

Overview

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MEDICAL INFORMATICS

A Course for Health Professionals



Educational Objectives and Outlines

Day 1 - Monday, May 28, 2001

Session 1: 8:30 - 9:00 AM

What is Medical Informatics?

Faculty

[James Cimino, M.D.](#)

[Daniel Masys, M.D.](#)

Educational Objectives

The class will develop its own definition of Medical Informatics and discuss the personal qualities and skills needed for success.

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Session 1A: 9:00 - 10:00 AM

HPCC, NII, Current Issues in Medical Informatics

Faculty

[Donald A.B. Lindberg, M.D.](#)

Educational Objectives

This lecture will summarize the federal interagency High Performance Computing and Communications program accomplishments in non-medical and health related aspects and will enumerate some past, current, and future research funding sources.

At the completion of the session, participants will:

- Understand the "interagency model" and the government-industry-university approach to the HPCC work.
- Understand the initial opportunities in biomedical applications of the NII.
- Have a beginning set of funding contacts.

Session Outline

1. High Performance Computing and Communications federal program
 - Background and Legislation
 - Objectives and Organization
 - Phase 1
 - Accomplishments - Grand Challenges
 - Progress on Grand Challenge Problems
 - Phase 2
 - National Information Infrastructure
 - National Challenge Applications
 - Non-medical
 - Medical
2. NLM Role in the NII
 - Intramural Research
 - UMLS
 - Visible Human

- Extramural Research
 - NII medical testbed
 - Telemedicine
 - Computer-based patient record
- Public Policy Issues
 - Medical Data Privacy
 - National Security
 - Intellectual Property Rights
 - Traditional Copyright Demands
 - Today's Revolution in Electronic Publishing
- Federal Research Funding Sources for Medical Informatics
 - NLM Programs
 - Other HHS Programs
 - Other federal agency support

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Session 2: 10:30 AM - 12:00 N

Telemedicine

Faculty

[Michal Ackerman, Ph.D.](#)

Educational Objectives

This lecture will summarize the NLM's historical involvement in telemedicine and discuss the concept of telemedicine as an information process. The need for medical data privacy and the role of HIPAA will be discussed.

At the completion of the session, the participant will:

- Understand telemedicine as an information process
- Become familiar with HIPAA and the misconceptions associated with its implementation
- Be familiar with the NLM Telemedicine Program as a demonstration of how information can influence health outcomes.

Session Outline

1. History
2. Definition
 - Information to support medical decision making
 - Signal processing and imaging
 - Arrangements to practice medicine at a distance
3. Security and privacy of medical records
4. HIPAA
5. NLM's National Telemedicine Initiative

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Session 3: 1:30 PM - 3:00 PM

Healthcare and the Next Generation Internet

Faculty

[Michal Ackerman, Ph.D.](#)

Educational Objectives

This lecture will summarize the concepts of a next generation internet and discuss the federal interagency Next Generation Internet program as well as the academic Internet2 Project. The application of NGI technology to healthcare will be demonstrated through the NLM Next Generation Internet Program.

At the completion of the session, the participant will:

- Understand the national need for a high-speed/high-reliability network and its relevance to healthcare
- Be familiar with the federal Next Generation Internet Program and the academic Internet2 Program, and how the two are inter-related.
- Be familiar with the NLM/NGI Program as a demonstration of the relevance of NGI technology in healthcare.

Session Outline

1. The National Challenges
2. Current Internet vs. NGI
 - Passive vs active
 - "Quality of Service" (QoS)
 - Priority services
3. Federal Next Generation Internet Program
 - Agencies
 - Goals and metrics
 - Applications areas
4. Academic Internet2 Project
 - Project goals
 - Corporate partners
 - Applications and application areas
 - Middleware
 - Abilene Network
5. NGI and Internet2
 - Joint engineering objectives
6. NLM/NGI Program
 - "Networking Health: Prescriptions for the Internet"
 - Needed NGI services
 - Phase I: Planning (FY-99)
 - Phase II: Implementation (FY-00/02)
 - Phase III: Scaling (FY-03/05)

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Session 4: 3:30 PM - 5:00 PM

Principles of Database Design

Faculty

[Daniel R. Masys, M.D.](#)

Educational Objectives

This lecture and lab session will introduce basic principles of organization of data in computerized systems. At the completion of the session, participants will:

- Understand the historical evolution of computerized data handling methods
- Know the relative strengths and weaknesses of hierarchical, relational, information network, and object-oriented database systems
- Understand the process of development of a set-theory-based relational data model, including entity-relationship definitions, principles of fully normalized relational models, state transitions and data flow diagrams.
- Understand the design principles involved in the transformation of a flat file record structure to a normalized relational structure (lab exercise).

