


INTERNET TOOL FOR INTERNATIONAL BIOMEDICAL ENGINEERING EDUCATION



International Symposium on Biomedical Engineering and Medical Physics
Dedicated to the 150 anniversary of the Riga Technical University, Latvia

Asta Kybartaitė
*Neuroscience Institute
Lithuanian University of Health Sciences*

Jaakko Matmivuo, Prof. Emeritus
*Department of Biomedical Engineering,
Tampere University of Technology*

Outline

- Introduction
- Portal
- Examination
- Results
- Conclusions

INTERNET TOOL FOR INTERNATIONAL
BIOMEDICAL ENGINEERING EDUCATION

INTRODUCTION

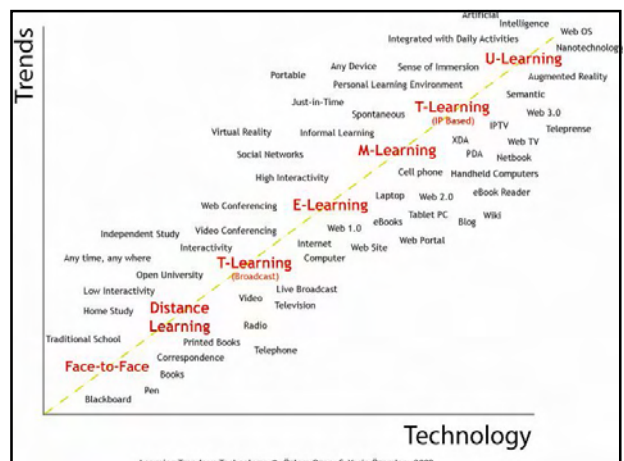
Biomedical Engineering

- Biomechanics
- Prosthetic devices & artificial organs
- Medical imaging
- Biomaterials
- Biotechnology
- Tissue engineering
- Neural engineering
- Biomedical instrumentation
- Bio nanotechnology
- Physiological modeling
- Rehabilitation engineering
- Medical & bioinformatics
- Clinical engineering
- Biosensors
- Medical & biological analysis
- ...

Challenges

1. Multidisciplinary field of engineering.
2. Multidisciplinary field of education.
3. Students with different background.
4. Up to date educational curricula.
5. Development of educational technology.

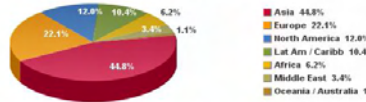
**New teaching and learning
methods are needed!**



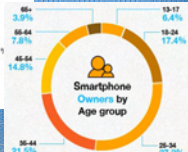
Motivation for e-Learning

- Over 2 billion of Internet users (2011)
- Over 1.08 billion smartphones in use (2012)

Internet Users in the World
Distribution by World Regions - 2011



Source: Internet World Stats - www.internetworldstats.com/stats.htm
Basis: 2,267,233,742 internet users on December 31, 2011
Copyright © 2012, Miniwatts Marketing Group



Motivation for BME e-Learning

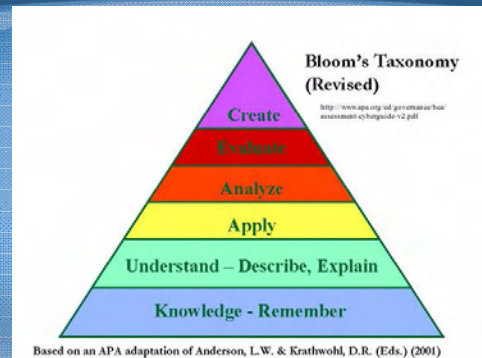
Quality assurance systems

- BOLOGNA process
- European Association for Quality Assurance in Higher Education (ENQA)
- ERASMUS programme
- ECTS learner-centered system
- BIOMEDEA

Designing Tomorrow's Education

- Open content
 - Strong curricula
 - Trained teachers
 - Prepared students
 - Technology applications
 - Online pedagogy
 - Online assessment
 - Collaboration
 - Internalization
 - Harmonization
 - Quality assurance
- How?

