IMPACT OF MODERN EDUCATIONAL TECHNOLOGIES ON LEARNING OUTCOMES
Application for e-Learning in Biomedical Engineering

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KEY TERMS

Biomedical engineering
• Multidisciplinary field of science:
  • Significant impact on human health and well-being,
  • Advanced knowledge in engineering, biology and medicine.

Educational technology
• Goal-oriented problem-solving approach utilizing tools, techniques, theories and methods from multiple knowledge domains.

E-Learning
• The use of various technological tools that are either Web-based, Web-distributed or Web-capable for the purpose of education.

Virtual campus
• Open system for designing, deployment and evaluation of reusable learning materials.

Learning outcomes
• Statements of what students are expected to achieve.
• Bioelectromagnetism
• Biomechanics
• Prosthetic devices and artificial organs
• Medical imaging
• Biomaterials
• Biotechnology
• Tissue engineering
• Neural engineering
• Biomedical instrumentation
• Bionanotechnology
• Physiological modeling
• Rehabilitation engineering
• Medical and bioinformatics
• Clinical engineering
• Biosensors
• Medical and biological analysis
• …
EDUCATIONAL TECHNOLOGY

• Internet and World Wide Web
  • Web-based applications
  • E-mail, chat, and instant messaging replacing traditional forms of communication

• Mobile Technologies
  • Personal handheld computers
  • Cell phones
  • Laptops
  • Wireless devices

• Video Transmission
  • Conferencing
  • Internet-based
  • Cell-phone based

• Internet2
  • Video streaming of multimedia content
  • Use of remote instruments such as microscopes

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VIRTUAL CAMPUS

Actors:
- Learner
- Teacher
- Content-expert
- Manager
- Designer

ReViCa Project

Inside-out dimension: large scale initiative

Outside-in dimensions: percent of the institutional budget, part of the institution’s business plan, etc.
LEARNING OUTCOMES

Bloom’s Taxonomy (Revised)

Create
Evaluate
Analyze
Apply
Understand – Describe, Explain
Knowledge - Remember

Based on an APA adaptation of Anderson, L.W. & Krathwohl, D.R. (Eds.) (2001)

EUROPEAN VIRTUAL CAMPUS FOR BIOMEDICAL ENGINEERING, EVICAB:

- The aim to develop, build up and evaluate sustainable, dynamic solution for virtual mobility and e-learning:
  - Mutually support the harmonization of the European higher education programs.
  - Improve the quality of and comparability between the programs.
  - Advance the post-graduate studies, qualification and certification.
EVICAB
(January, 2006 - December, 2007)

Activities:

- Evaluating existing Biomedical Engineering e-curricula and strengthening the harmonization process.
- Building up a common virtual pilot Biomedical Engineering curriculum among the partners.
- Developing a model to dynamically elaborate and innovate sustainable e-courses.
- Developing new practices for e-teaching and e-learning.
- Developing new administrative practices.
- Evaluating and disseminating results.
- Managing project.
OBJECTIVES OF THE STUDY

1. Review learning theories and technologies.
2. Develop the virtual campus.
3. Evaluate how students accept e-learning.
4. Analyze the development process of e-learning.
LITERATURE REVIEW

Learning theories

- Dual coding theory: visual and verbal codes.
- Cue summation theory: stimuli in multimedia environment.
- Atkinson-Shiffrin model: multi-memory model.
- Cognitive load theory: working memory.
- Mayer’s theory of learning: multimedia learning.
- Gagner’s Information processing theory: different types of learning.

...
Educational technology

Techniques, theories & methods from multiple knowledge domains which are standardized and reproducible (i.e., computer science, psychology, communications)

To design, develop and evaluate human and mechanistic resources effectively & efficiently

In order to facilitate and leverage all aspects of learning

To govern by tools (i.e., film, video, computers)

To guide change agency and transformation of educational systems and practices

In order to contribute to change within society

A systems definition of educational technology in society. Adapted from Luppicini 2005.
MATERIALS AND METHODS