Session Outline

- Database definitions and paradigms
 - What is a Database?
 - Historical Evolution of data management techniques
 - General benefits of Database Management Systems (DBMSs)
 - DBMS types

- Heirarchical
- Information Network (linked lists and pointers)
- Relational
- Object-oriented
- XML
- Principles of Relational database design
 - Representation of real world objects and their attributes
 - Relationships between objects
 - Table notation formalisms
 - Relationships: one-to-one, one-to-many, many-to-many
- System design and building methods
 - Entity-relationship diagrams
 - State Transition Models
 - Data Flow Diagram
- Transforming flat files to tables
- A sample problem in database design

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Evening Session

Class of 2000 Personal Web pages workshop

Faculty

[Daniel Masys, M.D.](#)

Educational Objectives

This hands on laboratory will introduce participants to WYSIWYG HTML editing, basic digital image editing and compositing, and publishing web pages to a server.

At the completion of the session, participants will:

- Have created a personal web page with one or more images, and hyperlinks using free HTML editor (Netscape Composer)
- Have a basic understanding of digital image editing software (Photoshop).
- Have created a class resource that enables participants to know one another better

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Day 2 - Tuesday, May 29, 2001

Session 1: 8:30 AM - 10:00 AM

Encryption and public policy issues

Faculty

[Donald A.B. Lindberg, M.D.](#)

Educational Objectives

This lecture and discussion will present the theoretical and practical bases for recommendations concerning medical data privacy, data encryption technology, and some of the national security considerations.

At the completion of the session, participants will:

- Know the issues facing the US regarding copyright and database protection world-wide
- Know if they support or do not support federal privacy legislation, and its features
- Understand the basis for current data encryption methods.
- Will have tested at least two Security Token Authentication devices.
- Know if they prefer to operate Challenge Response or Time Synchronous security devices.

Session Outline

1. Intellectual Property Rights
 - WIPO Treaty proposals
 - Pub Med Plans
2. Encryption
 - Basic concepts
 - DES Public-Private Key
 - Implementation and Devices
 - a) Data Encryption Technology
 - Private Key Encryption
 - Digital Encryption Standard
 - Kerberos
 - Public-Private Key Encryption
 - b) System Considerations
 - Length of Cipher Keys
 - Security Token Authentication
 - c) Devices
 - Challenge - Response
 - Time Synchronous
3. Medical Data Privacy
 - Requirements
 - Legislation
 - Overview
 - Status of Federal Privacy Legislation
 - Contentious Issues
 - Initial Practical Experience with Medical Data Privacy Assurance

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Session 2: 10:30 AM - 12:00 N

The Unified Medical Language System; Internet Futures

Faculty

[Lawrence C. Kingsland, III, Ph.D.](#)

Educational Objectives

This lecture has two independent segments. The first segment introduces the Unified Medical Language System (UMLS) project initiated by the National Library of Medicine in 1986. The second segment discusses several aspects of upcoming technologies that are having and will have an impact on the way we view and use the Internet. At the completion of the session, participants will:

- Have received an introduction to the history of the Unified Medical Language System
- Be introduced to the content of the UMLS Knowledge Sources: the Metathesaurus, the Semantic Network and the SPECIALIST lexicon
- Have viewed a demonstration of the UMLS Knowledge Source Server
- Have viewed a demonstration of the UMLS Metathesaurus browser application in the Internet Grateful Med program, including the introduction of related concepts and co-terms
- Have received an introduction to technologies that are shaping the further development of the Internet and the ways we use it.