What to Learn?



How to learn?



Virtual Campus

A Virtual Campus refers to the online offerings of a **college or university** where college work is completed either **partially or wholly online**, often with the **assistance of the teacher, professor, or teaching assistant**.

http://en.wikipedia.org/wiki/Virtual_Campus

The concept of a Virtual Campus refers to a **specific format of distance education and on-line learning** in which students, teaching staff and even university administrative and technical staff mainly **'meet' or communicate through technical links**.

<http://www.benvic.odl.org/indexpr.html>

The Virtual Campus is a metaphor for the **teaching, learning and research environment** created by the convergence of **new powerful instruction and communication technologies**.

Van Dusen (1997)

RE VICA
Reviewing (traces of) European Virtual Campuses
<http://revica.europace.org>

e-Learning providers:

- more than 170 in Europe
- more than 300 in the rest of the world
- altogether about 500 in 156 countries

- Learners
- Teachers
- Content-experts
- Managers
- Designers
- University administrators

Examples of Internet Education

Portals

- University of Berkeley
- Massachusetts Institute of Technology
- Yovisto
- etc ...

Course management systems

- Moodle
- Ilias
- etc ...

webcast.berkeley

<http://webcast.berkeley.edu/courses.php>

Chemistry 3AL, 001 - Spring 2013
ORGANIC CHEMISTRY
Organic Chemistry Laboratory - Introduction to the theory and practice of methods used in the organic chemistry laboratory. An emphasis is placed on the separation and purification of organic compounds. Techniques covered will include extraction, distillation, crystallization, and chromatography. Detailed mechanisms and applications of infrared and nuclear magnetic resonance spectroscopy will be included.

Civil and Environmental Engineering 100, 001 - Spring 2013
MARK F. ZUCKER
Intermediate Fluid Mechanics - Fluid statics and dynamics, including laboratory experiments with technical reports. Fundamentals: integral and differential formulations of the conservation laws are covered in special case such as boundary layers and pipe flow. Flows - visualization and computation techniques are introduced using Matlab. Empirical equations are used for turbulent flows, drag, pumps, and open channel, fluid flows.

Civil and Environmental Engineering 106, 001 - Spring 2013
MARKUS AGAPROPOULOS PANAGOPOULOS
Structural Engineering - Introduction to design and analysis of structural systems. Loads and load placement. Proportioning of structural members in steel, reinforced concrete, and timber. Structural analysis theory, hand and computer analysis methods, validation of results from computer analysis. Applications, including bridges, building frames, and long span cable structures.

Cognitive Science 2.001 - Spring 2013
CHRISTOPHER D. NORDBERG, PAUL DODD
History of Information - This course explores the history of information and associated technologies, answering who we think of now as "the information age." We will select moments in the evolution of production, recording, and storage from the earliest writing systems to the world of cloud storage services (SaaS) and blogs. read more.

Biology 1A1, 001 Fall 2009/UC Berkeley
by Michael HECHT, Jasper D. SINE
Go to the top of this section, hover over the title and click Play. Open Channels to download and subscribe to Channels in iTunes.

Section	Description	Revised	Price	Yes/No/Cancel
1	Section 1: Science and Society	11/12/09	Free	Yes/No/Cancel
2	Section 2: Evolution and Speciation	11/12/09	Free	Yes/No/Cancel
3	Section 3: Molecular Biology	11/12/09	Free	Yes/No/Cancel
4	Section 4: Population Genetics	11/12/09	Free	Yes/No/Cancel
5	Section 5: Systematics and Phylogenetics	11/12/09	Free	Yes/No/Cancel
6	Section 6: Developmental Biology	11/12/09	Free	Yes/No/Cancel
7	Section 7: Behavioral Biology	11/12/09	Free	Yes/No/Cancel
8	Section 8: Ecology and Evolution	11/12/09	Free	Yes/No/Cancel
9	Section 9: Human Evolution	11/12/09	Free	Yes/No/Cancel
10	Section 10: Conservation Biology	11/12/09	Free	Yes/No/Cancel
11	Section 11: Synthesis	11/12/09	Free	Yes/No/Cancel

