS/DATS TUTORIAL

Website: http://mis.eng.miami.edu/

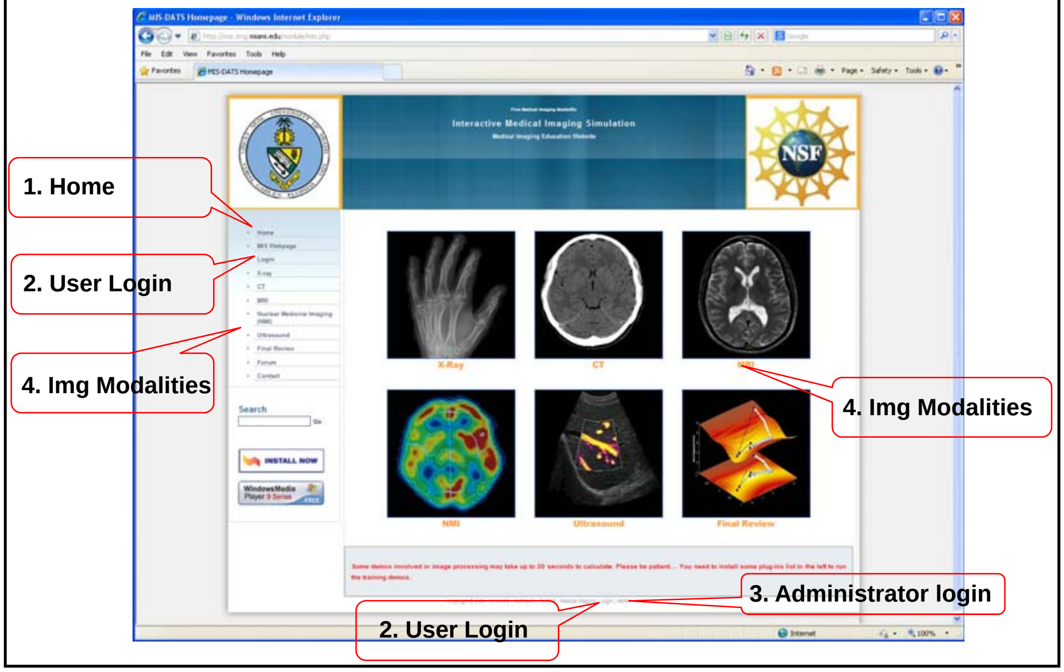
Start webpage



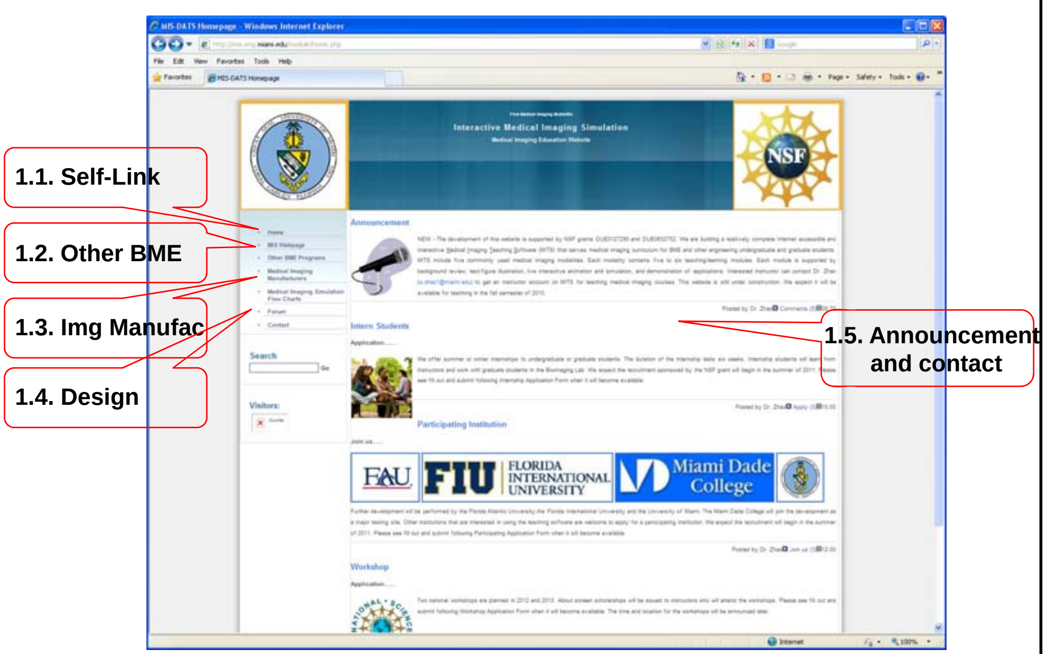
Click here to get onto the main page

Adobe Shockwave or Flush should be installed before use.

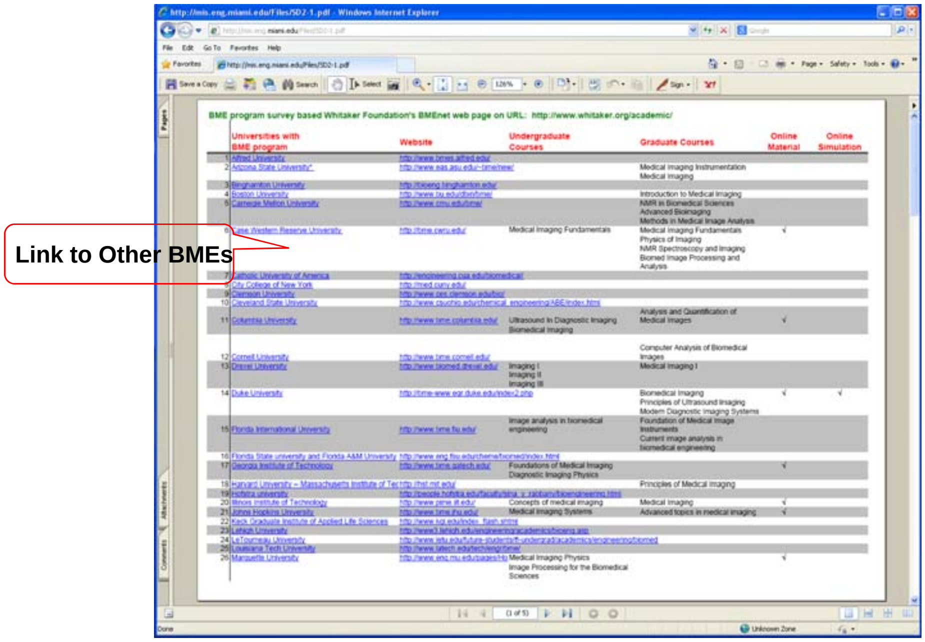
MIS Website: http://mis.eng.miami.edu/module/mis.php



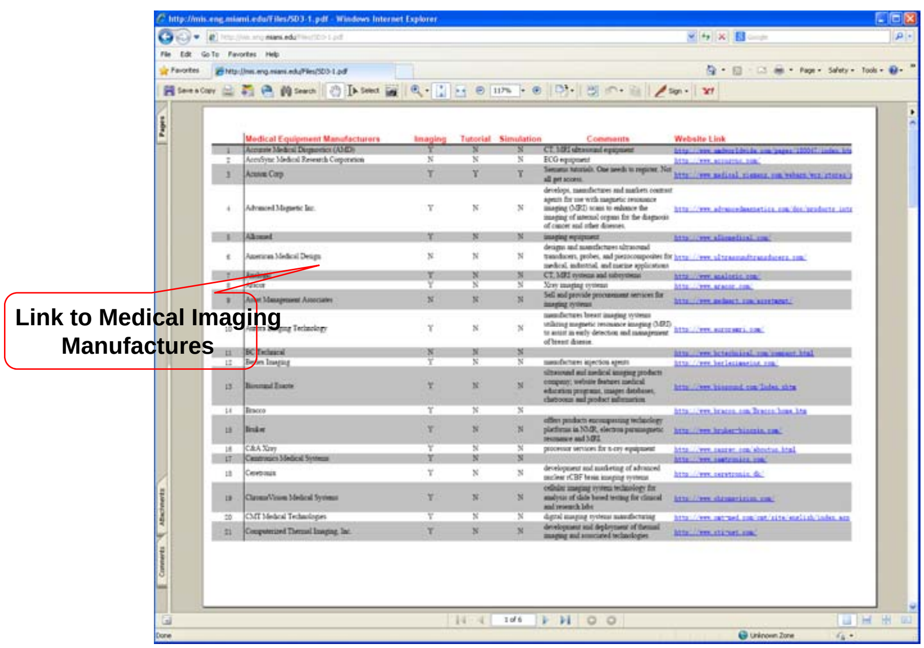
1. Home Page: http://mis.eng.miami.edu/module/home.php



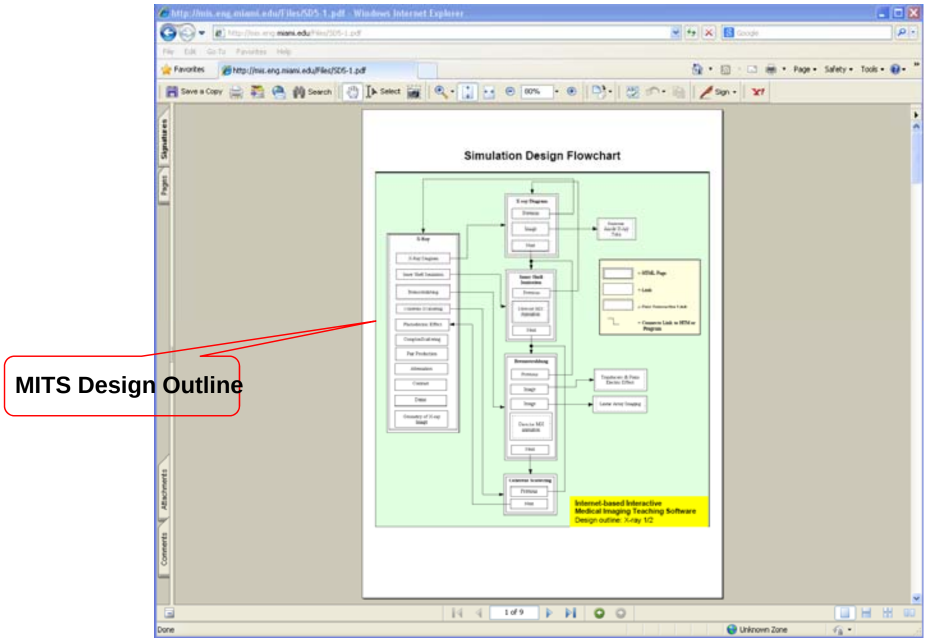
1.2. Link to other BME: http://mis.eng.miami.edu/Files/SD2-1.pdf



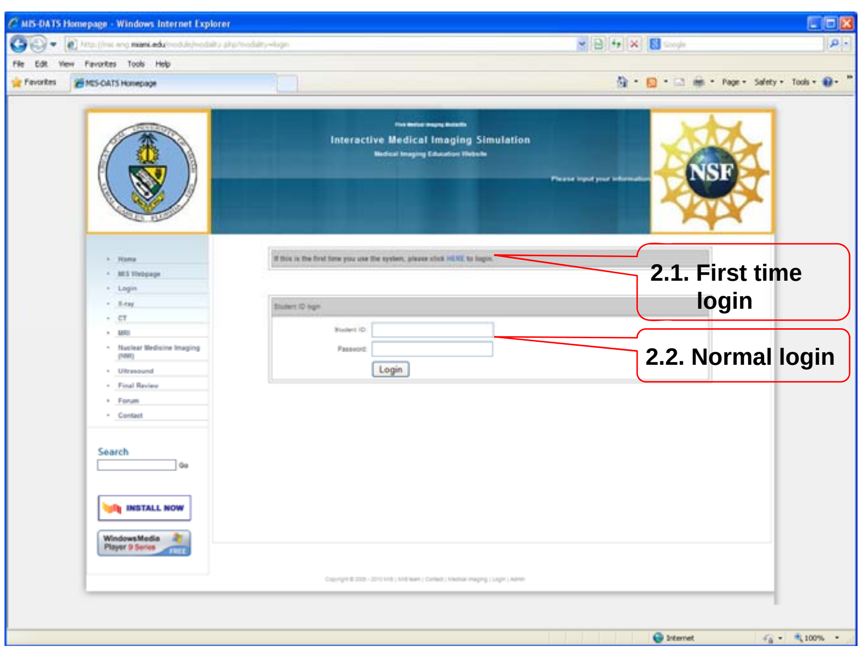
1.3 Link to Img Manufac: http://mis.eng.miami.edu/Files/SD3-1.pdf



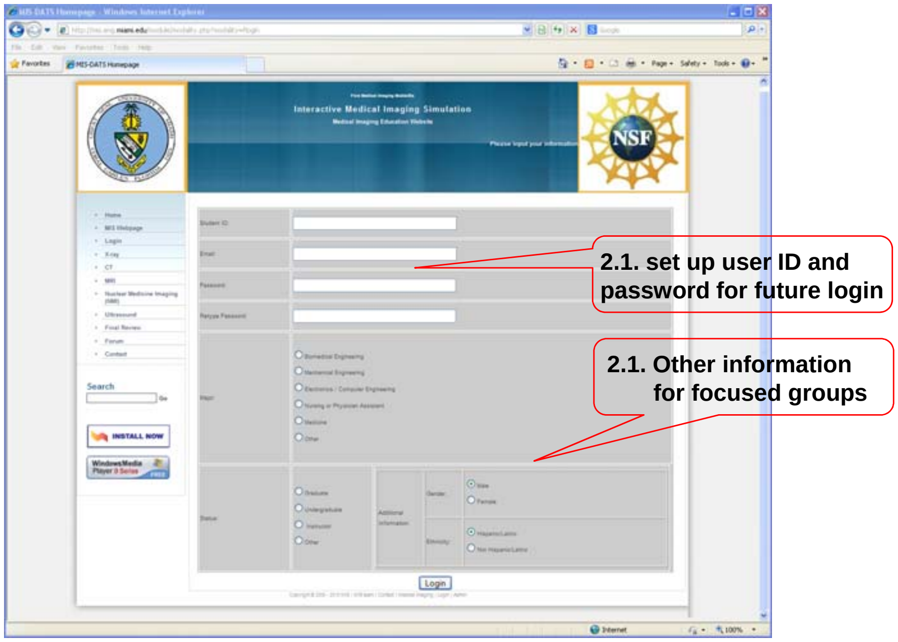
1.4. Design Outline: http://mis.eng.miami.edu/Files/SD5-1.pdf



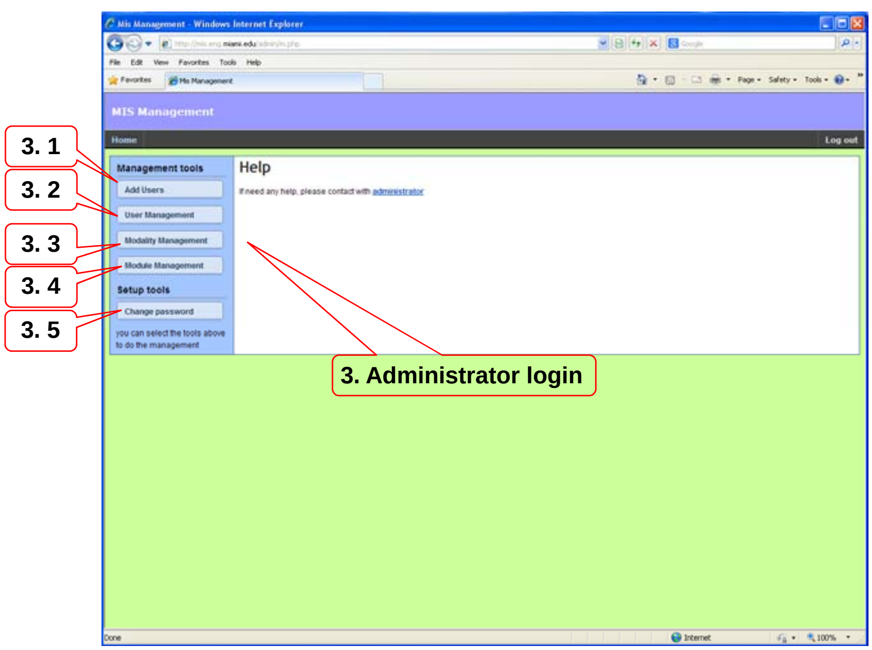
2. Login : http://mis.eng.miami.edu/module/modality.php?modality=login