Session Outline

- Unified Medical Language System
 - History
 - The UMLS Metathesaurus
 - The UMLS Semantic Network
 - The SPECIALIST lexicon
 - The UMLS Knowledge Source Server
 - The Internet Grateful Med Metathesaurus browser as an example of a UMLS application, with emphasis on related concepts and co-terms
- Internet Futures
 - Context

- Internet Protocol (IP)
- IPv6
- Quality of Service (QOS)
- Optical switching
- Virtual Private Networks (VPNs)
- Digital Spread Spectrum
- Bluetooth
- Wireless Access Protocol (WAP)
- Ubiquity (wearable computing)
- Dynamic content
- Standards/open source

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Session 3: 1:30 - 3:00 PM

Principles of Web page design

Faculty

David Remsen, MBL staff

Educational Objectives

At the completion of this session, participants will have an understanding of Hypertext Markup Language (HTML) and its application in the creation of World Wide Web pages.

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Session 4: 3:30 - 5:00 PM

PubMed and the NLM Gateway

Faculty

[Kathi Canese](#)

Educational Objectives

This lecture and lab session will discuss the National Library of Medicine's PubMed interface for searching MEDLINE. Searching techniques will be presented as well as a review of recent enhancements including the new "Cubby" feature. There will also be a demonstration of NLM's Gateway system which will provide an interface for searching multiple NLM products. Students will be provided with hands-on lab time.

Session Outline

1. PubMed Overview
2. Automatic Term Mapping
 - Search Formulation and Retrieval
 - Search Refinement
 - Feature's Bar (Limits, Preview/Index, History and Clipboard)
3. Related Articles
4. LinkOut
5. Cubby
6. NLM's Gateway Overview
7. Searching Multiple Databases
8. Using MeSH
9. Define Your Own Display Format
10. Hands on lab time

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Evening Session

Introduction to Personal Databases

Faculty

David Remsen

Educational Objectives

This hands on workshop will create sample databases and discuss the implications of different data models.

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Day 3 - Wednesday, May 30, 2001

Sessions 1 and 2: 8:30 AM - 12:00 N

Evaluation Methods in Medical Informatics

Faculty

[Charles P. Friedman, Ph.D.](#)

Session Outline

This section of the course examines medical informatics as an empirical science. As such, the section will focus on formal studies of applications of information technology in medicine. We refer to these applications generically as information resources. Studies can be conducted while information resources are under development as well as after they are in routine service. Studies typically address questions such as: Is the resource functioning as anticipated? How can it be improved? Does it make a difference? Are the differences it makes beneficial?

Within medical informatics, there is increasing interest in evaluation and empirical studies. From an administrative perspective, as institutions invest in new technology, it is critical for them to know how these systems can contribute to health care, education, and research so they can set development plans and set priorities. From a more academic perspective, research projects in informatics, including doctoral dissertations and masters theses, now often include an evaluation or empirical study component. Much of the funded research in informatics is required to have such a component.

This day-long session on evaluation will provide participants with an understanding of the range of evaluation methods that are used in informatics and will address how studies are designed as well as how data for these studies are collected, analyzed, and reported. We will address during the day many of the challenges that make evaluation difficult, emphasizing those challenges that are particular to medical informatics, and we will discuss methods that have been developed for addressing many of these challenges.

Educational Objectives:

At the completion of the session, participants will be able to:

1. Describe the purposes of evaluation in medical informatics.
2. List several factors that can make it difficult to do evaluation in medical informatics effectively, as well as strategies that can be employed to address these difficulties.
3. Distinguish objectivist (quantitative) and subjectivist (qualitative) approaches, describe the assumptions that underlie them, and explain why both methods are used.
4. Identify the major steps in the process of conducting objectivist and subjectivist studies.
5. Identify the individuals or groups comprising the "audience" for an evaluation study.
6. Describe how the methods and purposes of a study can be matched the level of maturity of an information resource.
7. Frame many of the recurring difficulties of evaluation in medical informatics as problems of measurement.
8. Distinguish between measurement errors that are issues of reliability from those that are issues of validity. Distinguish between different types of validity.
9. Explain how "measurement studies" can be conducted to identify the sources of error in any measurement process, and to estimate the magnitude of these errors.
10. Explain what is meant by a "gold standard" in the framework of a measurement study.