Structural engineering

- EXAMINE a system to suit the required function
- OPTIMIZE the loads
- LAY OUT structure to provide load path
- FIND internal forces and reactions
- PRODUCE and detail components to be safe for chosen analysis
- Check a. deformations, compatibility.

webcast.berkeley

<http://webcast.berkeley.edu/courses.php>

- Large number of courses
- Archive
- Downloadable, viewable from iTunes, YouTube
- Web camera shows the teacher in the classroom at the blackboard
- Or captured slides are shown
- No supporting educational material
- Videos provided by the free access

MITOPENCOURSEWARE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Home > Courses > Brain and Cognitive Sciences > The Brain and Cognitive Sciences II

The Brain and Cognitive Sciences II
As taught in: Spring 2002

Instructors:
Prof. Earl Miller
Prof. Nancy Kanwisher

MIT Course Number:

Course Description
This course is the second half of the first-year graduate curriculum. Each module is led by leading researchers in the current state of the discipline to prepare students as cogn...
Topics include: perception, language, and other issues; neural, behavioral and comp...

So I've got the inverse of this, I've got three matrices in

MITOPENCOURSEWARE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

- Large number of courses (2000)
- Archive
- Downloadable course material
- Course syllabus
- Supporting materials
- Translated information in several languages (Spanish, Portuguese)
- Video lectures with subtitles available
- Downloadable from iTunes
- Viewable with YouTube
- Opencourseware



yovisto
ACADEMIC VIDEO SEARCH

- Large number of speakers (> 1 000)
- Large number of videos (> 12 000)
- Archive (Webcast)
- Only video or slides
- No supporting educational material
- Free upload of videos
- High technology Portal
- Powerful search functions
- Free access



KHANACADEMY

- Large number of lectures with narrations
- Archive - Library
- Only video or slides, no person recorded
- Exercises and intelligent tests
- Student tracking possibility
- Activity report
- Communication system
- Possible subtitles
- Hand writing system
- High technology Portal
- Free access

INTERNET TOOL FOR INTERNATIONAL BIOMEDICAL ENGINEERING EDUCATION

PORTAL

EVICAB

The aim was to develop, build up and evaluate sustainable, dynamic solution for virtual mobility and e-learning:

- To support the harmonization of the European higher education programs.
- To improve the quality of and comparability between the programs.
- To advance the post-graduate studies qualification and certification.

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European Virtual Campus for Biomedical Engineering is a:

- high quality
- free access

Biomedical Engineering Curriculum on the Internet

EVICAB is not a university

<http://www.evicab.eu>

Biomedical Engineering Curriculum

BIOELECTROMAGNETISM

Teacher	Course	Book	Video	PDF	Phone	Slide	Exercise
Jaakko Malmivuo	Bioelectromagnetism						
Frank Sachse	Computational Modelling of Cardiovascular System						
Rikto Ilmoniemi	Transcranial Magnetic Stimulation						

BIOMECHANICS

Teacher	Course	Book	Video	PDF	Phone	Slide	Exercise
Rami Korhonen	Biomechanical Modelling of Bone and Cartilage						

OPTICS

Teacher	Course	Book	Video	PDF	Phone	Slide	Exercise
Goran Saloner	Biomedical Optics						

SIGNAL AND IMAGE ANALYSIS

Teacher	Course	Book	Video	PDF	Phone	Slide	Exercise
Jiri Jani	Introduction to Biomedical Signal Analysis						
Rangaraj M. Rangayyan	Biomedical Signal Analysis						
Rangaraj M. Rangayyan	Biomedical Image Analysis						
Loif Stromer	Biomedical Signal Processing in Cardiac and Neurological Applications						

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

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Lecture Videos and Textbook

Jaakko Malmivuo: Bioelectromagnetism

Recorded at the Ragnar Granit Institute, Autumn 2006.