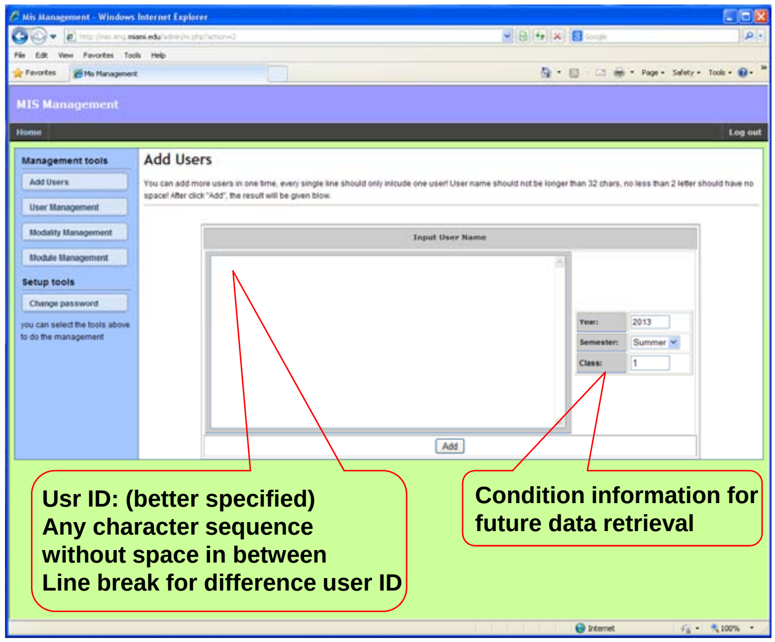
1st time Login : http://mis.eng.miami.edu/module/modality.php?modality=flogin



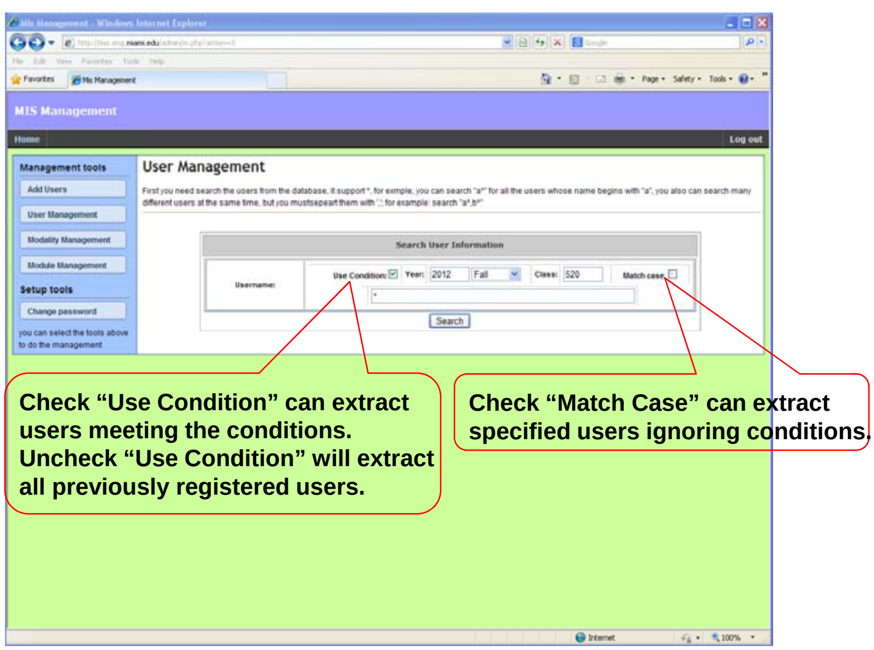
3. Admin Login: http://mis.eng.miami.edu/admin/m.php



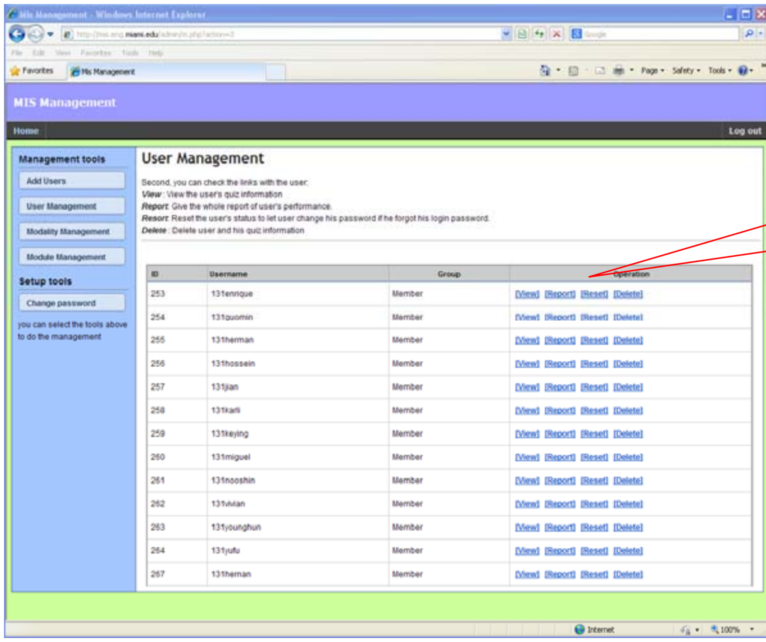
3.1. Add Users



3.2.1. User Management

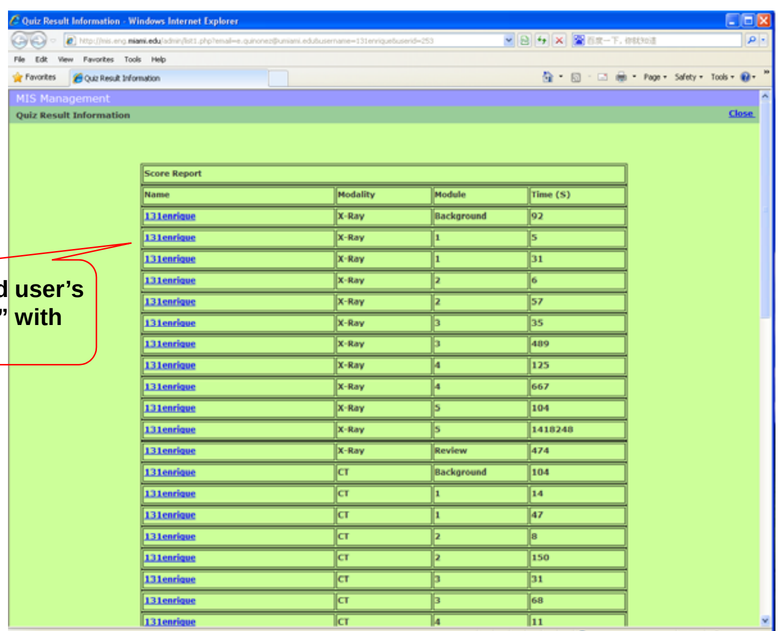


3.2.2. User Management



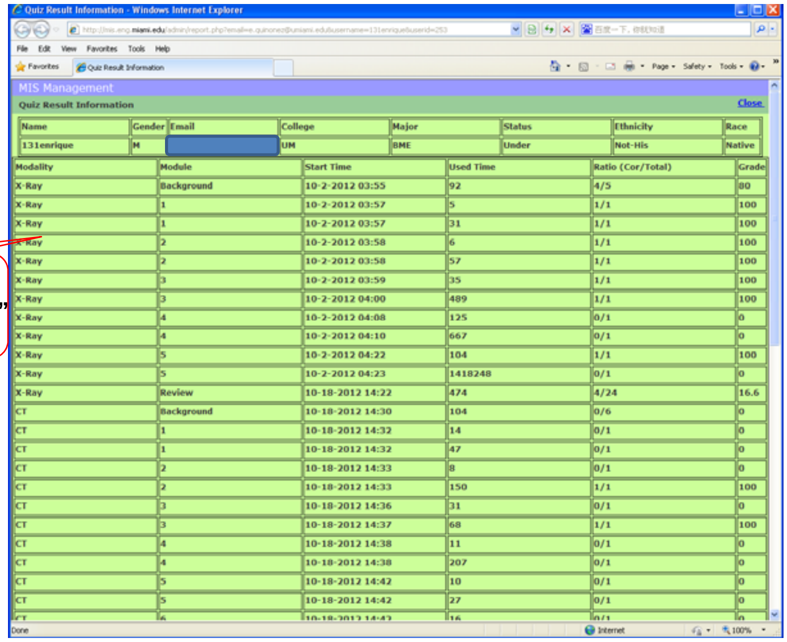
View
Report
Reset
Delete

3.2.3. User Management → View



View specified user's "engagement" with the system.

3.2.4. User Management → Report

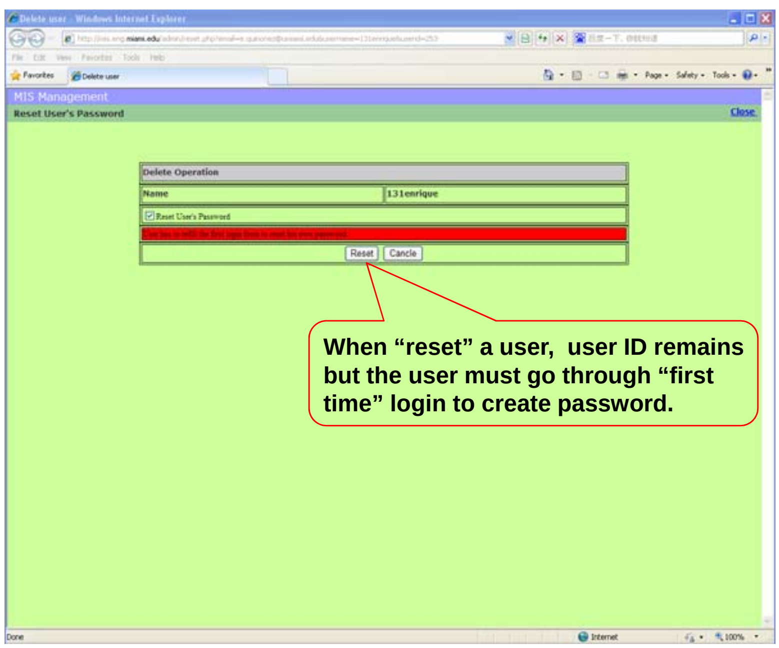


Name	Gender	Email	College	Major	Status	Ethnicity	Race
131enrique	M	[redacted]	UM	BME	Under	Not-His	Native

Modality	Module	Start Time	Used Time	Ratio (Cor/Total)	Grade
X-Ray	Background	10-2-2012 03:55	92	4/5	80
X-Ray	1	10-2-2012 03:57	5	1/1	100
X-Ray	1	10-2-2012 03:57	31	1/1	100
X-Ray	2	10-2-2012 03:58	6	1/1	100
X-Ray	2	10-2-2012 03:58	57	1/1	100
X-Ray	3	10-2-2012 03:59	35	1/1	100
X-Ray	3	10-2-2012 04:00	489	1/1	100
X-Ray	4	10-2-2012 04:08	125	0/1	0
X-Ray	4	10-2-2012 04:10	667	0/1	0
X-Ray	5	10-2-2012 04:22	104	1/1	100
X-Ray	5	10-2-2012 04:23	1418248	0/1	0
X-Ray	Review	10-18-2012 14:22	474	4/24	16.6
CT	Background	10-18-2012 14:30	104	0/6	0
CT	1	10-18-2012 14:32	14	0/1	0
CT	1	10-18-2012 14:32	47	0/1	0
CT	2	10-18-2012 14:33	8	0/1	0
CT	2	10-18-2012 14:33	150	1/1	100
CT	3	10-18-2012 14:36	31	0/1	0
CT	3	10-18-2012 14:37	68	1/1	100
CT	4	10-18-2012 14:38	11	0/1	0
CT	4	10-18-2012 14:38	207	0/1	0
CT	5	10-18-2012 14:42	10	0/1	0
CT	5	10-18-2012 14:42	27	0/1	0
CT	6	10-18-2012 14:42	16	0/1	0

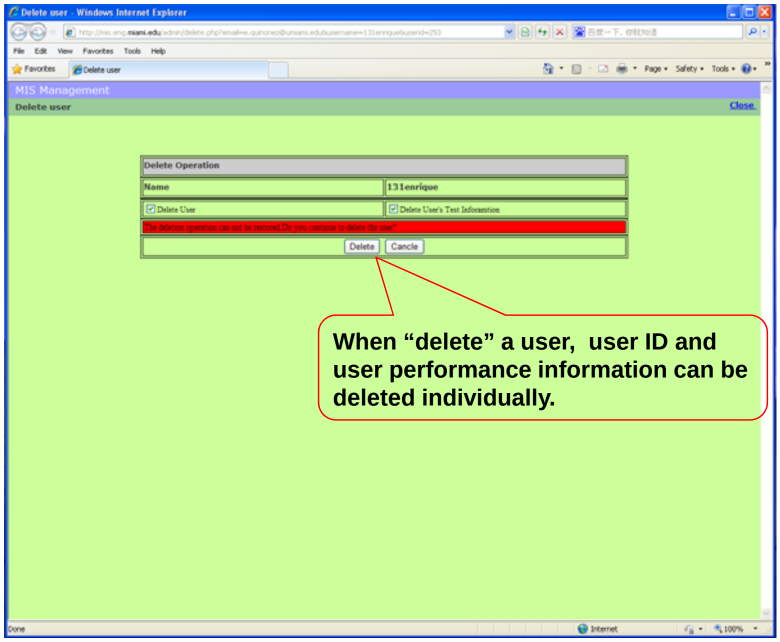
Output specified user's "performance" In each module.

3.2.5. User Management → Reset

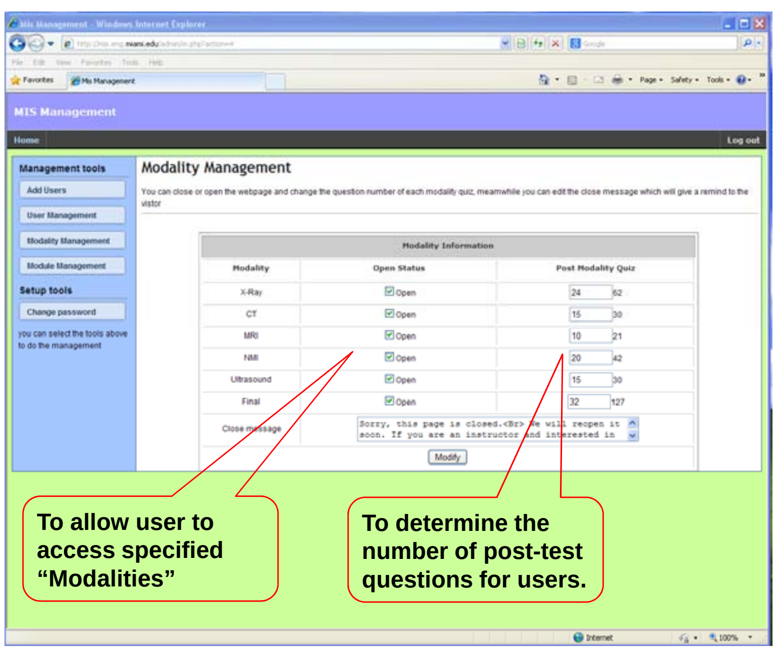


When "reset" a user, user ID remains but the user must go through "first time" login to create password.

