

# Active Teaching and Learning of Mathematics in Higher Education.

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- 1 Digital Times
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- 5 Mathematics: pre-requisites for first year at university

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- 1 Digital Times
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# Digital Times

- In the last 40 years people **lifestyle has been greatly modified**.
- Motivated by **development of IT** and **ease to access** to electronic devices.
- These changes have affected all aspects of our life, including **education**. So, changes in aims, methodologies and assessment have been required.

# Changes in Higher Education

- In 1999, the bases for the **European Higher Education Area** were set up (Bologna Declaration).
- In 2003, **Tuning Project** released their reflections on education with the aim of creating an integrated higher education area.
- The new system was based on competencies. Three types of generic competencies were considered: instrumental, interpersonal and systemic competencies.
- In the first type, skills related to using **technological devices, computing and information management** were included.

# Changes in Secondary Education

- A system based on learning competencies was adopted.
- ICTs skills were incorporated:

Technological tools, in particular the use of **calculators** and **computer applications** should help both to **better understand** concepts and **solve problems** and to **process complex calculations**, while keeping to work with fluency and precision the manual calculation introduced in progressive complexity.

# Changes in Secondary Education

- In 2010, the requirements for being a secondary school teacher changed.
- Before 2009, graduates have to pass a course related to education (between 100 and 300 hours).
- After 2009, a **master** (60 credits) is necessary.

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# Active Learning and Competencies

- The new systems implied changes regarding teaching, learning, assessment, methodology, etc.
- Many courses, experiences and conferences took place.
- Active methodologies were recommended.
- *Active learning refers to classroom practices that **engage** students in activities, such as **reading, writing, discussion, or problem solving**, that promote higher-order thinking.*

# Active Learning and Competencies

- Changes in the **syllabus** were carried out and **ICTs** were incorporated. But I am not sure about practical effects.
- Applying these methodologies in HE is not very common, it depends on several factors.
- In general, **programmes of computation in Mathematics** (MatLab, ect., ...) were incorporated in HE.
- In SE, the situation is different and not many schools use programmes of computation.

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# The Subject

- Title: Using programmes for calculating in experimental sciences.
- Credits: 7,5 (2,25 Attendant).
- Kind: Optional. Second semester.
- General Objective: to provide the capacity of **using** programs for computation and **being capable** of applying them for teaching and learning.

# Specific Objectives

- 1 **Understand and evaluate** the use of computers as both an instrument of **calculation** and a tool to help better understanding of concepts in different areas of knowledge.
- 2 **Management** of simple data processing and visualization **programmes**, oriented to Secondary Education.
- 3 **Describe and use** the basic instructions to manage data, operate with elementary functions and represent simple graphics with programs such as **GeoGebra**.

# Specific Objectives

- 1 **Design didactic activities** of learning based on calculation and visualization programs. These activities will be in accordance with the contents of the curricula of secondary education, and will have the purpose of simplifying detailed calculations and **facilitating the understanding of concepts**.
- 2 **Implement** didactic activities of subjects included in their speciality with programs like **eXeLearning**.

# Contents

## Chapter 1: Using computers in teaching.



(Tomada de <http://aprendiendoconjem.blogspot.com.es/>)

# Contents

Chapter 2: Tools helping to teach.





# Contents

## Chapter 3: Designing teaching activities using computer resources.

- 1 Point out specific objectives.
- 2 Plan carefully the tasks to be performed.
- 3 Plan the collection of results.
- 4 Determine the evaluation system.

# Methodology

- Practical guidance.
- Active methodologies.
- We use an online platform.
- The activities are adapted to students' training: Initial test.

# Activities

- At the beginning not very much participation.
- Then very active
  - Working in groups.
  - Presentation and evaluation of group tasks.
  - Individual task.
  - Presentation and evaluation of individual tasks.

# Assessment

We have continuous evaluation

- Tasks for solving in the classroom and at home.
- Presentations and assessments of group tasks.
- Final Mark: 55 % tasks during the course y 45 % individual task.