Rating and Commenting Site

Lecture 1

Introduction

- 1.1-1.2 Bioelectromagnetism, Subdivisions of bioelectromagnetism
- 1.3 Bioelectric phenomena, Generation of bioelectric signals, Importance of bioelectromagnetism, Funny example
- 1.4 History of bioelectromagnetism, William Ohlstedt, Jan Swannertun, Luigi Galvani, Electrotherapy
- 1.4.2 Hans Christian Ørsted, Hans Berger - EEG, Magnetoencephalogram, Hermann Helmholtz, Nernst equation

Lecture 2

Anatomical and Physiological Basis of Bioelectromagnetism

- 2.1 Nerve and muscle cell, Cell membrane, Motor neuron
- 2.2.1 Synapse, Striated muscle, Bioelectric function, Response of the membrane potential, Conduction of nerve impulse
- 2.2.2 Subthreshold membrane phenomena, Nernst equation, Electric potential and field, Nernst-Planck equation, Illustration
- 2.3 The origin of resting voltage, Electric circuit of membrane, Goldman-Hodgkin-Katz equation, Reversal voltage, Transmembrane ion flux

Lecture 3

Transmembrane ion flux at resting state

Subthreshold membrane phenomena
Nernst equation
Goldman-Hodgkin-Katz equation
Transmembrane ion flux

5.1 Factors Affecting Ion Transport Through the Membrane

This section explores the flow of various ions through the membrane under normal resting conditions. The flow of ions through the cell membrane depends mainly on three factors:

1. the ratio of ion concentrations on both sides of the membrane
2. the voltage across the membrane, and
3. the membrane permeability.

The effects of concentration differences and membrane voltages on the flow of ions may be made commensurable if, instead of the concentration ratio, the corresponding Nernst voltage is considered. The force affecting the ions is then proportional to the difference between the membrane voltage and the Nernst voltage.

Regarding membrane permeability, we note that if the biological membrane consists solely of a lipid bilayer, as described earlier, all ionic flow would be greatly impeded. However, specialized proteins are also present which cross the membrane and contain aqueous channels. Such channels are specific for certain ions, they also include gates which can modify the membrane voltage. The ions result in the membrane permeability is different for different ions, and it can be affected by changes in the membrane voltage.

Video Files for iPod

Motoneuron

Analytical and Physiological Basis of Bioelectromagnetism

Video Files for Portable Devices

Media Phone
3gp format
87x45 min = 0.5 Cb

iPod Nano: 4 or 8 Cb
m4v format
87x45 min = 1 Cb

Table of Contents:

- 1. PREFACE
- 2. INTRODUCTION
- 3. ANATOMICAL AND PHYSIOLOGICAL BASIS OF BIOELECTROMAGNETISM
- 4. NERVE AND MUSCLE CELLS
- 5. SUBTHRESHOLD MEMBRANE PHENOMENA
- 6. ACTIVE BEHAVIOR OF THE MEMBRANE
- 7. SYNAPSE, RECEPTOR CELLS, AND BRAIN
- 8. THE HEART
- 9. BIOELECTRIC SOURCES AND CONDUCTORS AND THEIR MODELING
- 10. VOLUME SOURCES AND VOLUME CONDUCTOR
- 11. SOURCE FIELD MODELS
- 12. BIDOMAIN MODEL OF MULTICELLULAR VOLUME CONDUCTORS
- 13. ELECTROSTATIC NEURON MODELS
- 14. THEORETICAL METHODS IN BIOELECTROMAGNETISM
- 15. THEORY OF BIOMAGNETIC MEASUREMENTS
- 16. ELECTRIC AND MAGNETIC MEASUREMENT OF THE ELECTRIC ACTIVITY
- 17. ELECTROENCEPHALOGRAPHY
- 18. ELECTRIC AND MAGNETIC MEASUREMENT OF THE ELECTRIC ACTIVITY
- 19. 10-20 Hz EEG SYSTEM
- 20. VECTORCARDIOGRAPHIC LEAD SYSTEMS
- 21. OTHER EEG LEAD SYSTEMS
- 22. BIOPHYSICAL FACTORS IN THE EEG
- 23. THE BASIS OF EEG DIAGNOSIS
- 24. BIOMAGNETOCARDIOGRAPHY
- 25. ELECTRIC AND MAGNETIC STIMULATION OF NEURAL TISSUE
- 26. FUNCTIONAL ELECTRIC STIMULATION
- 27. MAGNETIC STIMULATION OF NEURAL TISSUE
- 28. ELECTRIC AND MAGNETIC STIMULATION OF THE HEART
- 29. CARDIAC PACING
- 30. CARDIAC DEFIBRILLATION
- 31. MEASUREMENT OF THE DYNAMIC ELECTRIC PROPERTIES OF BIOL
- 32. BIOPHYSICAL FLUENCY BIOPHYSICS
- 33. BIOPHYSICAL TOMOGRAPHY
- 34. THE ELECTROGRAM RESPONSE
- 35. OTHER BIOELECTROMAGNETIC PHENOMENA