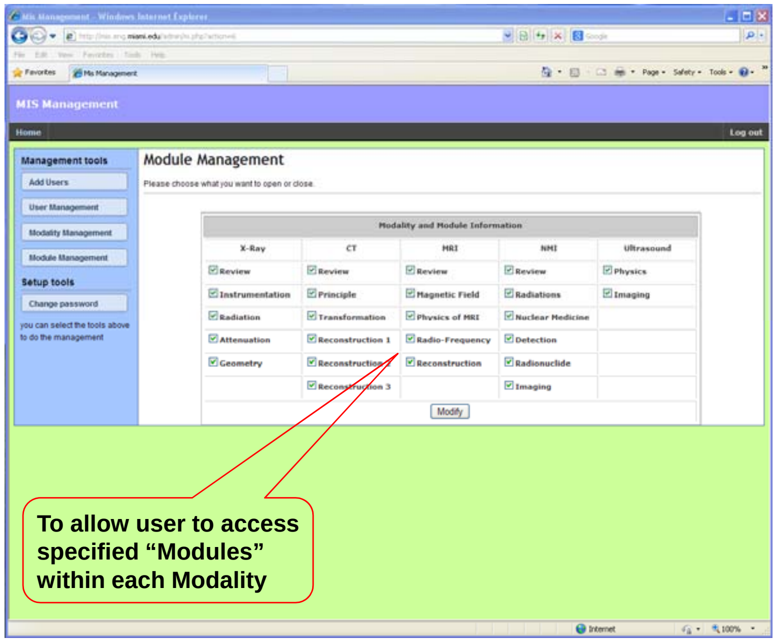
3.2.6. User Management → Delete



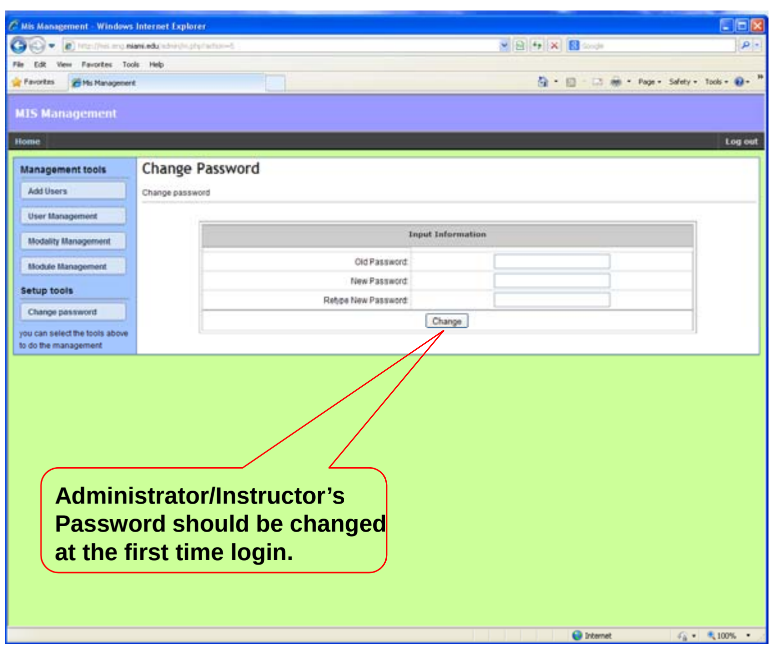
3.3. Modality Management



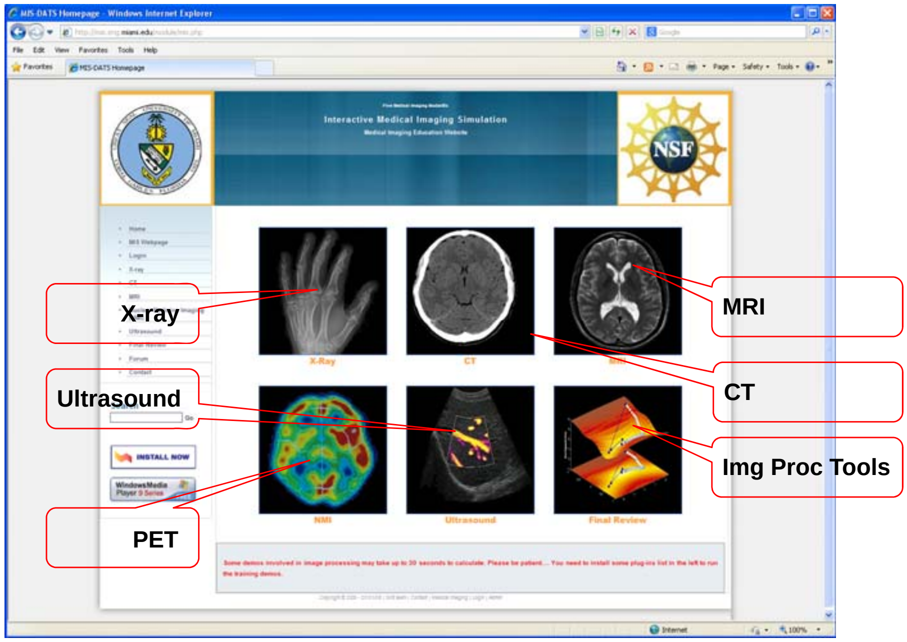
3.4. Module Management



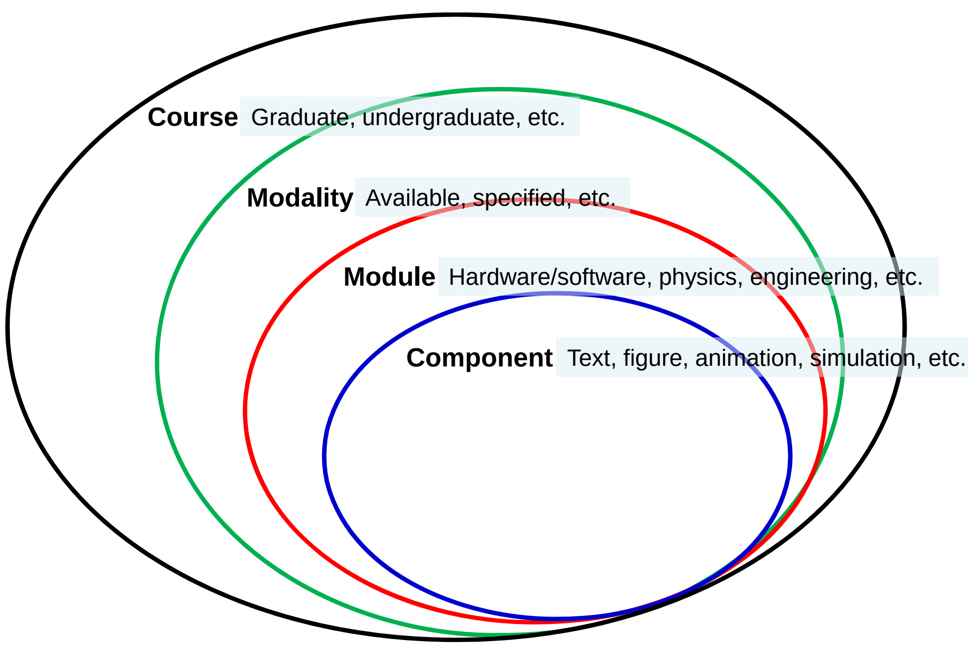
3.5. Change Password



4. MIS Website: http://mis.eng.miami.edu/module/mis.php



4.1. Hierarchical Design



4.2. Learning Assessment

Pre-Modality Test (4~5 concept questions)

Pre-Module Test (1~2 concept questions)

Module 1

Post-Module Test (1~2 concept questions)

Pre-Module Test (1~2 concept questions)

Module 2

Post-Module Test (1~2 concept questions)

MODALITY 1

Post-Modality Test (10~20 out of ~40 questions)

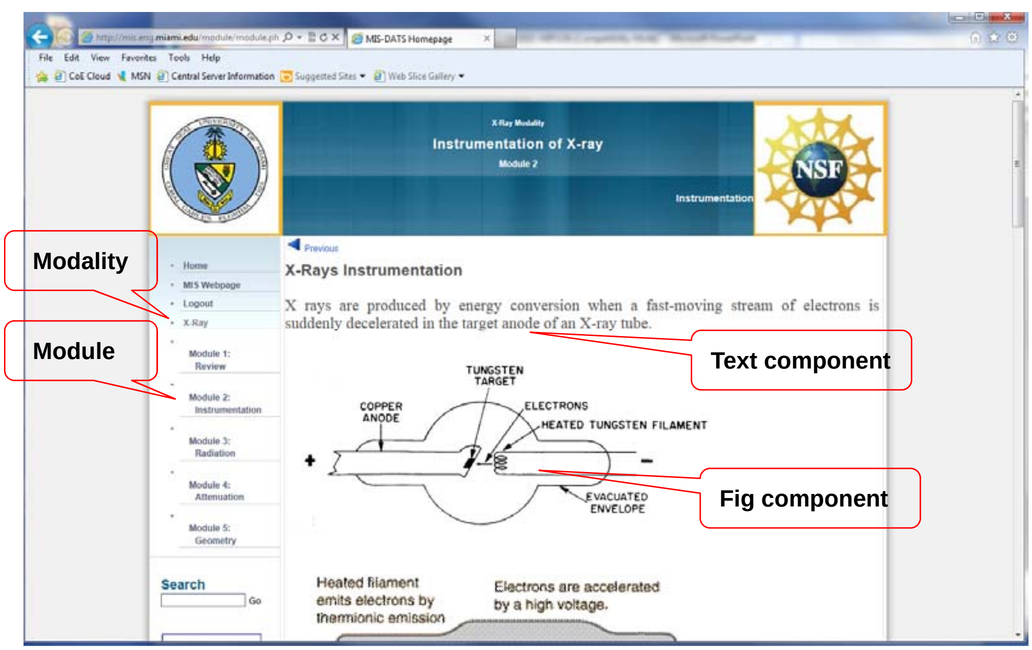
Final Review Test (40~50 out of ~100 questions)