Identify measurement methods and features of measurement instruments that can be employed to reduce measurement errors.

11. Identify some specific evaluation questions or issues that lend themselves particularly well to subjectivist approaches.
12. Explain how the questions and key issues of a study arise through the process of immersion.
13. Describe the major data collection strategies in subjectivist research, how these are used in a complementary way within a study, and how the data generated by each are analyzed.
14. Explain the steps a researcher can take to ensure the veracity of the findings of a subjectivist study.
15. Describe some of the barriers to combining objectivist and subjectivist methods within a single study.

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Session 3 - 1:30 - 3:00 PM

Data Capture and Speech Recognition

Faculty

[Justin Starren, M.D., Ph.D.](#)

Educational Objectives

1. Be able to list the various techniques and types of entities involved in data acquisition
2. Describe the different types of data in clinical information systems
3. Contrast structured from unstructured data acquisition
4. Describe the basic ASR approaches and the challenges in implementing them
5. Describe the justification for NLP and the basic challenges.

Outline

- Data Acquisition Entities
- Acquisition Techniques
- Signal Acquisition
- Image Acquisition
 - Image Storage
 - Picture Archiving and Communications Systems (PACS)
 - Image Acquisition Challenges
- Collecting Data from People
 - Text versus codes
 - Structured Data Entry
 - Automated Speech Recognition (ASR)
 - Types of ASR Techniques
 - Types of ASR Systems
 - Economic Issues in ASR
 - HCI Issues
 - Implementation Issues
- Natural Language Processing
 - Linguistic Layers
 - The Languages in Medicine
 - What are Sublanguages?
 - Challenges for Language Analysis
 - Natural Language Processing Techniques
 - Language Analyzer
 - Lexicon
 - Syntactic Grammar
 - Semantic Grammar

ASR Demonstration

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Session 4 - 3:30 - 5:00 PM

Messaging, XML and Natural Language Processing

Faculty

[Justin Starren, M.D., Ph.D.](#)

This session will discuss the principles behind inter-system communication in healthcare computing. The current de-facto

standard, HL7 will be described. Current development in XML will be discussed. An exercise will involve the use of the Medlee NLP system and XML parser.

Educational Objectives

1. Describe the requirement for intersystem communication
2. Discuss the basic principles behind the development of HL7
3. Discuss the major changes and challenges of HL7 version 3
4. Define "markup language" and contrast XML to other markup languages
5. Understand the relation between XML, DTDs and XSLT

Outline

- Need for Inter-system communication.
- ISO Open System Interconnection (OSI) level
- Health Level 7
 - History
 - Current Version
 - Upcoming Version 3
 - Reference Information Model
 - Integrating the Healthcare Enterprise (IHE)
 - HL7 and HIPAA
- XML
 - What is Markup
 - XML Basics
 - DTD
 - XML and HL7 history
 - Extensible Style Sheets (XSL)
 - XML Architectures
 - Why XML?
 - What XML is not
 - XML Heuristics
- Exercises
 - NLP

XML

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MBL Clambake (no evening workshop)

Day 4- Thursday, May 31, 2001

Sessions 1 and 2: 8:30 AM - 12:00 N

Principles of Controlled Terminology

Faculty

[James J. Cimino, M.D.](#)

Educational Objectives

This session examines medical data, where they come from, how they are represented, and how they are used. In order for a computer to manipulate data symbolically, the data must be represented in a way that the computer can "understand"; this is generally accomplished through the use of controlled terminologies. The objectives for these sessions are:

- Define medical terminologies and their attributes
- Review the state of the art
- Examine advanced uses of medical data through the use of advanced terminologies

Session Outline

- Examination of typical medical data
- Uses of medical data
- Terminology characteristics