1. Theoretical approach
   - Literature review

3. Practical approach
   - Software tools
   - Hardware tools

4. Evaluative approach
   - Questionnaires
   - Web statistics

5. Developmental approach
   - International survey
RESULTS
Theoretical approach

Virtual Campus

Introduction Curriculum

Course 1 Course 2 Course ...n

Support Technical requirements

Tutorial links Feedback

Commenting and rating system

Internet exam system

Information Deliverables

For student

For teacher

Course information

Textbook/e-book

Video lectures on PC

Video lectures on iPod

Video lectures on phone

Exercises

Lecture 1 Lecture 2 Lecture ...n

Lecture notes

Animations

Multimedia content

Graphs

Models

Simulation examples
## Biomedical Engineering Curriculum

### BIOELECTROMAGNETISM

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Course</th>
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<tbody>
<tr>
<td>Jaakko Malmivuo</td>
<td>Bioelectromagnetism</td>
</tr>
<tr>
<td>Frank Sachse</td>
<td>Computational Modelling of Cardiovascular System</td>
</tr>
<tr>
<td>Risto Ilmoniemi</td>
<td>Transcranial Magnetic Stimulation</td>
</tr>
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### BIOMECHANICS

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<th>Teacher</th>
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<tbody>
<tr>
<td>Rami Korhonen</td>
<td>Biomechanical Modelling of Bone and Cartilage</td>
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### OPTICS

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<th>Teacher</th>
<th>Course</th>
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<tbody>
<tr>
<td>Goran Salerud</td>
<td>Biomedical Optics</td>
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### SIGNAL AND IMAGE ANALYSIS

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<th>Teacher</th>
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<tr>
<td>Jiri Jan</td>
<td>Introduction to Biomedical Signal Analysis</td>
</tr>
<tr>
<td>Rangaraj M. Rangayyan</td>
<td>Biomedical Signal Analysis</td>
</tr>
<tr>
<td>Rangaraj M. Rangayyan</td>
<td>Biomedical Image Analysis</td>
</tr>
</tbody>
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For suggestions and inquiries and for reporting on problems, please use the Feedback Page 📩.
RESULTS
Practical approach

Software tools:
- Internet
- Media players
  - Adobe Flash
  - iTunes, Quick Time
- Video and audio editing software
  - Camtasia Studio
  - Windows Movie Maker

Hardware tools:
- Computers
  - Windows, MacOS
- Portable video and audio players
  - iPods, MP3 players
- Media phones
RESULTS
Learning objects

• Video lectures
• e-Book
• Virtual interactivity system
• Quizzes and exercises
• Lecture notes
• Animations
• Virtual models and simulations
• Internet examination
• Laboratory works
• Moodle
• Video conferencing
VIDEO LECTURES

Motivation:

• To grasp students’ attention and motivate them to learn.

• To provide highly realistic depiction of situation, which students would not otherwise have the occasion to see:
  • Medical procedure,
  • Lecture in another university.

• To watch again or later recorded live face-to-face lectures.
Usefulness of learning elements presented as averages and standard deviations. Evaluation scale was from 1 (not useful) to 5 (very useful). A: Learning elements were available in virtual campus. Students had possibility to test them. N: Learning elements were not available in virtual campus. Students anticipated their usefulness.
RESULTS
Web log-ins

Number of visits for each month, 2009 and January-April, 2010.
RESULTS
Web log-ins

EVICAB

From 12 Feb 2009 to 13 Feb 2010: Total: 2,958
RESULTS
Development

Resources that BME educators are able to provide to the virtual campus.

- Not interested
- Virtual laboratory works
- e-Book
- Textbook
- Video lectures
- Lecture materials including slides, animations etc.

Percent
DISCUSSION

• Role of lecturer in e-learning.
• Recommended techniques for educators in e-learning.
• Learning with video lectures.
• Production team for good quality Internet materials.
• e-Learning depends on values and goals of organization.

Virtual education:
  • Administrators
  • Instructions
  • Student recruitment
  • Technology
  • Library systems
  • ...
FUTURE IMPLEMENTATIONS

- Intelligent students’ knowledge testing machine.
- Intelligent system with self-converting files for video lectures.
- Intelligent video lectures.
CONCLUSIONS

• Technologies for virtual education are available and relative user friendly.
• The main advantage of virtual education is the global open access.
• Virtual education does not replace or eliminate education on the university scale but support and augment on the global scale.
• e-Learning still support teacher-centered approach, where knowledge is unidirectional, i.e., transferred from teacher to students.
  • There is a great need for virtual laboratory works and exercises, where students could apply theoretical knowledge and develop practical skills.
THANK YOU!