Book Cover: **Bioelectromagnetism**
Jaskier Malinowska
Robert Plonsey

EVICAB

Build-up of the BME Curriculum:

- EVICAB creates a platform for a BME curriculum on the Internet.
- Universities may propose a course to EVICAB.
- The Steering Group decides what courses are accepted to EVICAB.
- EVICAB courses are free of charge.
- The courses are updated and maintained by those universities which produced them.

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Why to provide a free course on the Internet?

- Virtual campus may become the internationally recognized standard in Internet education.
- If a course is accepted to EVICAB, that demonstrates the high quality of the biomedical engineering education in that university.
- It will attract international students and increase the reputation of that university/institute.
- The international assessment and ranking of universities has come more popular and universities compete for their position on the lists.
- EVICAB will offer in BME a platform to demonstrate excellent courses.

INTERNET TOOL FOR INTERNATIONAL
BIOMEDICAL ENGINEERING EDUCATION

EXAMINATION

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Due to the globalization:

- education is given on the Internet,
- documentation is made on the Internet,
- information is searched from the Internet,
- Internet is available everywhere.

Why not to arrange the examinations on the Internet?

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iExam

- Allows examiners to assess learning outcomes and performance of the students.
- Students have possibility to demonstrate their individual knowledge within particularly subject.

Under certain conditions:

- Confidence in using ICT.
- Ability to express ideas in digital format.

EVICAB

Type of Examination

In a classical examination it is tested:
How much the students remember detailed information?

It is **NOT** tested:

How much the students *understand* the information?

Role of Information

If someone asks me:

"What is ... ?"

If I do not know, I answer:

"I do not know, but I know from where I can find the answer."

EVICAB

Correct Questions in i-Exam

Since all the information is available in i-Exam, it should NOT be asked:

"What is ... ?"

It should be asked:

"Why it is ... ?"

"How to apply ... ?"

"Compare the properties of ... ?"

"Which one is better and why ... ?"

"Design a system which ... ?"

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Conducting the i-Exam

- 1) The students go to the computer class in any university at the time of the exam. The assistant supervises the exam in the class.
- 2) The assistant gives the password for the students to write on the answer document.



EVICAB

Conducting the i-Exam

- 3) Students open the *Internet Exam* page:
 - before the examination, the page informs that the examination is approaching,
 - shortly before the examination the page is replaced with another page encouraging to reload the page,
 - when the examination starts this page is replaced with the examination page and the students may download the exam.

EVICAB

Internet Examination

Quick help for the Internet Examination

- The **Examination Form Icon** will be here during the examination time.
- Download the **Examination Form** as a Word file by clicking the icon.

Reload The **Examination Form** is soon available here. The examination starts in a moment. Please, click the **Reload**,

- Save the Examination Form to your computer.
- Write to the Form your name and student number.
- Write to the Form the Password given by the assistant.
- Write your answers to the Form.
- You may use all the material available on the Internet.
- You are not allowed to communicate with another person.
- Send the Form as an attachment to e-mail to the address: exam@evicab.eu
- The Form must be sent before the examination time ends.
- Note: You may send the Form only once.
- The Examination Form Icon will be removed at the end of the exam.