- Terminology desiderata
- Survey of what's available
 - ICD9-CM and ICD-10
 - DRGs
 - NDC Codes
 - SNOMED
 - Read
 - Nursing terminologies
 - MEDCIN
 - LOINC
 - MeSH
 - UMLS
- The Medical Entities Dictionary
- Case studies of advanced uses of data
 - Summary reporting
 - HCFA requirements
 - Clinical research
 - Expert systems
 - Automated decision support
 - Linking to on-line information sources
- Learning more

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Sessions 3 and 4: 1:30 - 5:00 PM

Decision-Analytic Methods for Evidence-based Practice

Faculty

[Suzanne Bakken, RN, DNSc](#)

Educational Objectives

At the conclusion of the workshop, the learner will be able to do the following:

1. Define evidence-based practice.
2. Describe the foundation for evidence-based practice.
3. Access and interact with Web-based systematic review resources.
4. Analyze a patient case using a Web-based diagnostic decision support system.
5. Identify the components of expected value decision making.
6. Construct and solve a decision tree using a decision analysis software package.

Outline

1. Definitions of Evidence-based Practice
2. Foundation for Evidence-based Practice
 1. Standardized terminologies
 2. Outcome measurements sensitive to health care interventions
 3. Techniques for routinely capturing and analyzing relevant data
 4. Electronic networks and standards supporting interoperability
 5. Informatics competencies
 1. Information retrieval
 2. Critical analysis
 1. Trial Bank
 2. Cochrane Collaboration
 6. Tools and techniques for applying domain knowledge to patient-specific situations
 1. Issues related to clinical decision making
 2. Diagnostic decision support
 1. DXplain
 3. Expected value decision making
 1. Building and solving a decision tree using DATA

Utility assessment

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Evening Workshop: 7:00 - 9:00 PM

Building Web Interfaces to Databases

Faculty

David Remsen, MBL staff

Educational Objectives

This workshop will give participants hands-on experience in serving databases to the web. In this session they will learn the different necessary components of a database web server. They will create their own interface to a database and learn how to conditionally format the results in HTML. They will get an understanding how HTML form elements translate to database calls, how an HTML form translates to a database query, and how a query is processed and the results are returned.

Session Outline

1. Present an overview of a generic database web serving system. This overview will consist of identifying and defining the function of the the different elements that compose a database server.
2. A brief introduction to a few of the different database solutions to show how different vendors address the model described in 1.
3. Create an interactive web database using Filemaker Pro 4.0 with a sample database which will address the following: Querying the database using FORM and embedded URLS
4. Editing a Record via the web
5. Adding/Deleting Records
6. Processing results with format files.
7. Understanding how HTML and database meta tags can interact by:
 - a. Listing multiple records
 - b. Formatting a single record
 - c. Using conditionals to selectively format records
 - d. Using color and graphics with numeric content

Creating embedded links to Entrez, PubMed, others

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Day 5 - Friday, June 1, 2001

Session 1: 8:30 - 10:00 AM

Digital Library Research

Faculty

[Alexa T. McCray, Ph.D](#)

Educational Objectives

This lecture presents the basic principles and practices involved in designing and implementing a digital library, as well as the research issues that need to be addressed. A case study, NLM's *Profiles in Science* system is introduced, and participants are given an opportunity to do a short exercise.

- Understand the basic principles that underlie the design, implementation, and maintenance of a successful digital library.
- Have an understanding of digital library research issues.
- Have pointers to useful resources in digital library research.

Session Outline

1. Informatics Research Agenda for Digital Libraries
2. Basic Principles in the Design and Implementation of a Digital Library
 - System Design Principles and Practices

- Standards
 - Modularity
 - Extensibility
 - New technologies
 - Content and Collection-based Principles and Practices
 - Data acquisition and selection
 - Metadata
 - Intellectual property
 - Permanence and persistence of digital objects
 - Human Factors Principles and Practices
 - Accessibility, usability
 - Automation of manual tasks
- 3. Case Study
 - [Profiles in Science](#)
 - [ClinicalTrials.gov](#)
- 4. Hands-on Exercise
 - Assigning metadata tags

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Session 2: 10:30 AM - 12:00 N

Genomics

Faculty

[Issac Kohane, M.D., Ph.D.](#)

Educational Objectives

Session Outline

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Sessions 3 and 4: 1:30 -5:00 PM