Module Assessment

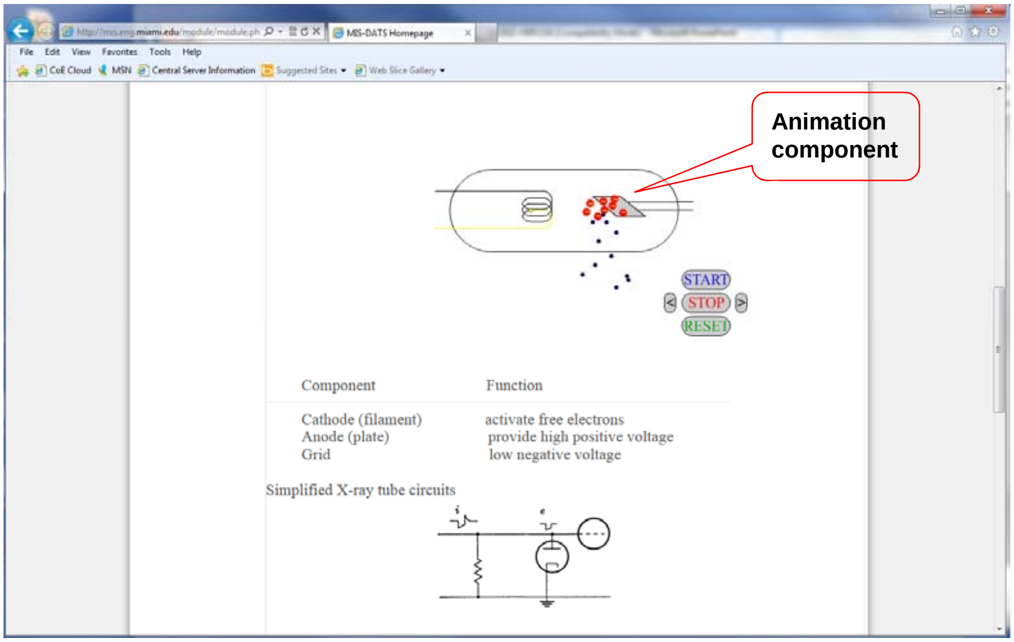
Modality Assessment

Course Assessment

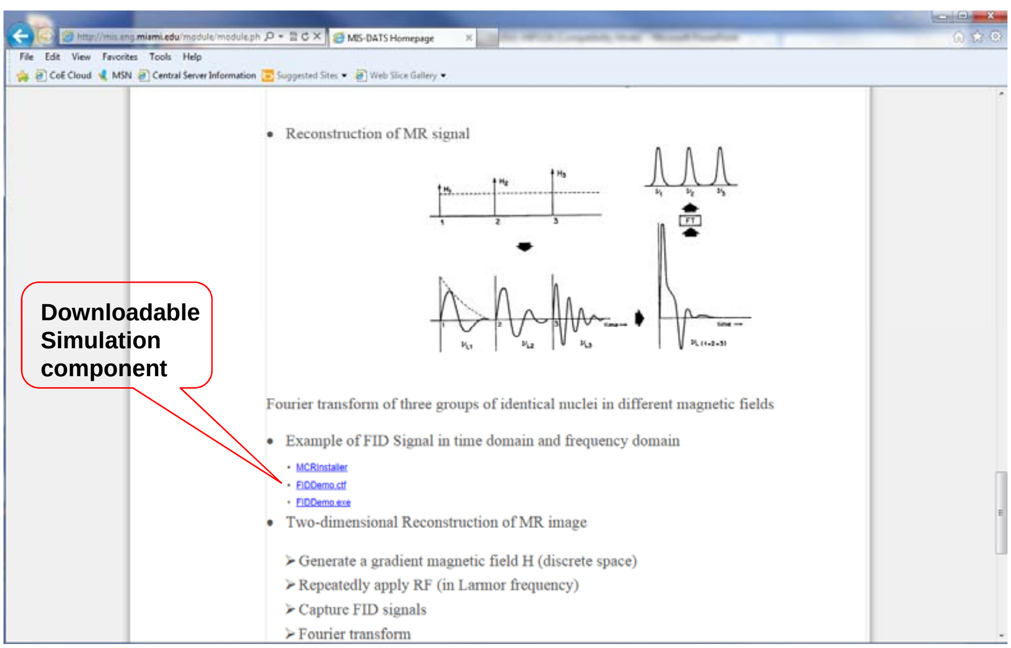
4.3. Example



4.3. Example

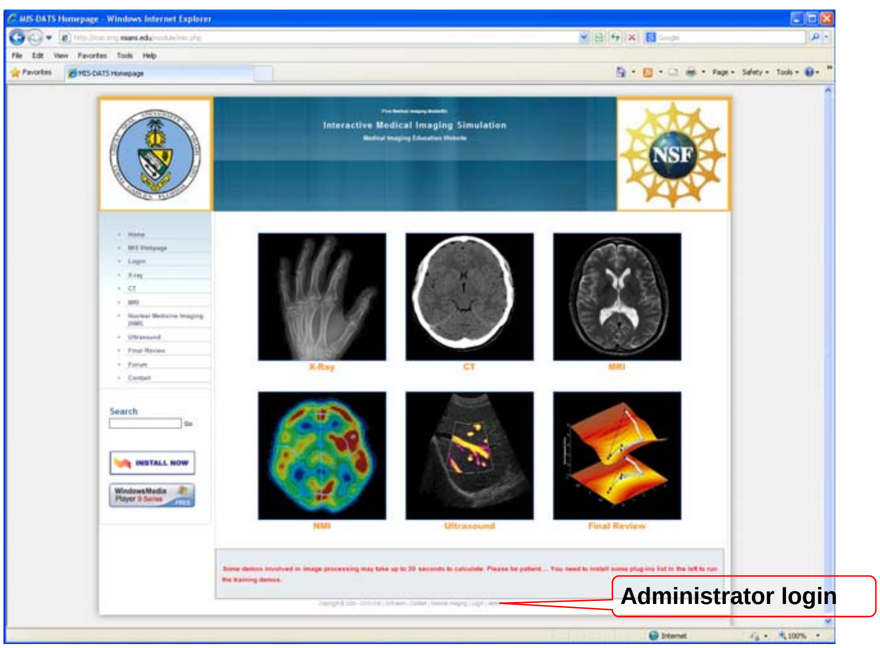


4.3. Example

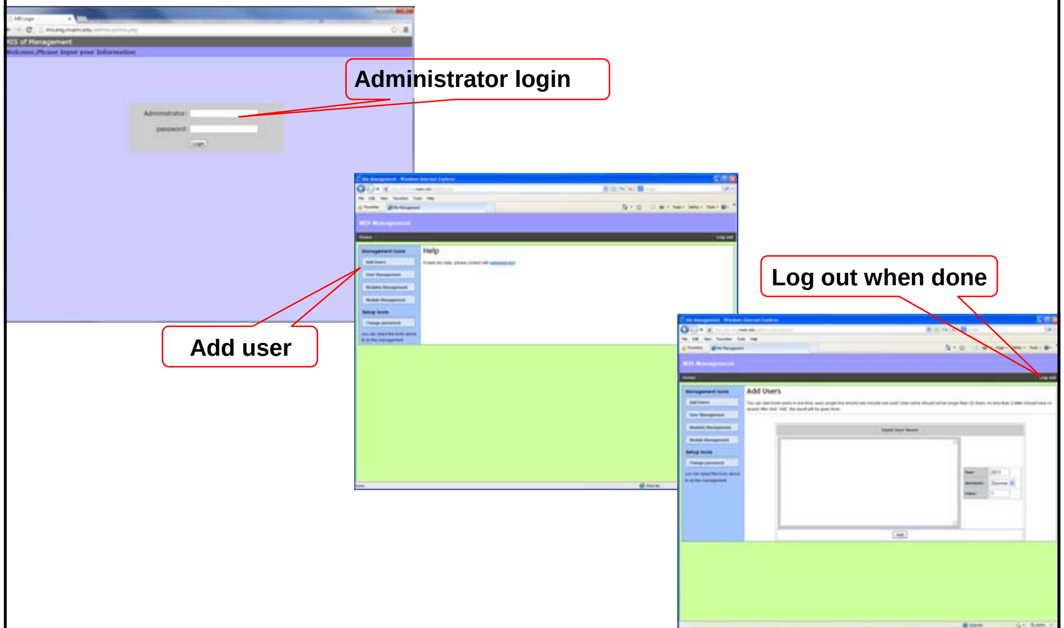


Go through an Imaging Modality

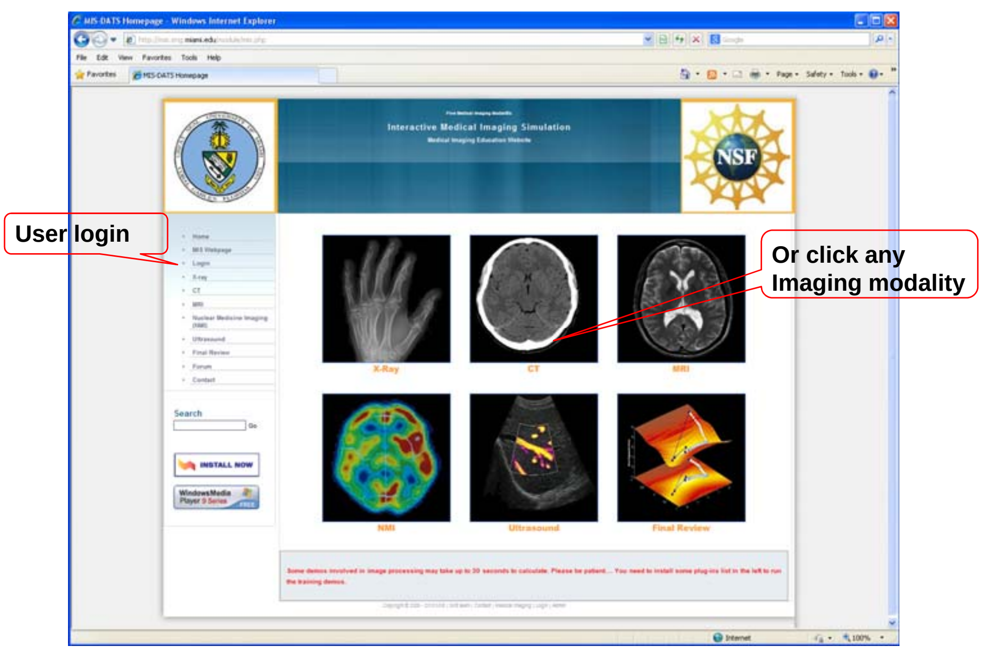
Step 1: Administrator Login



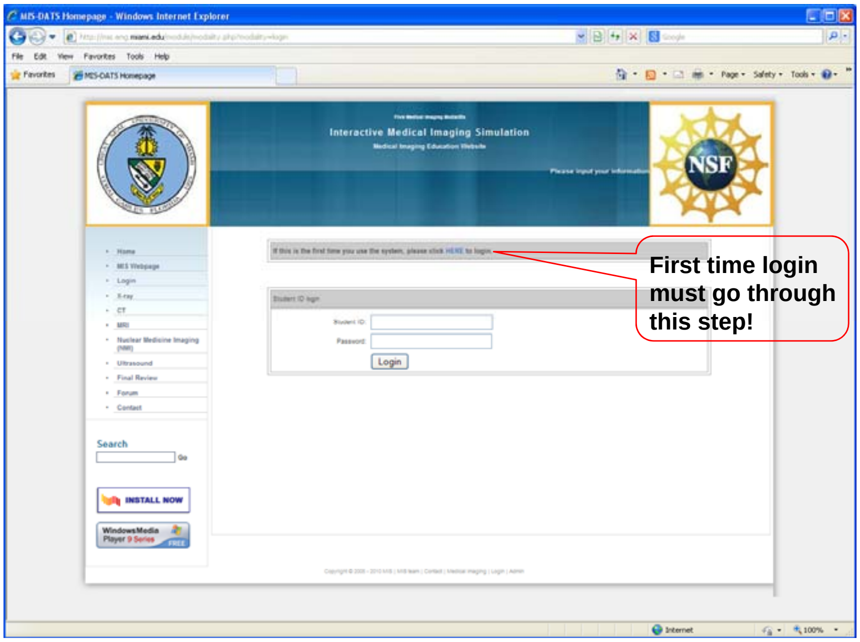
Step 2: Create User Account



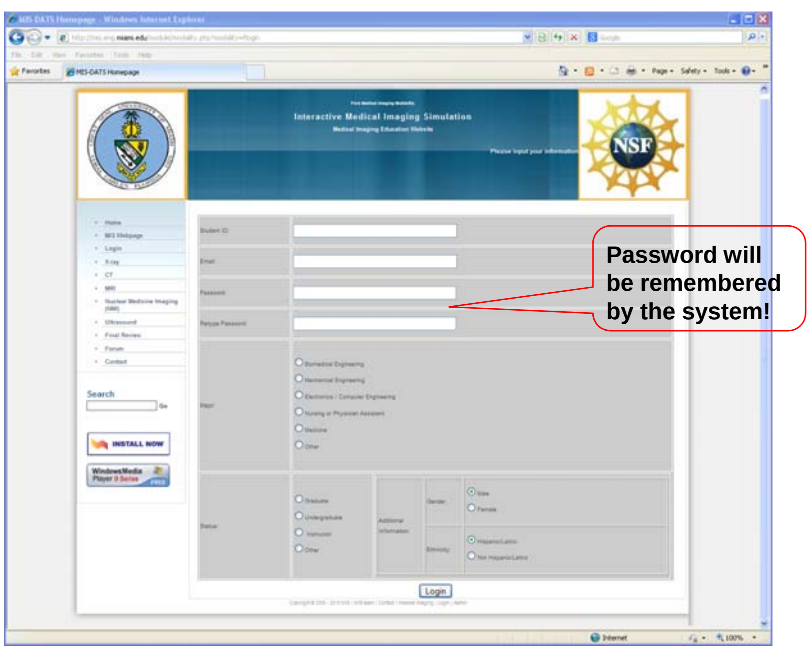
Step 3: User Login



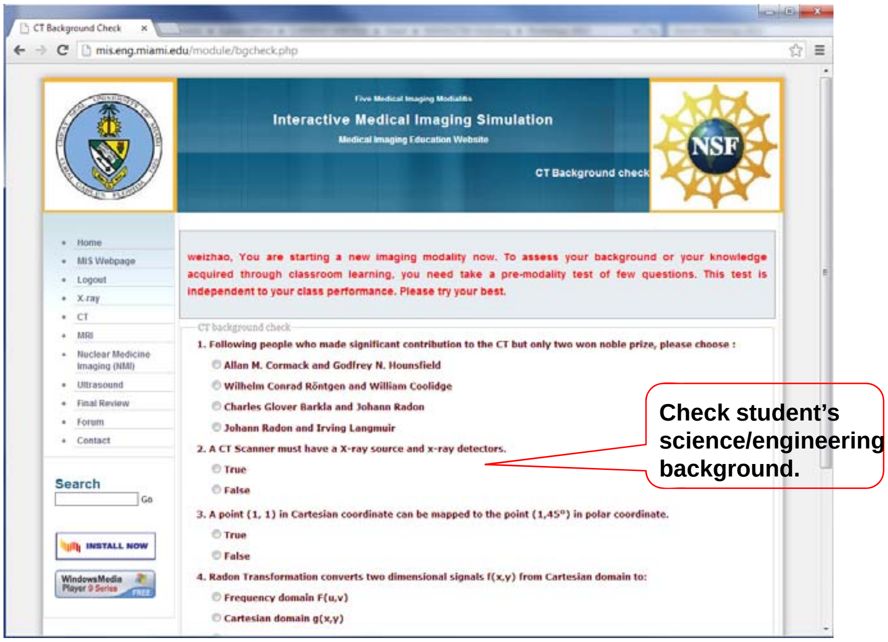
Step 3: User Login



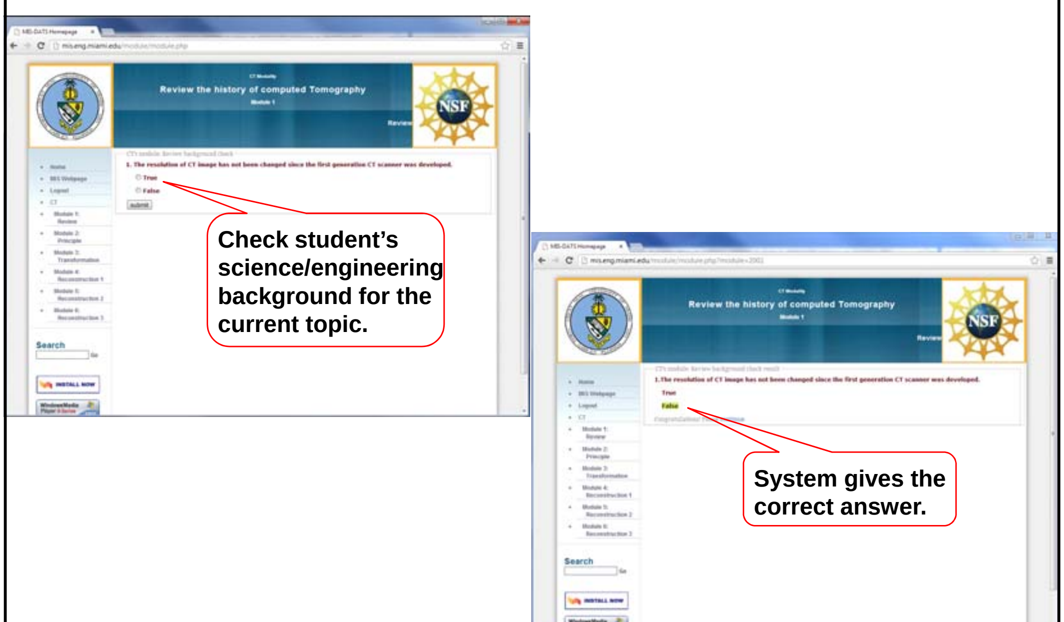
Step 4: User Information



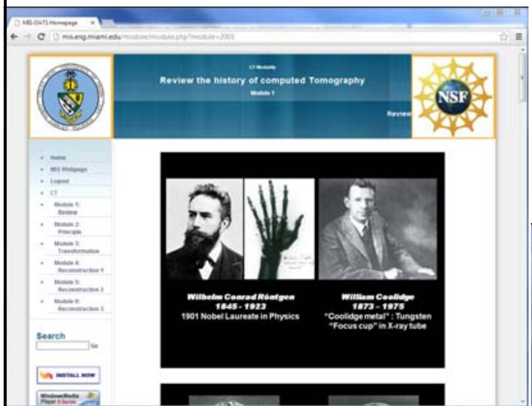
Step 5: Go through CT Modality: Pre-Modality Assessment

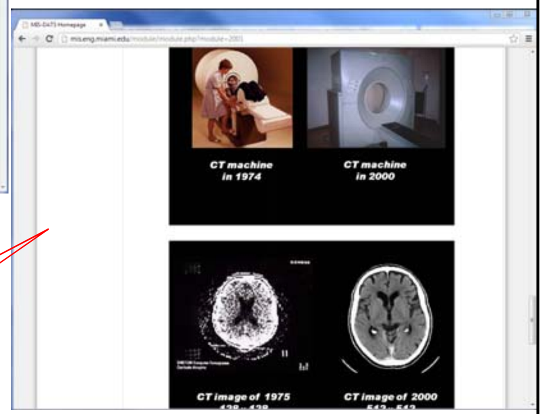


Step 6: Go through CT Modality: Pre-Module 1 Assessment



Step 7: Go through CT Modality: Module 1



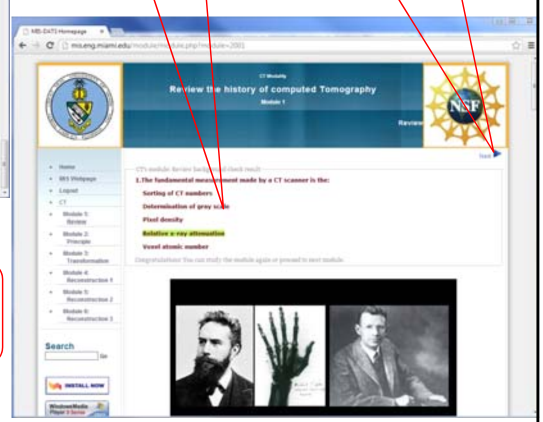


This module mainly uses slide presentation.

Step 8: Go through CT Modality: Post-Module 1 Assessment

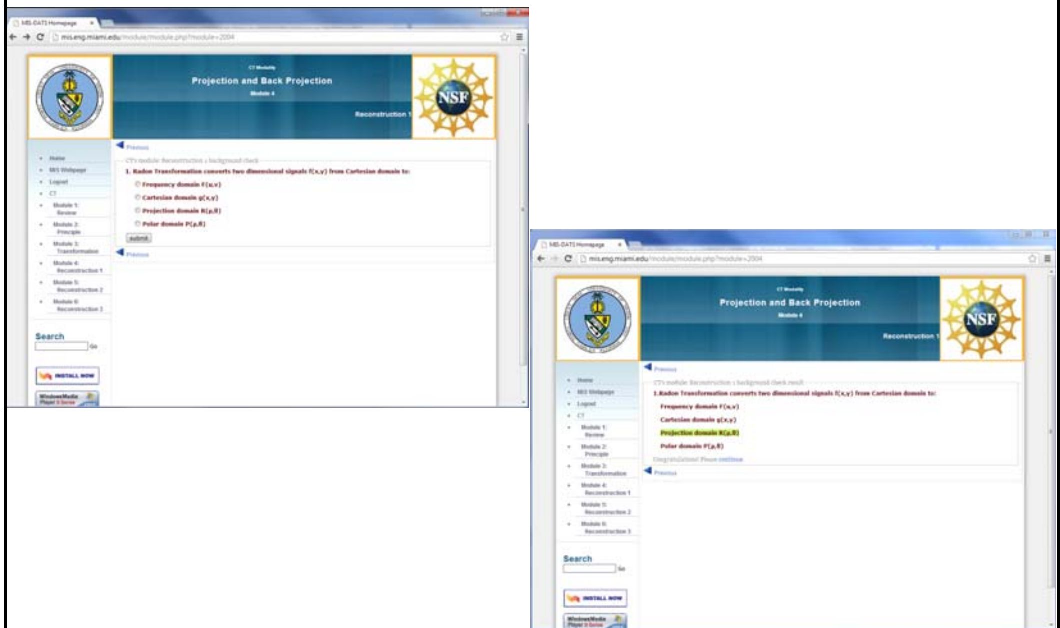
System gives the correct answer.

Click Next to proceed to next module.

