# E-Learning and *Mathematical Methods in Chemistry*

### TEMPUS Joint European Project EQIBELT
### $2^{nd}$ *Workshop on E-learning Support Centers*

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# Introduction

## *Faculty of Science at the University of Zagreb*

- One of the leading academic and scientific institutions in Republic of Croatia
- Departments of:
    - Biology
    - Chemistry
    - Geography
    - Geology
    - Geophysics
    - Mathematics
    - Physics

# Introduction

## Department of Chemistry

# Introduction

### Department of Chemistry - academic stuff

- 3 Members of *Croatian Academy of Sciences and Arts*
- 47 Professors
- 23 Junior researchers
- 43 Associates
- 600 Students/4 different study programs

# The State of E-learning

### *Department of Chemistry - available infrastructure*

- Several servers and broadband connection
- 2 Classrooms equiped with multimedia projectors (each with 150 places)
- 2 Computer classrooms for students
- Merlin - LMS based on Moodle at the University E-learning center
    - Large storage place
    - No need/costs for administration
    - No need/costs for hardware or software upgrades
    - All these activities are hidden from the users

# The State of E-learning

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*E-learnings Adoption Cycles (according to Zemsky and Massy)*

- *1. Enhancements to traditional course/program configurations*
- *2. Course Management Systems*
- *3. Imported course objects*
- *4. New course/program configurations*

# The State of E-learning

> *Department of Chemistry - E-learnings Adoption Cycles (according to Zemsky and Massy)*
>
> - Over the $70\%$ courses are in the Adoption Cycle
>   *1. Enhancements to traditional course*
> - Less than $10\%$ of courses are in the Adoption Cycle
>   *2. Course Management Systems*
> - The aim is to enhance the level of courses:
>   *0. $\Rightarrow$ 1. Enhancements to traditional course*
>   *1. Enhancements to traditional course $\Rightarrow$ 2. Course Management Systems*
>   *2. Course Management Systems $\Rightarrow$ 3. Imported course objects*

# The State of E-learning

### *Mathematical Methods in Chemistry 1* and *2 - Courses Overview*

- Mandatory courses on the second year of Chemistry study
- Linear algebra. Quantum mechanical treatment of molecules. Symmetry in chemistry. Group theory.
- Numerical methods. Probability theory. Statistics and statistical data analysis.
- 62 Students - 56 ($90\%$) are frequently using Merlin (students with no prior knowledge about e-learning)

# The State of E-learning

> ### *Mathematical Methods in Chemistry 1* and *2 - Teaching Materials*
>
> - Interactive presentations and handouts
> - Script with theory and exercises
> - On-line quizes with theoretical and numerical problems
> - Additional materials which include numerical simulations and animations were apropriate

# The State of E-learning

## *Mathematical Methods in Chemistry 1* and *2 - Grades*

- 2 Partial written exams (obligatory)

- Oral exam (obligatory)

- E-learnings activities:
    - On line exercises on the current topic (not obligatory)
    - Student seminar series on wiki covering selected chemical problems (not obligatory)
    - Forum *Consultations*

## Student's Motivation

### *John Keller's ARCS Model of Motivation*

- **A**ttention
    - Lesson must gain the learner's attention
- **R**elevance
    - Connection of content to important goals of the learners (future job or academic requirements)
- **C**onfidence
    - Accomplished by helping students to establish positive expectancies for success
- **S**atisfaction
    - Positive feelings about one's accomplishments and learning experiences

# Student's Motivation

## *Mathematical Methods in Chemistry 1* and *2*

- **A**ttention
  - Chemical problems that engage a deeper level of curiosity
- **R**elevance
  - Simulations and case studies of the real chemical problems (mostly in Physical and Theoretical Chemistry)
- **C**onfidence
  - The objectives of course are clearly stated and achievements can be monitored during the semester
- **S**atisfaction
  - Students receive recognition and additional credits by solving the on line exercises and making seminars
  - It is important that they know they have been treated fairly

## Expected Support

### *General support from the University E-learning center*

- Exploring the possibilities in Moodle
- Enhancing Moodle
- Obtaining specific desktop software for building learning materials

### *Specific support from the University E-learning center*

- Extension of courses with specific applications
  - Building desktop, server and web oriented applications
- Building multimedia materials

# Case Study

### *Symmetry in Chemistry*

- Each molecule has some symmetry elements
- Symmetry operators bring a molecule into coincidence with itself operating with a respect to the corresponding symmetry elements
- There are two types of symmetry operators:
  - $C_n^k$ proper $n$-fold rotation operator for $k$ successive rotations through an angle of $\frac{2\pi}{n}$ about a proper $n$-fold rotation axis $\mathrm{C}_n$
  - $S_n^k$ improper $n$-fold rotation operator for $k$ successive rotations through an angle of $\frac{2\pi}{n}$ about an improper $n$-fold rotation axis $\mathrm{S}_n$
- Transition from 2D picture to 3D molecular models