Clinical Information Systems

Faculty

[W. Edward Hammond, Ph.D](#)

Educational Objectives

Session Outline

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Day 6 - Saturday, June 2, 2001

Session 1: 8:30 - 10:00 AM

Education Informatics - Technology, Objectives, and the Learning Environment

Faculty

[Christopher Cimino, M.D.](#)

Educational Objectives

This session will look at the application of technology to teaching health care and the integration of medical informatics teaching in the educational environment. At the completion of this session participants will

1. have an understanding of the basic building blocks of the educational interaction: communication, assessment, role-modeling, skills development, and dialogue.
2. be exposed to an example of Medical Informatics objectives with a focus on distinguishing skills, knowledge and attitudes.
3. understand how Informatics skills, knowledge, and attitudes relate to different educational interactions; particularly role-modeling and skill development.
4. understand how specific Medical Informatics objectives relate to specific types of educational technology
5. be exposed to several types of educational technology and understand how each complements or complicates each type of interaction
6. understand how Informatics teaching can be integrated with other medical education.

Outline

- How Does Education Occur?
 - How do we teach?
 - How do we choose what to teach?
 - What is the educational environment?
- How does teaching occur?
 - Where does teaching occur?
 - What passes between teacher and student
 - Benefits of Integrated Education
 - Obstacles to Integrated Education
 - Where does technology fit in?
- How do we decide what to teach?
 - Mission
 - Needs
 - Goals
 - Objectives
 - Solutions
- How do we decide what to teach?
 - Knowledge Objectives
 - Skill Objectives
 - Attitude Objectives
- IMIA Medical Informatics Objectives
 - Organizing principles
 - Domain topics
 - IT User vs. IT Specialist
 - Degree of career progression
- Examples of teaching and assessing Informatics objectives
 - Skills
 - Knowledge
 - Attitude
- Technology as a teaching tool
 - Infrastructure needed to teach skills
 - Role models needed for teaching attitude
 - Integration into work-flow needed to develop role models
- How do we decide what to teach?
 - Student Evaluation
 - Program Evaluation
- Evaluation of educational technology
 - Education success as measured by science
 - Cost
 - Satisfaction
 - Social Change
- Changing the environment
 - What kind of institution are you at?
 - Your setting determines stakeholders
- Stakeholders
 - Who determines educational approach?
 - Who determines educational content?
 - Who supports technology?
- Instigating Change
 - Innovation
 - Long term growth
 - "Willing" but cautious participants

- Implementing Change
 - Make use of power of iteration
 - Conserve support effort
 - Shape user expectations to be reasonable
 - Making use of early failure

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Session 2: 10:30 AM - 12:00 N

Education Informatics - Faculty Development

Faculty

[Christopher Cimino, M.D.](#)

Educational Objectives

This session will look at the adaption of clinical faculty to teaching medical informatics. Using specific examples on the internet, participants will face and overcome some of the common obstacles. At the completion of this session participants will have

1. gained practical skills in finding informatics information geared to education.
2. understand the obstacles to motivating faculty to integrate informatics teaching into other disciplines
3. know the types of behaviors that promote positive attitudes among colleagues and students

Session Outline

Each exercise will be followed by a group discussion of the results of the exercise and concrete lessons learned.

Exercise 1:

Internet resources to enhance the teaching of a skill objective
Examining learning curve obstacles.

Exercise 2:

Internet resources to enhance the teaching of a knowledge objective
Examining quality obstacles

Exercise 3:

Internet resources to enhance the teaching of a attitude objective
Examining reliability obstacles

Other obstacles:

Social obstacles
Work flow obstacles
Resource obstacles

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Session 3: 1:30 - 3:00 PM

Designing a medical informatics curriculum

Faculty

Faculty Panel

Educational Objectives

At the completion of this session, participants should have an understanding of issues attendant to the development and implementation of a medical informatics curriculum at the fellows' home institutions.

Session Outline

This session will be an interactive discussion among faculty and fellows. It will review the topics covered at the MBL course and promote discussion regarding future changes.

:00 PM

Course Wrap-Up and Farewell

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Last Updated: 13 May 2001