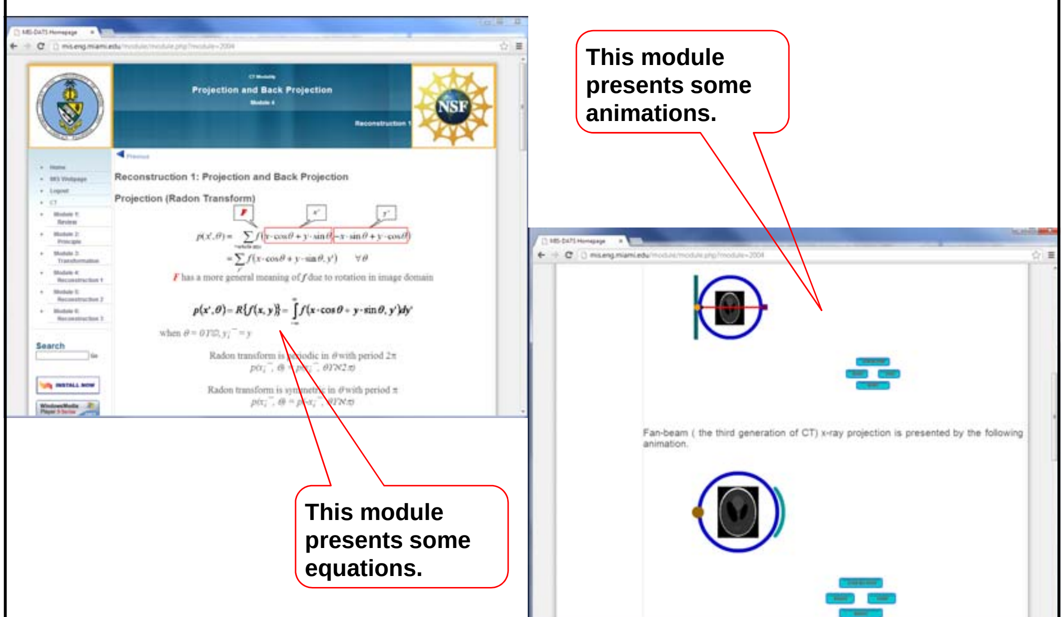


This post-quiz question is usually the key concept for the module.

Step 9: Go through CT Modality: Pre-Module 4 Assessment

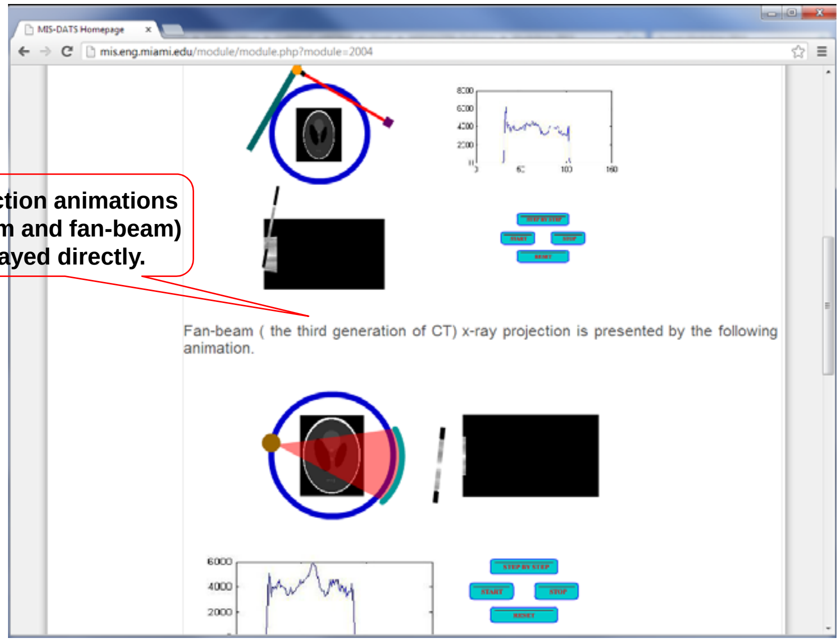


Step 10: Go through CT Modality: Module 4



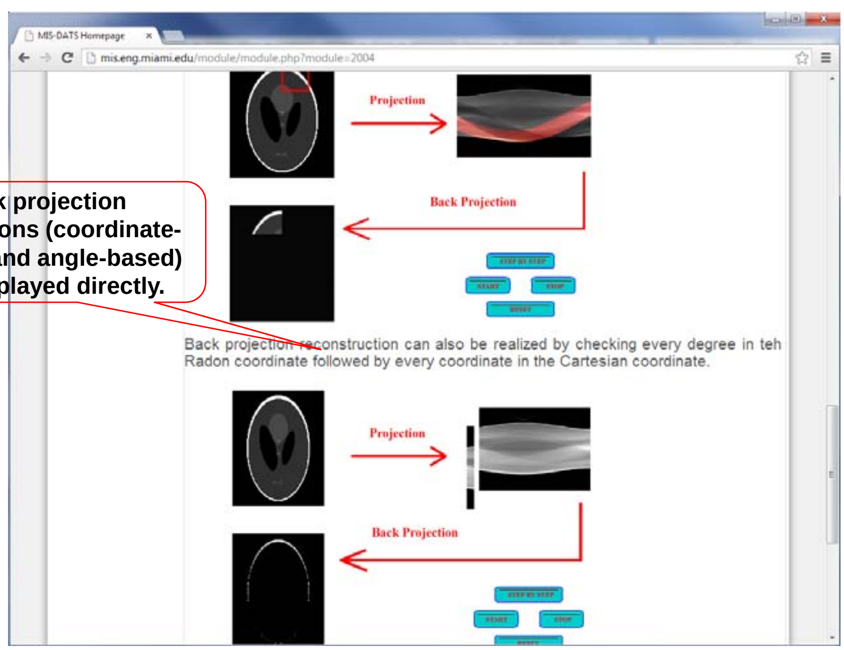
Step 11: Go through CT Modality: Module 4 (Projection)

CT projection animations (pen-beam and fan-beam) can be played directly.

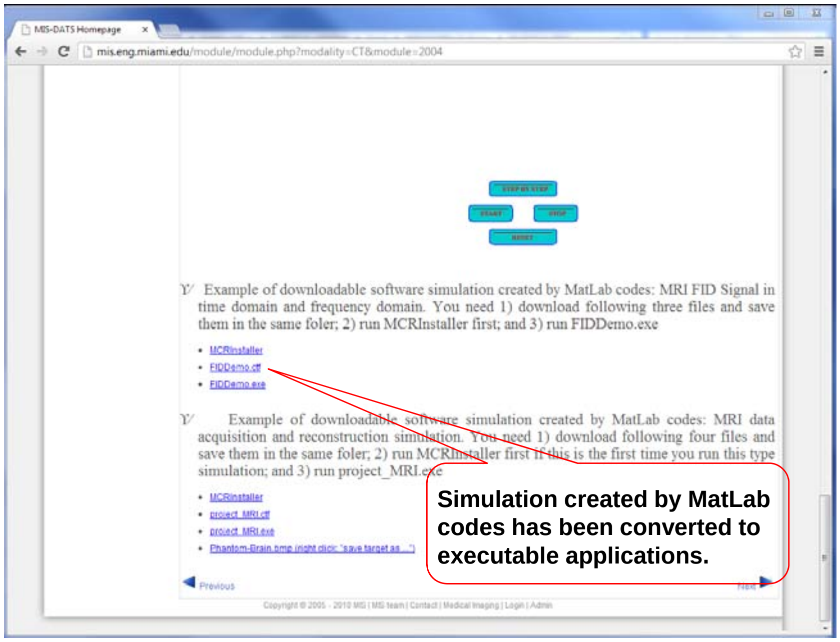


Step 12: Go through CT Modality: Module 4 (Back Projection)

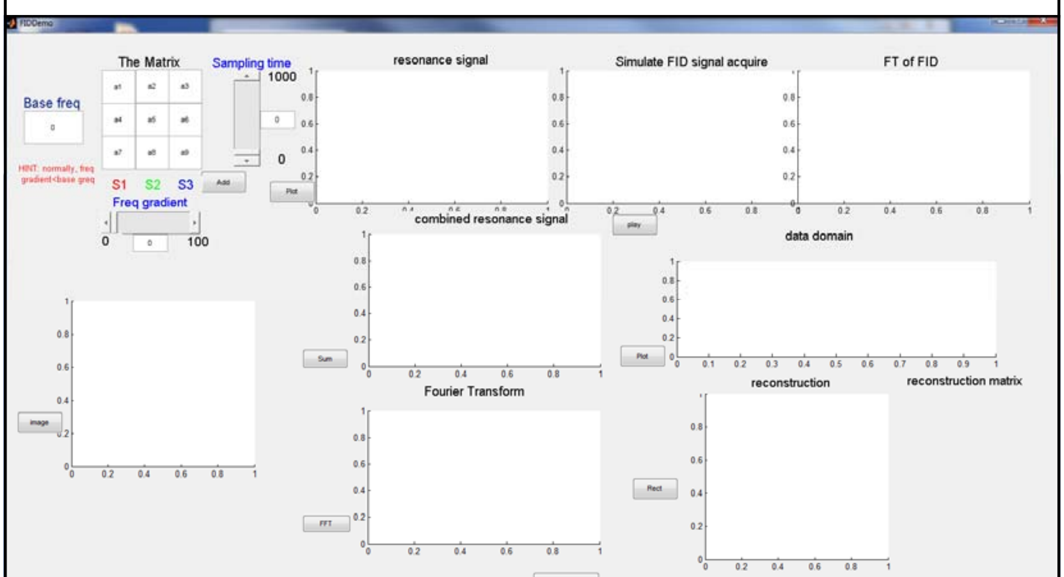
CT back projection animations (coordinate-based and angle-based) can be played directly.



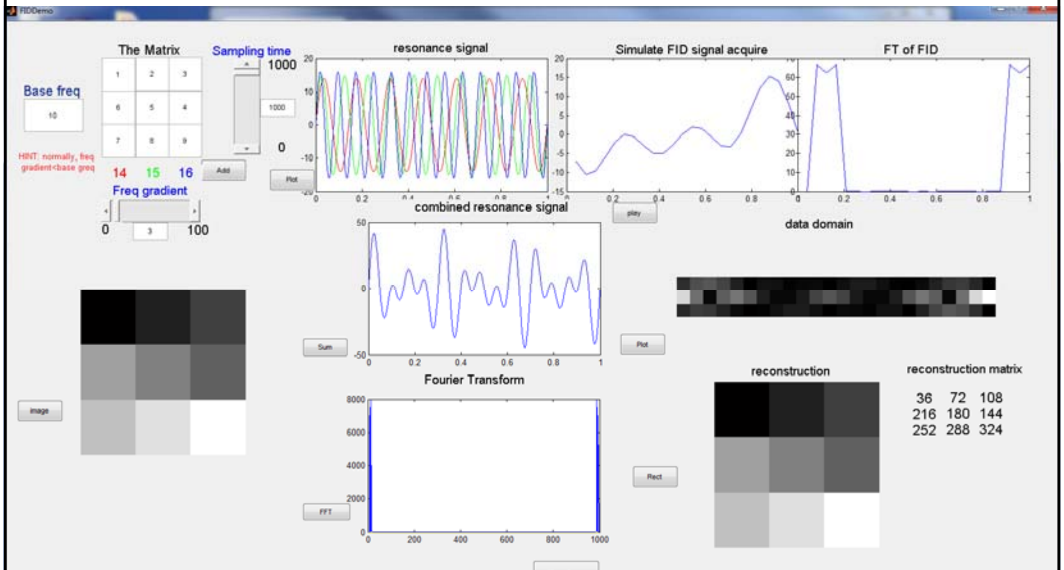
Step 13: Download Executable Simulation created by MatLab



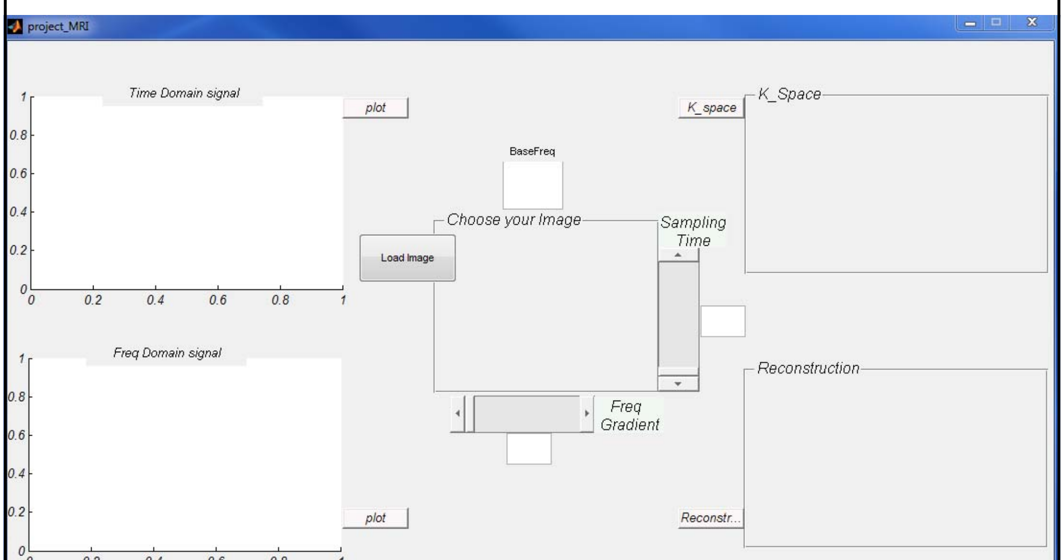
Step 14: Executable Simulation (FID)



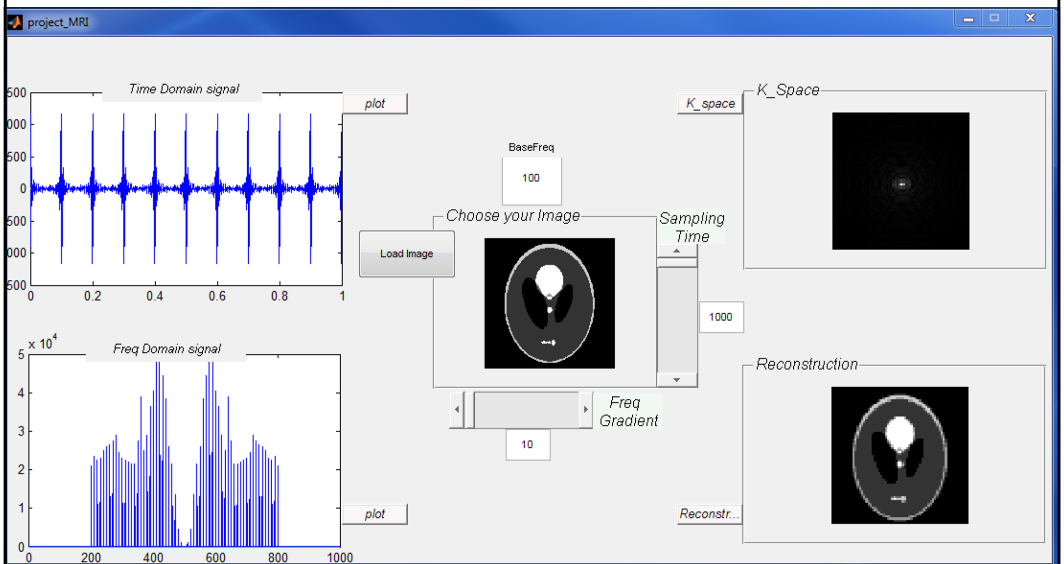
Step 15: Executable Simulation (FID)



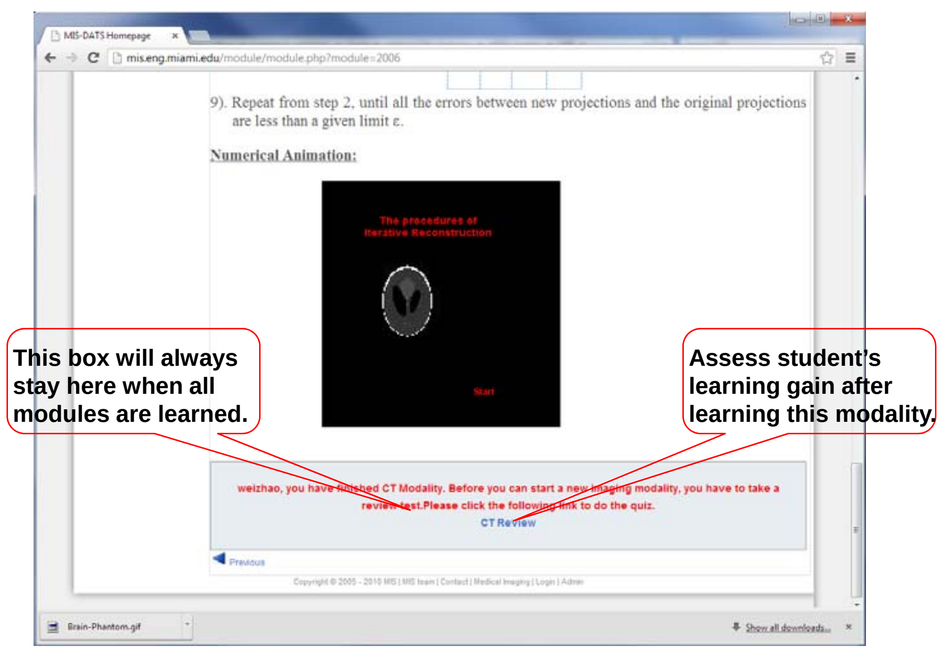
Step 16: Executable Simulation (MRI)