◀ Curriculum page ▲ Top of page DRAFT 1

EVICAB

Internet Examination

Quick help for the Internet Examination

- The **Examination Form Icon** will be here during the examination time.
- Download the **Examination Form** as a Word file by clicking the icon.

Examination Form **Bioelectromagnetism**
HUT 2010.09.27 at 13.00-16.00 o'clock
Send the Form as an attachment to e-mail to: exam@evicab.eu

- Save the Examination Form to your computer.
- Write to the Form your name and student number.
- Write to the Form the Password given by the assistant.
- Write your answers to the Form.
- You may use all the material available on the Internet.
- You are not allowed to communicate with another person.
- Send the Form as an attachment to e-mail to the address: exam@evicab.eu
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- Note: You may send the Form only once.
- The Examination Form Icon will be removed at the end of the exam.

◀ Curriculum page ▲ Top of page DRAFT 1

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Bioelectromagnetism
Helsinki University of Technology
Examination 2010.09.27 13.00-16.00 o'clock

Name _____
Student No _____
Password _____

Examination
2010.09.27

- 1)
 - a) What are the ion concentrations in- and outside the cell membrane in resting state?
 - b) What factors affect to the flow of ions through the cell membrane?
- 2)
 - a) What is the lead vector?
 - b) For what purpose it is used?
- 3)
 - a) What is the standard clinical EEG-recording system?
 - b) What benefits and drawbacks a considerable increase of the number of EEG electrodes brings?
- 4)
 - a) What is vectorcardiography?
 - b) Which VCG system is most insensitive to the displacement of electrodes and why?
- 5)
 - a) What are the electric and magnetic stimulations of the central nervous system.
 - b) Compare their technical and clinical properties.

Your answers: _____

DRAFT 1

EVICAB

Conducting the i-Exam

- 4) The examination form is a Word document. Students write their answers to the document. They may use all material available on the Internet but *must not* communicate with other persons.
- 5) Before the exam ends the students send the document to the assistant as an attachment to the e-mail (exam@evicab.eu).
- 6) The teacher/ assistant checks the answers and gives the marks.
- 7) The results are informed to the students.

EVICAB www.moodle.fi/evicab/moodle

Conducting the i-Exam

Other Internet education platforms than EVICAB may be used, e.g.,:

- Moodle
- Blackboard
- etc ...

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How to prepare questions?