Step 17: Executable Simulation (MRI)



Step 18: Go through CT Modality: Post-Modality Assessment

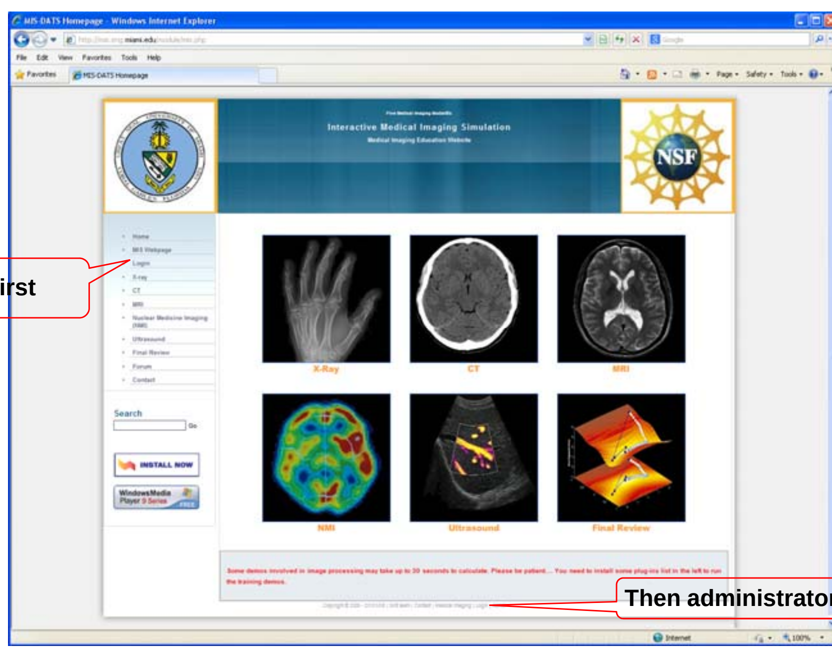


Step 19: Go through CT Modality: Post-Modality Assessment

Every question must be answered to completer the assessment.

Deficits? Answers are not provided to user but to Instructor.

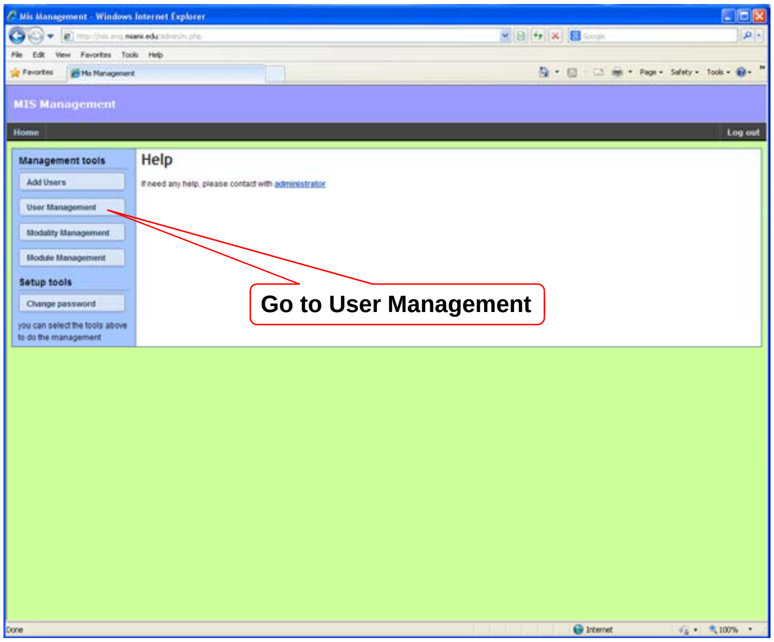
Step 20: Track Student Performance



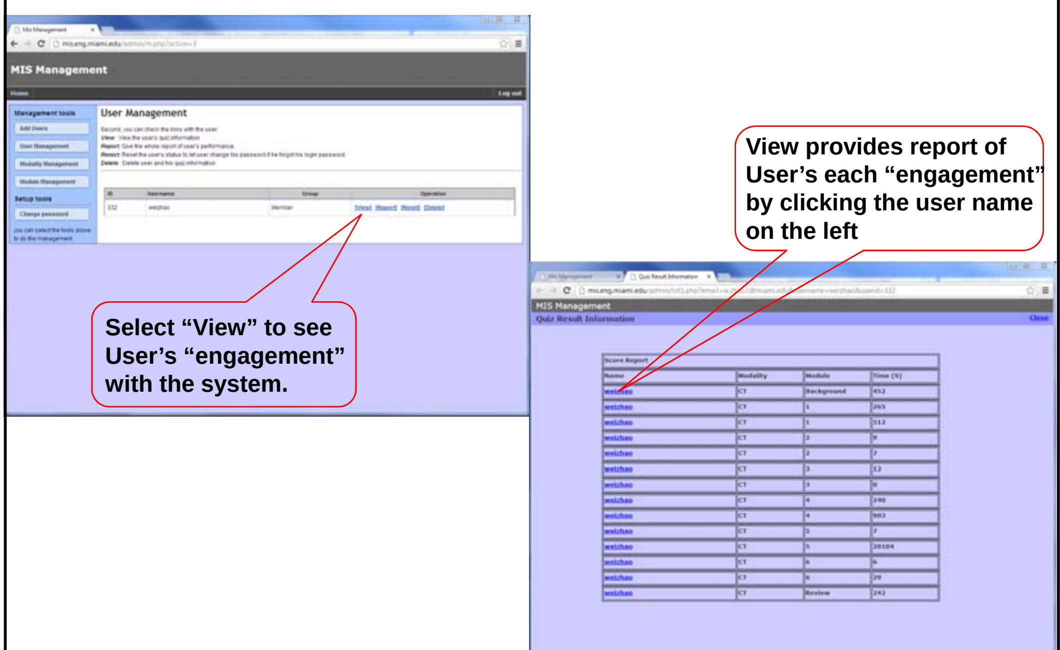
Log out first

Then administrator login

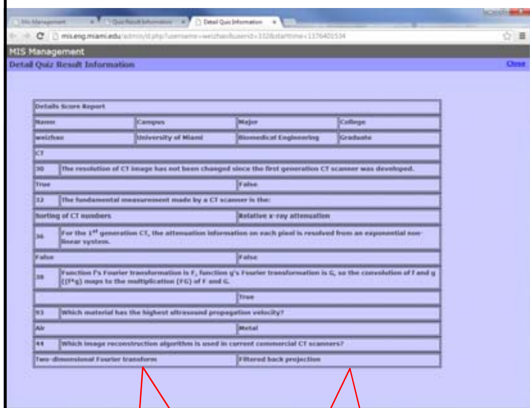
Step 20: Track Student Performance



Step 21: Track Student Performance



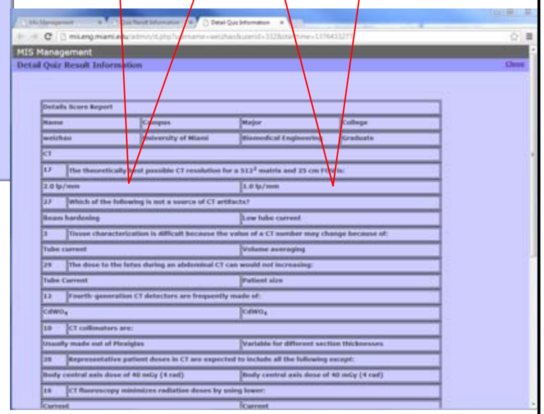
Step 22: Track Student Performance



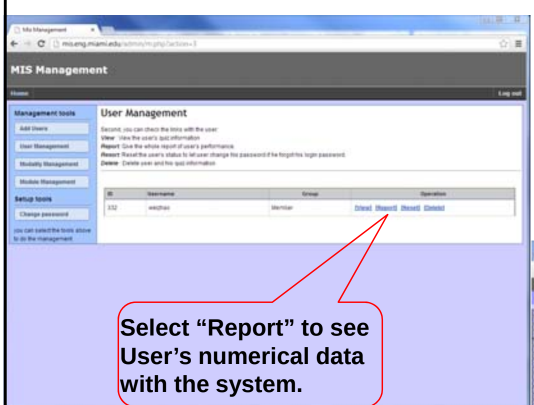
Left column is user's answers.
Right column is correct answers.

Performance on assessment questions for Pre-post Modality and Pre-post Module are reported here.

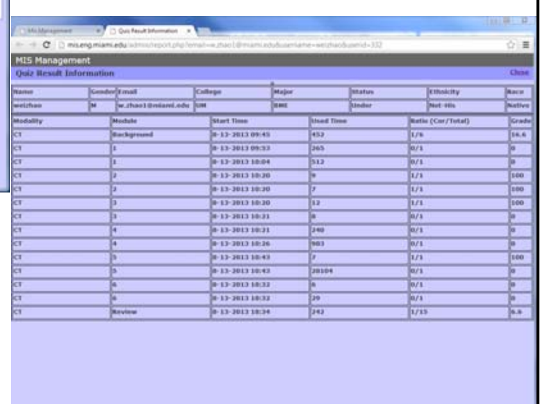
Left column is user's answers.
Right column is correct answers.



Step 23: Track Student Performance



Select "Report" to see User's numerical data with the system.



- Administrator is a “User”
- Modalities are “Parallel”
- Modules are “Sequential”
- User Manual is attached
- System will be updated continuously
- Correction and revision are welcome
- New development are very much welcome

Instruction to MITS/DATS online courseware

MITS: Medical Imaging Teaching Software
DATS: Dynamic Assessment Tracking System

MITS/DATS is designed for medical imaging education as an online courseware that is particularly used under a hybrid teaching/learning environment. The courseware consists of five commonly used medical imaging modalities (X-ray, CT, MRI, PET, and Ultrasound) and commonly used image processing tools (under construction). Each imaging modality consists of six basic components to deliver knowledge to students, 1) text description, 2) figure/picture/image illustration, 3) interactive animation, 4) interactive simulation, 5) pre-post assessment and 6) library of medical imaging application (under construction).
Each imaging modality in MITS contains several teaching modules (teaching/learning topics).
DATS is a database under MySQL environment. DATS is the "manager" of MITS. DATS controls turning on/off modalities, modules, assessment questions and user enrollment.

Home page: http://mis.eng.miami.edu/module/home.php,

On the home page, we provide
Links to Other BME Program in USA (updated 2009)
Links to Medical Imaging Manufactures (updated 2009)
Links to Imaging Simulation Flow Charts (updated 2008)

Announcement: updating news for MITS/DATS
Intern Students: application for internship
Participating Institution: application as a user-institution
Faculty Workshop: application for attending NSF-funded workshop

From the home page to the MITS page, either click the MIS Webpage or enter the MITS address http://mis.eng.miami.edu/module/mis.php

see captured screen:

Note that the MIS link is a webpage under the MITS/DATS home page

Login as Administrator/Instructor

Go to the **bottom of the page** (home page or MIS page)

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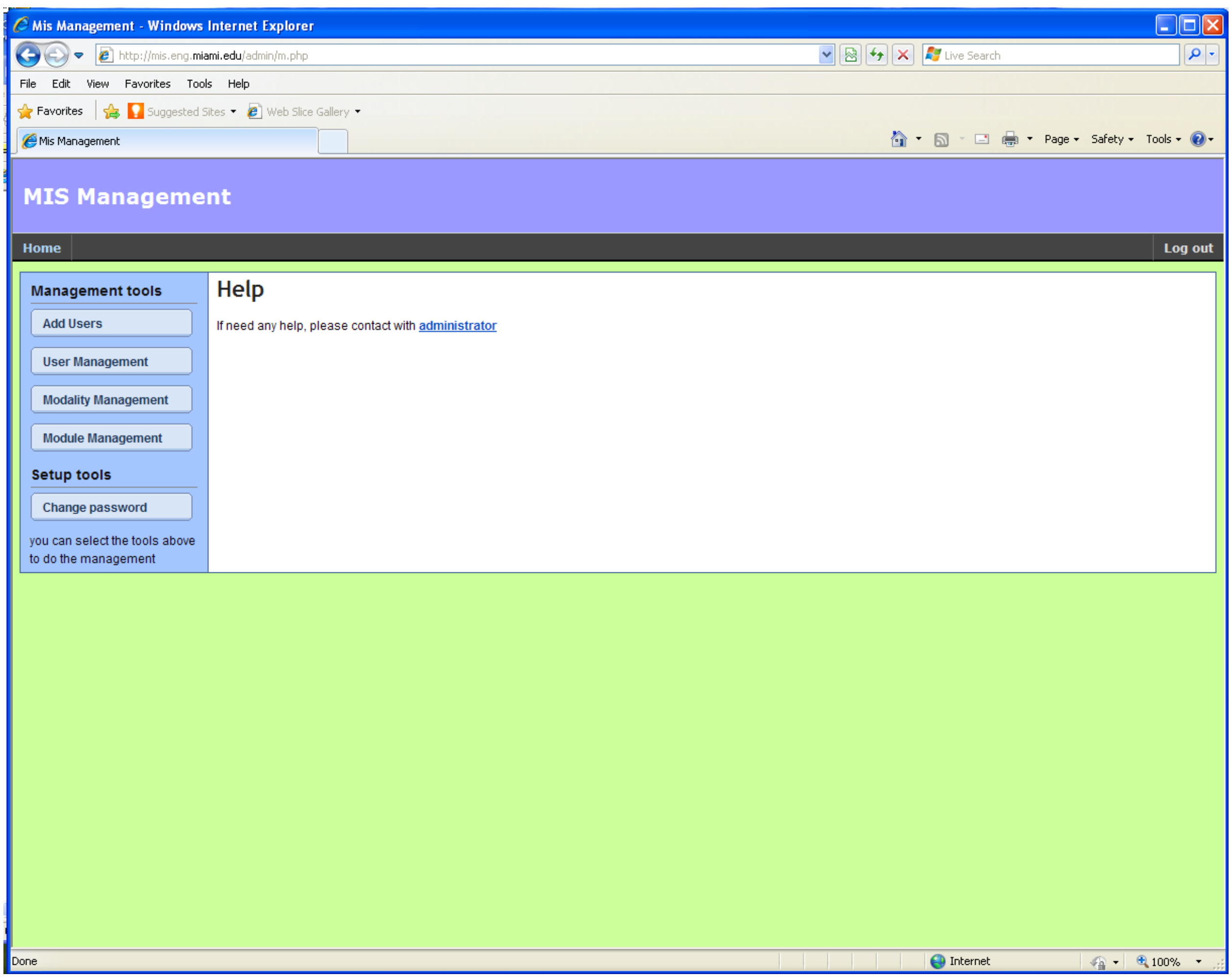
Click "Admin", enter your username and password, it will link you to the **administrator login page**. Administrator/instructor can do following:

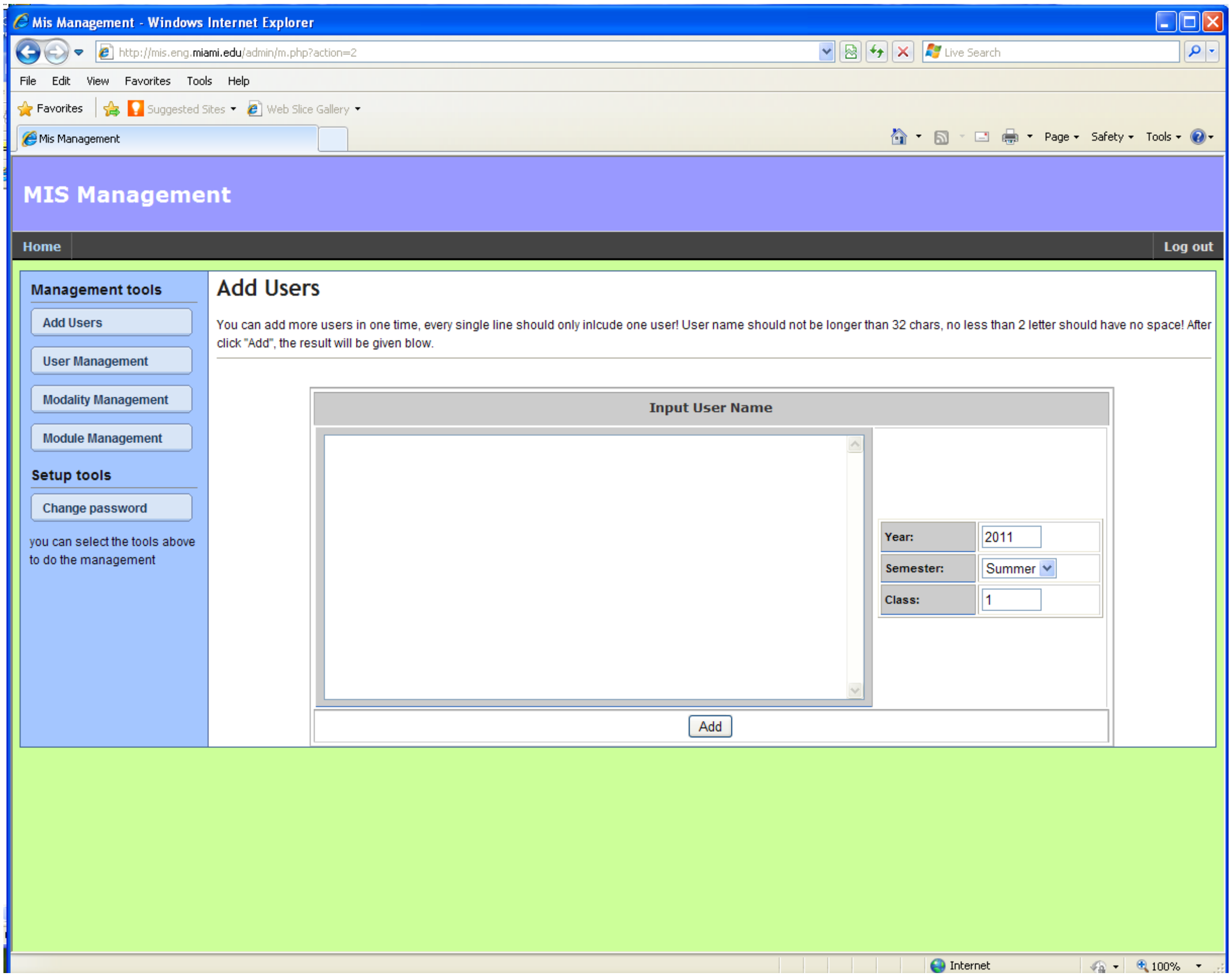
1) Add Users
2) User Management
3) Modality Management
4) Module management
5) Change Password

The interface is displayed as following:



You can select the tools listed above to manage the system.

Add Users:



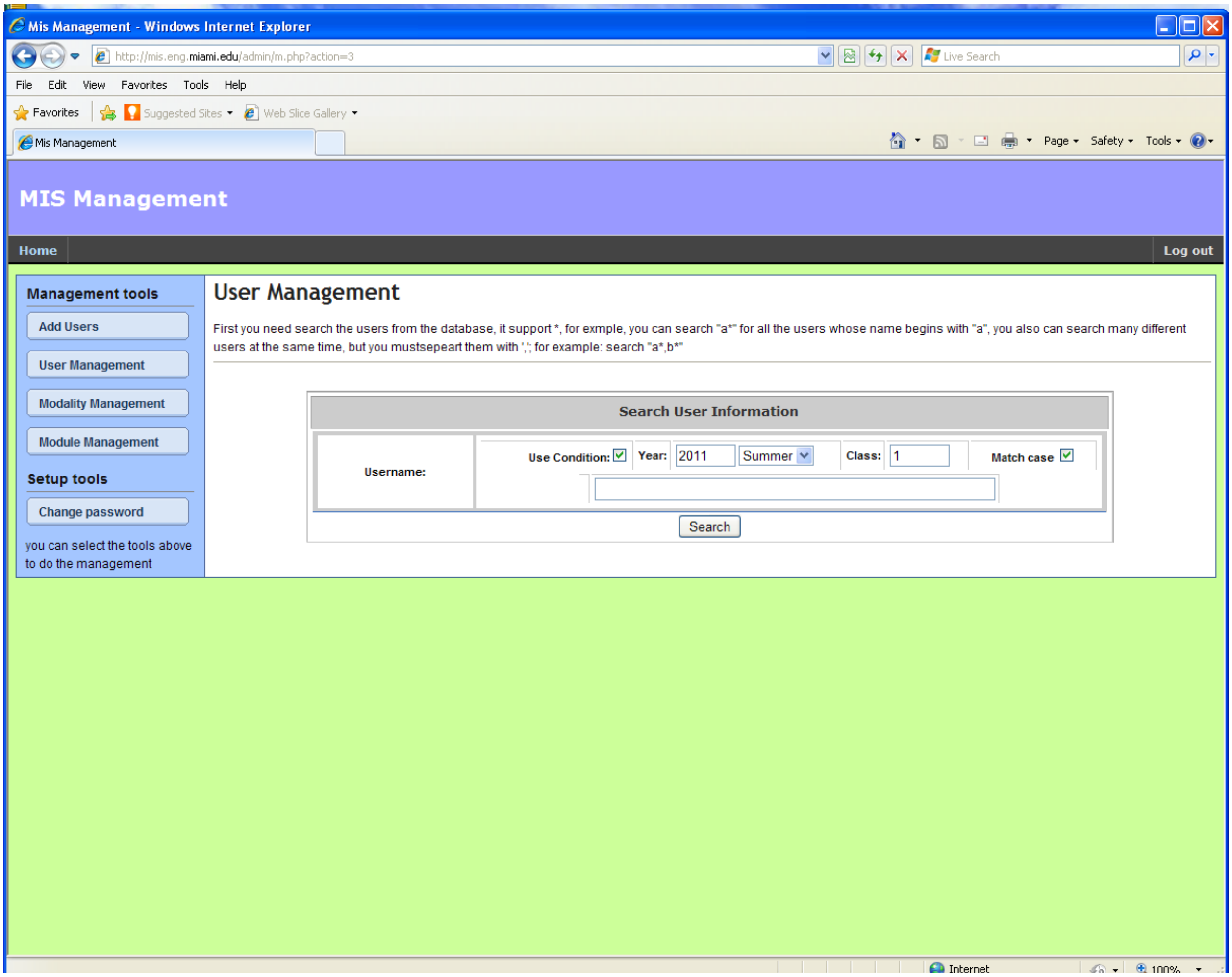
Administrator/instructor can add users through the window provided by the system. You should first specify "Year", "Semester" and "Class" first (for easy future retrieval).

Year is a 4-digit number.
Semester is selected from the dropdown list (Fall, Summer, or Spring).
Class is course code, such as BME300, ECE400.

These entries will be associated with the users for assessment. Administrator/instructor can retrieve user's performance or engagement through the information.

Username can be entered in the provided window separated by line break (return key) if more than one username entered. Username can be any more-than-two character string. Email address can also be username. Administrator/instructor can enroll multiple users, who belong to the same Year/Semester/Class, in one window/time.

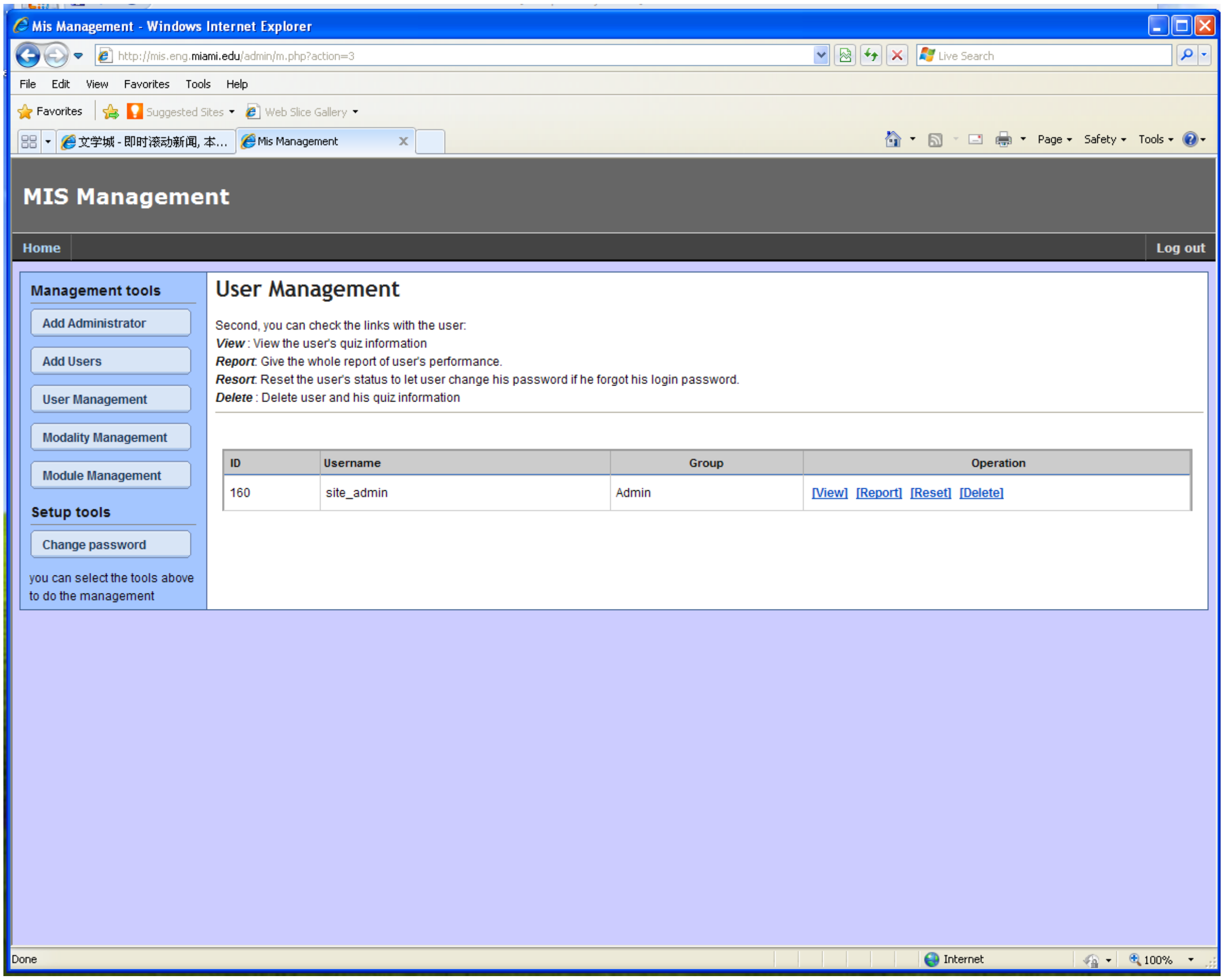
User Management:



In order to manage a user, administrator/instructor must select the user(s) first.

Selecting user(s) can use the “condition” searching provided while enrolling users (year/semester/class) by typing part of the username (or *) in the space, or uncheck the option by typing part of the username (or *). If “Use Condition” is unchecked, the specified user (username) or all users satisfying wildcard * will be displayed.

Once the user(s) is retrieved, administrator/instructor can select a specific user. For example,



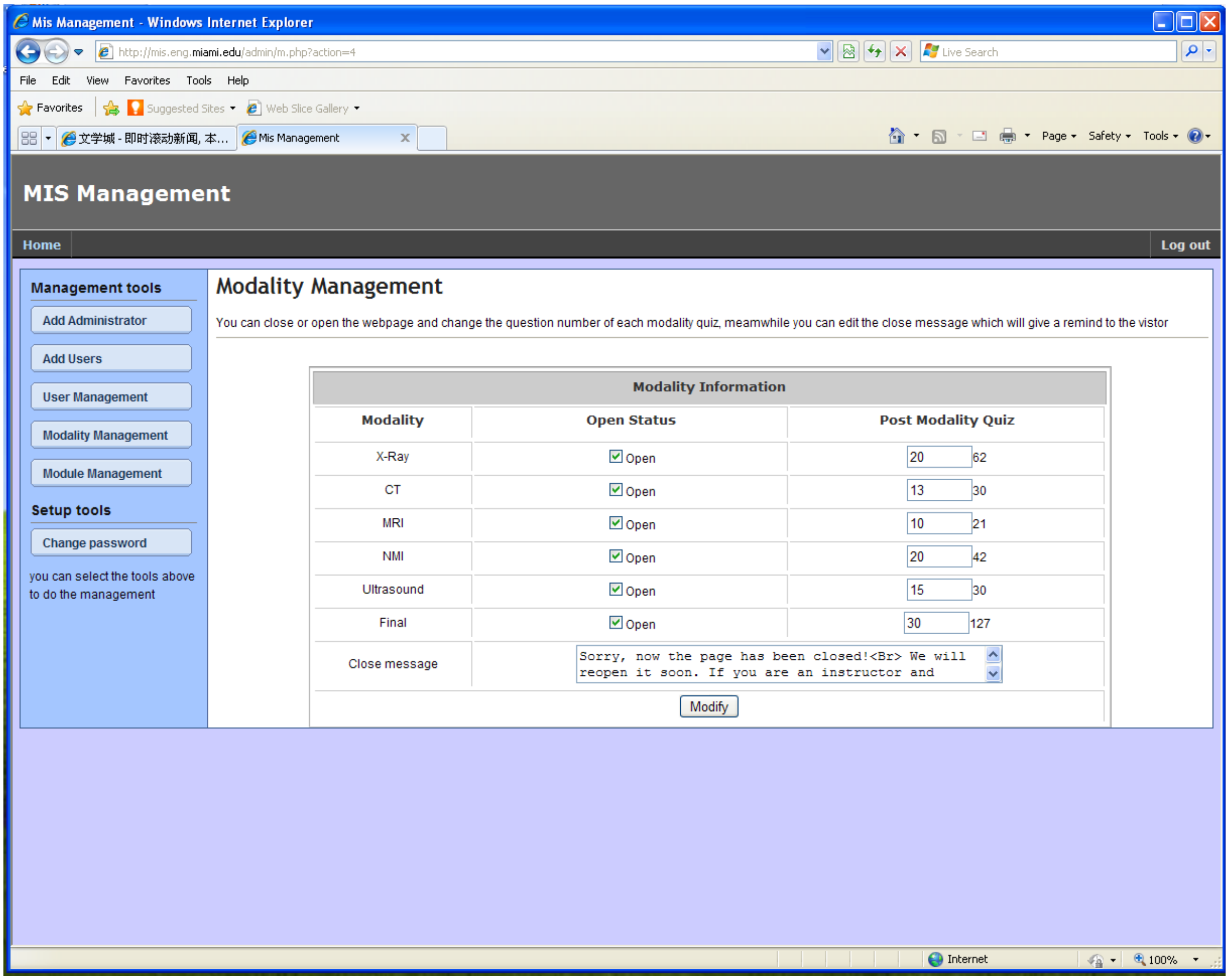
ID	Username	Group	Operation
160	site_admin	Admin	[View] [Report] [Reset] [Delete]

Administrator/instructor can do following management to the user:

View: engagement of the user to MITS/DATS, (duration of login, pre-post test, etc.)
Report: output user's all information
Reset: reset user's password to be "blank", when user login, just feel the password
Delete: remove the user from the database

Modality Management:

This management option is provided to administrator/instructor to control each imaging modality's availability to user (student) in accordance with the teaching/learning progress.