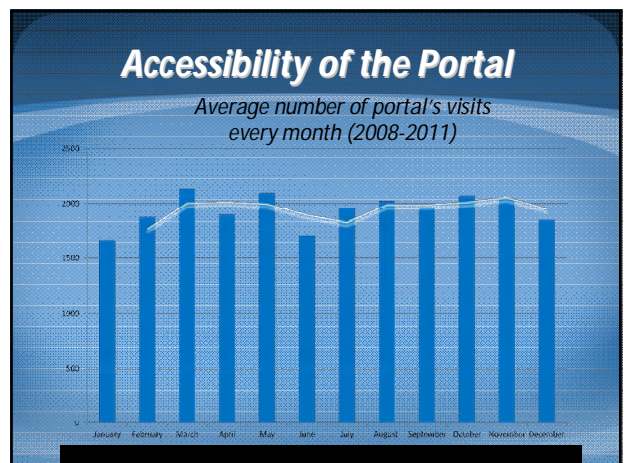
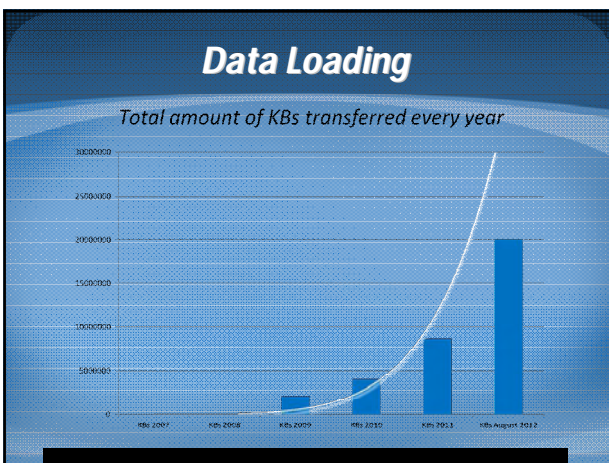
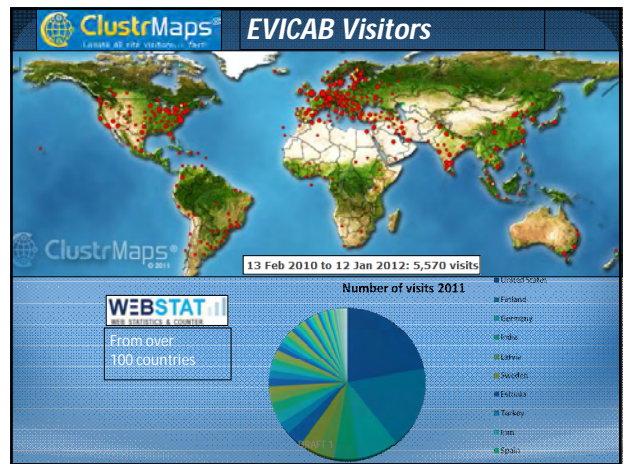
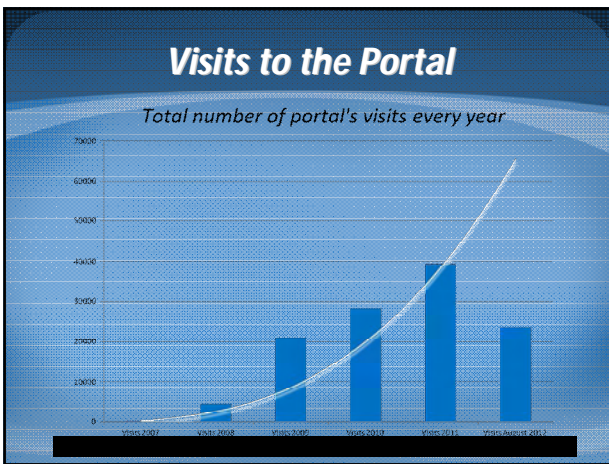
- 1)
 - a) What are the ion concentrations in- and outside the cell membrane in resting state? 2 pt
 - b) What factors affect to the flow of ions through the cell membrane? 4 pt
- 2)
 - a) What is the lead vector? 2 pt
 - b) For what purpose it is used? 4 pt
- 3)
 - a) What is the standard clinical EEG-recording system? 2 pt
 - b) What benefits and drawbacks increase of the number of EEG electrodes brings? 4 pt
- 4)
 - a) What is vectorcardiography? 2 pt
 - b) Which VCG system is most insensitive to the displacement of electrodes and why? 4 pt
- 5)
 - a) What are the electric and magnetic stimulations of the central nervous system. 2pt
 - b) Compare their technical and clinical properties. 4 pt