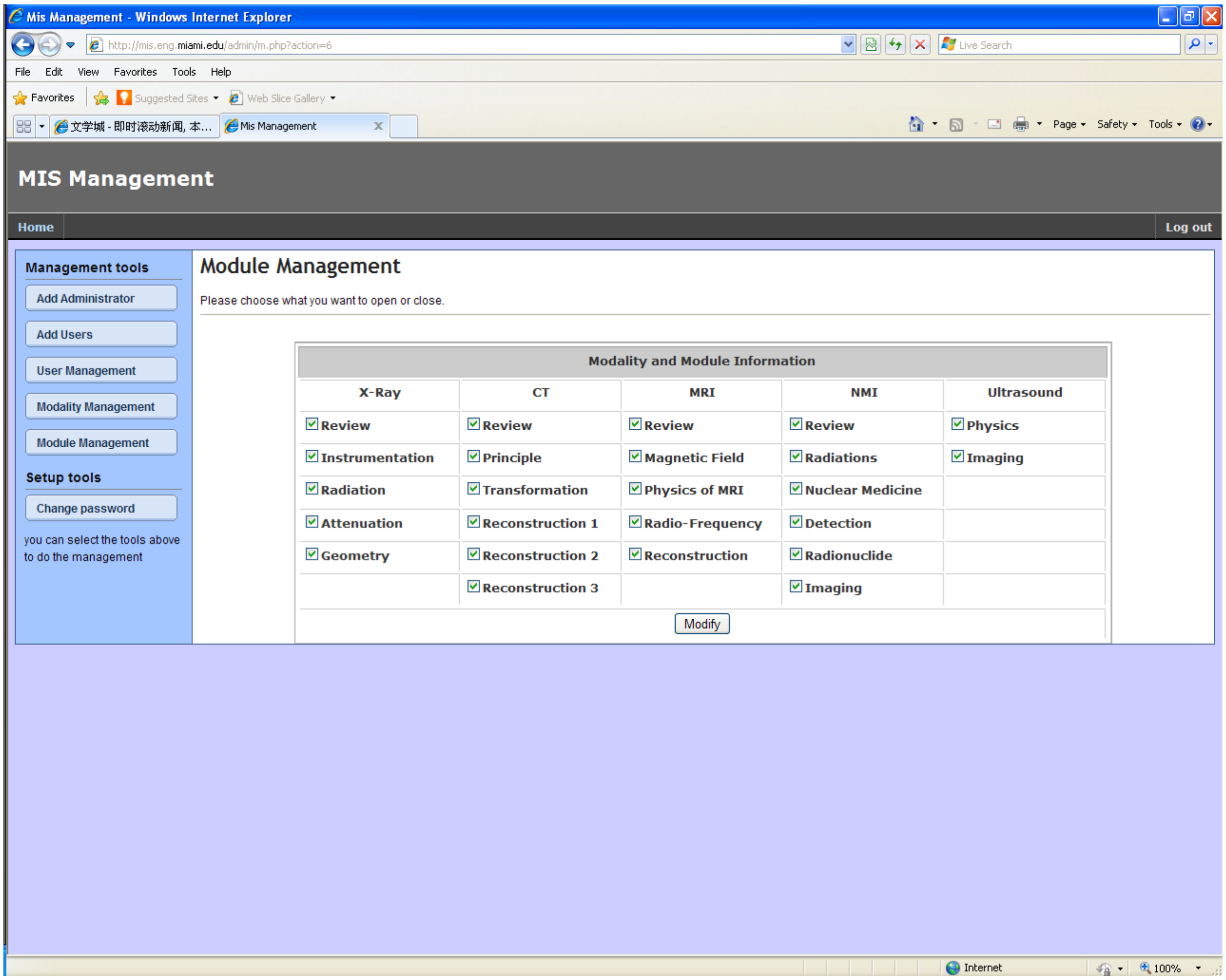


Administrator/instructor can do following management to the user:

Enable or disable an imaging modality to users (students).
Enter a message to for the closed modality(ies).
Determine the **number of post quiz questions** from the quiz question pools. The number of post quiz questions is the same to each user but not identical because the quiz questions are randomly selected from the question pools.
Add more quiz questions to the question pools (under construction).

Module Management:

This management option is provided to administrator/instructor to control each module (teaching/learning topic) within an imaging modality's availability to user (student) in accordance with the teaching/learning progress. For example, entry level imaging class does not need "reconstruction" modules in the CT modality.



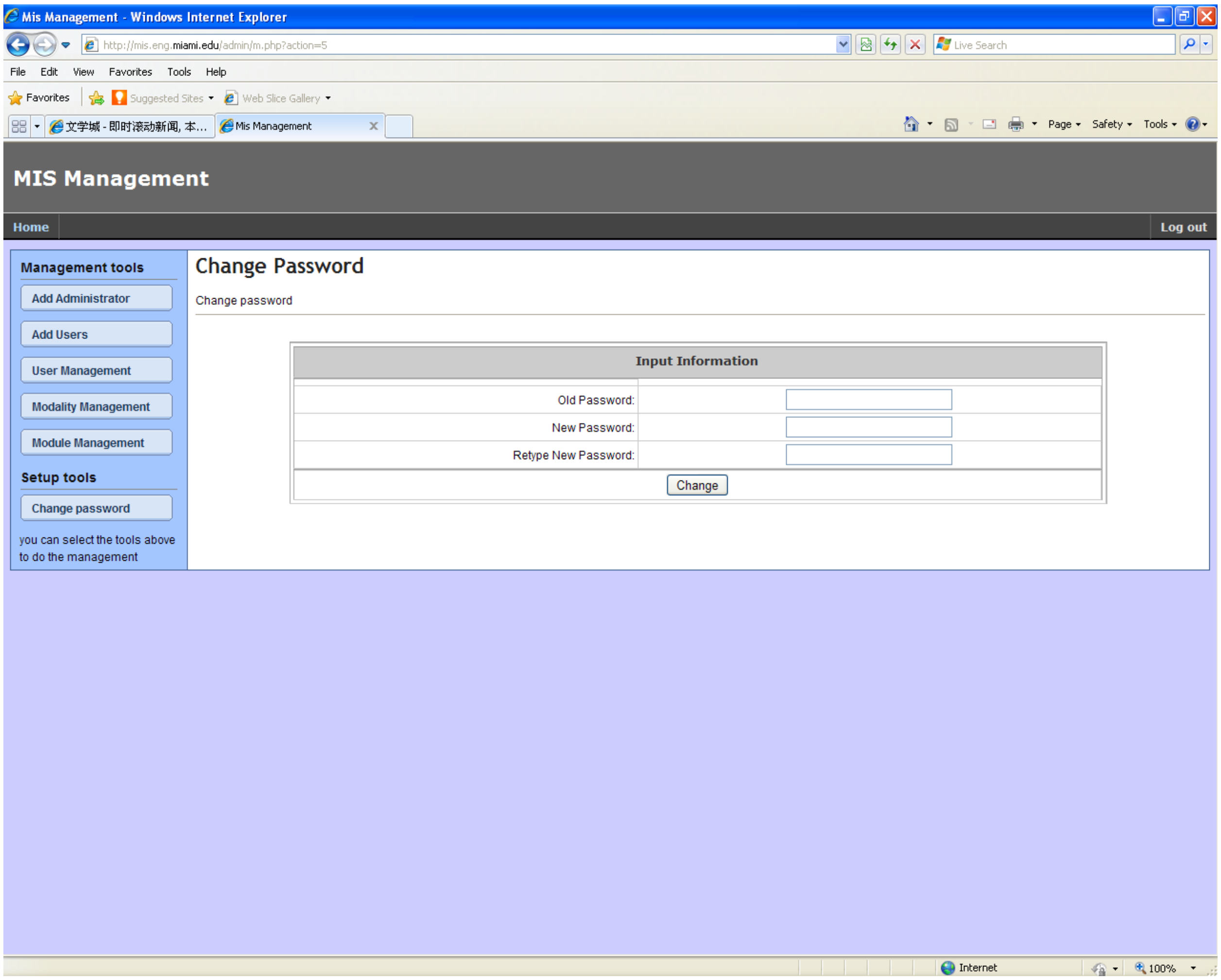
Administrator/instructor can check/uncheck selected modules and then click Modify button.

Please note that "module" is under "modality" so that if the modality is closed, users (students) will not be able to see any module within the modality no matter the module is checked or unchecked.

Change Password:

Administrator/instructor can change his/her own password.

Please note that this function is set for administrator/instructor. A user's password can also be reset. That function is under the "User Management" option.



Login as User

After Administrator/instructor has added a user to the system, the user can login from **two** places

1) The "Login" link at the **bottom of the page**

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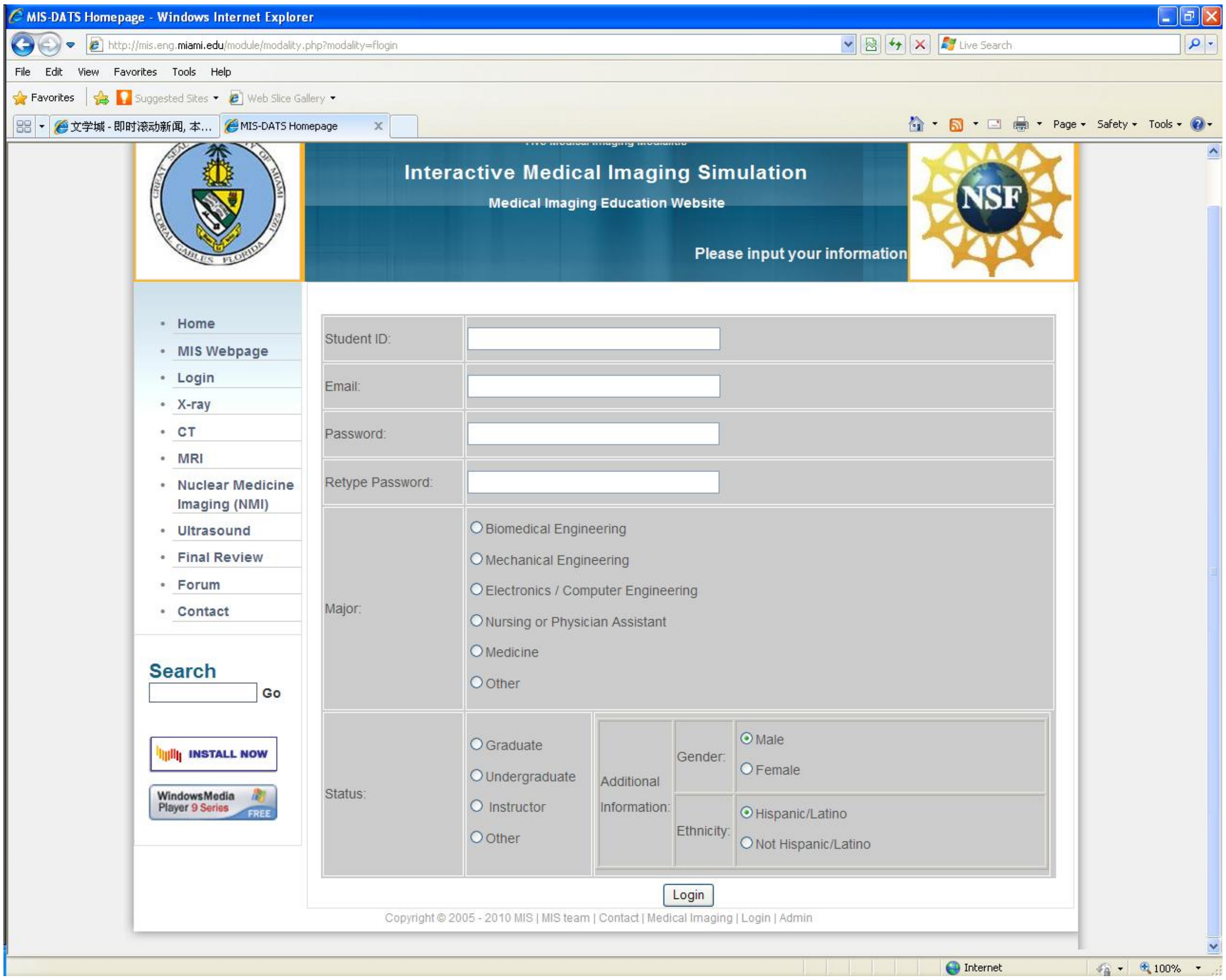
2) The MIS page: http://mis.eng.miami.edu/module/mis.php, click any imaging modality

User will see a login prompt as following:

If this is the first time the user uses MITS/DATS, he/she must click top "HERE" button to setup his/her account (including password). Without this account setup, MITS/DATS will not recognize the user.

The “HERE” button links the account setup prompt window. A first-time user needs to fill in required information.

Student ID is the **username** entered by the administrator/instructor.
A valid email address is required too.
Password is a more than 6-character string.
Other information is self-explained.



Once the user sets up his/her account, he/she can use **the username (student ID) with the same password to login**. Student ID login is to use the username to login. The password is the same for both. If he/she forgets the password, the administrator/instructor can go to “User Management” to “Reset” his/her password. Password becomes blank now! The user can then simply enter his/her username or email and fill in a new password to login.

Please note that **Administrator/instructor is also a User**. Following description is applied any user. A simple practice is that the administrator/instructor creates a user account for him/her-self first and uses the user account to browse the courseware.

Considering that each institution may have a different teaching schedule, imaging modalities in MITS/DATS system are “independent” each other. Our teaching/learning sequence is as follows: X-ray, CT, MRI, NMI (PET), and Ultrasound. Administrator/instructor can open the imaging modalities one by one based on teaching/learning schedule (this is our hybrid teaching practice) or open all imaging modalities at the same time.

As administrator/instructor, one should browse through all pages to have a general idea of how the system is composed before assign it to students.

When a user enters any imaging modality, he/she will pass through following learning steps

Modality pre-test (about 5 questions) to exam user’s pre-knowledge
 Module 1 pre-quiz (1~2 questions) to exam user’s background for the module
 Contents of Module 1
 Module 1 post-quiz (1~2 questions) to exam user’s understanding for the module

 Module 2 pre-quiz (1~2 questions) to exam user’s background for the module
 Contents of Module 2
 Module 2 post-quiz (1~2 questions) to exam user’s understanding for the module
 …
 Module n pre-quiz (1~2 questions) to exam user’s background for the module
 Contents of Module n
 Module n post-quiz (1~2 questions) to exam user’s understanding for the module

Modality post-test (the number of questions is set by Administrator/instructor in Module Management)

Modality pre-test
… …
Modality post-test

Within each imaging modality, a user (student) must go through the steps sequentially (we consider the modules are logically designed in such sequences. We understand that different institutions may have different methods to deliver the contents for the teaching modules. We just follow the commonly used approach.

After the user finishes all modalities, he/she can go to the Final Review section where a combined review test is given. The number of final review questions is controlled by administrator/instructor (under Modality Management)

All pre/post quizzes within a module, pre/post tests within a modality and final review test appear one time only. After a user submits the post-quiz question, the module becomes “open” to the user (he/she can access the module any time later).

As introduced in the beginning, the contents of each module include

1) text description
2) figure/picture/image illustration
3) interactive animation
4) interactive simulation
5) pre-post assessment
6) library of medical imaging application (under construction)

1) and 2) can be used as class handouts. Interactive animation is the “cartoon” type presentation, mainly used to describe physics or chemistry/biology principles. Interactive simulation is the “real” engineering process behind the screen for image reconstruction or other processing. 5) can be used to assess students’ performance or used as test practice. 6) can be used as demonstration examples (this function is under construction).

The MITS/DATS system is updated on a semester basis. Three institutions are developing this system together. In terms of imaging modalities,

Florida Atlantic University (FAU) works on Ultrasound imaging modality
Florida International University (FIU) works on NMI (PET) imaging modality
University of Miami (UM) works on X-ray, CT and MRI imaging modalities

The updates include text/figure revision, animation revision and addition, simulation revision and addition. We plan to develop 40 to 50 animation simulations (10 animations have been embedded, Aug. 2011) and 5 to 10 simulations (2 simulations have been embedded, Aug. 2011) to the system. The progress and other announcement will be announced at the MITS/DATS homepage.

We very much appreciate your feedback on any issue related to the system. Our goal is to create an efficient hybrid teaching/learning environment to deliver medical imaging education to students.