max: 30 pt



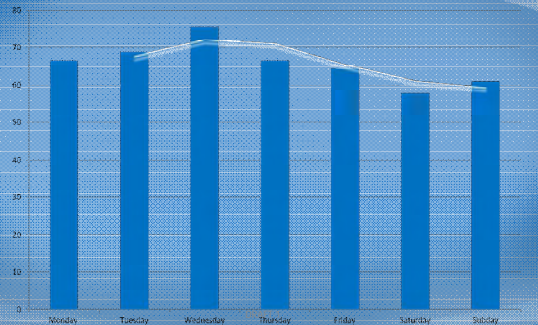
INTERNET TOOL FOR INTERNATIONAL BIOMEDICAL ENGINEERING EDUCATION

RESULTS



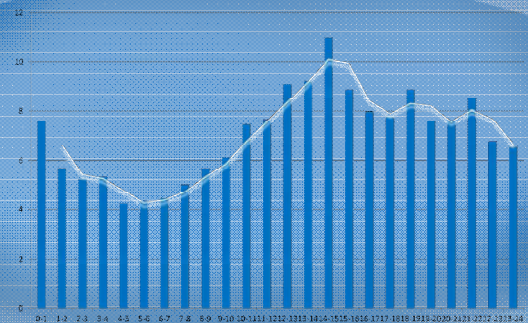
Weekly Accessibility of the Portal

Average number of visits during weekdays

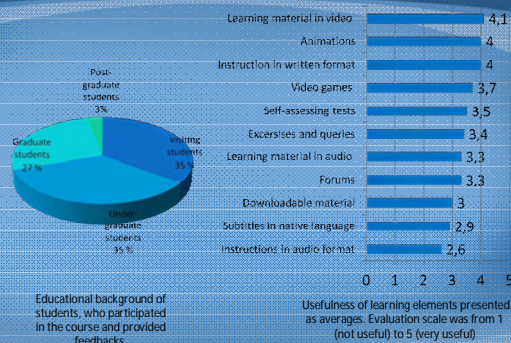


Hourly Accessibility of the Portal

Average number of visits at certain hour (GMT +2)



Feedback Results



Future Features of Virtual Material

- Interactivity
- Collaboration
- Discussion forum
- Semantic linking
- Wiki principle
- Evaluation system
- Intelligent assessment system
- Quizzes
- Subtitles in native language

Students' Comments on the i-Exam

Positive comments:

- Internet exam was not memory based.
- Was focused on understanding but not on mechanical learning.
- References were available.
- It was possible to access the exam anywhere.
- Served as a learning process, possible to enhance knowledge even during an exam.
- Knowledge application was like in the real world.
- Good change.

A. Kybartaitė, J. Nausialienė and J. Melnikovas. Evaluation on Students' Attitudes towards Virtual Learning Objects for Biomedical Engineering IEEE Multidisc. Eng. Educ. Mag. 4(4) Dec. 2009.

Students' Comments on the i-Exam

Negative comments:

- Boring to read on the screen.
- Traditional exam was less stressful.
- Necessary to read material in advance to know where to take references from.
- Open book Internet exam provided too many reference materials.
- Possible to copy and paste answers without understanding or knowing the meaning.
- Not absolutely sure that exam answers will end up in a correct place.
- Internet connection problems or related technical issues might suddenly ruin the exam.
- Slower to write with computer than by hand.
- Not sure how well it tests knowledge.

Teachers' Comments on the i-Exam

Advantages:

- Internet is independent of location, the i-Exam may be:
 - taken anywhere in the world,
 - administered from anywhere.
- Because the answers are on computer:
 - they are easier to read,
 - they are easier to store to archives.
- Answers describe more effectively students' understanding of the issues of the question.

Teachers' Comments on the i-Exam

Disadvantages:

- Plagiarism.
- Copying and pasting.
- Possibility for collaboration with other people via digital or mobile devices.
- Incorrect attendance information.
- Exceeding deadline for submitting the examination form.
- Answers as the essays are more time consuming to check.

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CONCLUSIONS

Conclusions (1)

- The main advantage of virtual education is the global open access.
- e-Learning has achieved the level to be accepted as a standard method of learning.
- Technologies for virtual education are available and relative user friendly.
- Different measures are in use for quality assurance of e-courses.
- Students' mobility has been increasing. Virtual mobility is a new dimension in education.
- Widely recognized qualifications are needed for developing e-courses.
- Virtual education does not replace or eliminate education on the university scale but support and augment on the global scale.

Conclusions (2)

- Implementation and application of education via the Internet requires additional efforts from the students, teachers, educational institutions and virtual education developers.
 - The students should have confidence in using information communication technologies.
 - The teachers should be able to produce pedagogically sound virtual course materials.
 - The educational institutions should provide computers with the internet connection and ensure proper administration during the learning process.
 - The developers should understand how these issues are solved in different international environments in order to provide the optimal solutions.

Thank you for your attention!