# Conclusions

- In general:
  - students show **fluency in handling the basic instructions** of GeoGebra and eXeLearning,
  - they are **able to design and implement teaching activities** in platforms such as Exelearning (or Moodle).
- Some tasks have been the **origin of communications** in conferences.
- Many students **include activities with GeoGebra and ExeLearning in their final task in the master (TFM)**.

# Examples

- Exponencial
- Método del Simplex
- Operaciones con conjuntos

# Conclusion

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  - they are **able to design and implement teaching activities** in platforms such as Exelearning (or Moodle).
- Some tasks have been the origin of **communications in conferences**.
- Many students **include activities with GeoGebra and ExeLearning in their end of master project** .

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# Method for Solving Problems

Experience in Advanced Calculus.

# Solving problems

- **Solving Problems** is also an ability included in the general competencies of both higher and secondary education programmes.
- It is usually included in Mathematics.
- How do students learn to solve problems?
- Many authors have thought about the procedures that experts use when they face a problem. Polya was a pioneer in his book "How to solve it?" (1945).
- The analysis of these procedures turn the **capacity of solving problems into a skill that can be learnt.**

# Activity

- Activity in Advanced Calculus, a subject of second course in Telecommunication Engineering (2004-2005).
- Small groups were formed.
- General ideas were introduced.
- A list of questions was given.
- Students practiced with non-routine problems.
- When students could not continue, then we ask questions of the list.

# Method

The method is structured in four steps:

- 1. Understanding the problem.

What is the unknown? What are the data? What is the conditio?

Draw a figure...

- 2. Devising a plan.

Have you seen it before? Have you see the same problem in a slightly different form? Do you know a related problem? ...

# Method

- 3. Carrying out the plan.

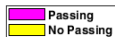
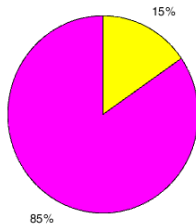
Carrying out your plan of the solution, check each step. Can you see the step is correct? ...

- 4. Looking back.

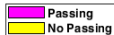
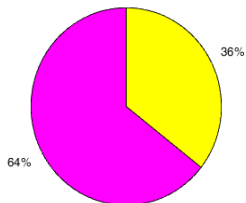
Can you check the result? Can you check the argument? Can you derive the result differently? Can you see it at a glance?...

# Results

### Students Participating



### Students No Participating



# Conclusions

- Almost all students used the method for solving problems. In particular, when they cannot see how to solve an exercise at first glance.
- Students tried to apply the method to other subjects but in these cases the result was worse.
- All students think the method is useful and using it they improved their marks.

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# AN ONLINE LEARNING COURSE FOR MATHEMATICS AND STATISTICS

# Online introduction course

- It is well known that success or failure of students in first course of Higher Education strongly depend on their personal circumstances and **academic background**.
- Authorities of the University of Oviedo proposed some projects with the purpose of designing activities in order to improve academic results of first year students.
- Teachers of the Departments of Mathematics and Statistics and teachers of Secondary Schools formed a working group with the purpose of implementing an online course covering the pre-requisites in Mathematics and Statistics.

# Objectives






- Encourage students to develop their ability to work autonomously and become responsible for their own learning.
- Reduce the number of dropouts in the subjects of Mathematics and Statistics.
- Improve the performance of students in those subjects in which mathematical knowledge is a prerequisite.

# Contents

- The platform is organized in four subjects divided into topics as follows:
- Algebra: Trigonometry, Vectors in the plane, Bases and coordinates, Scalar product, Complex numbers, Systems of linear equations.
- Calculus: Functions, Derivatives, Integrals.
- Statistics: Sets, Descriptive statistics, Probability calculus.
- Numerical calculus: Estimating, rounding and errors, Matricial calculus.

# Example

**LEMSUO:** *Learning Environments on Mathematics and Statistics, University of Oviedo*

-  [Novedades](#)
-  [Proyecto entregado en el vicerrectorado](#)
-  [Datos Becario](#)
-  [Enlace al desarrollo del curriculum en la ESO](#)
-  [Enlace al desarrollo del curriculum de Bachillerato](#)

1

## Álgebra

-  [Componentes del grupo de Álgebra](#)
  -  [Trigonometría](#)
  -  [Vectores en el Plano](#)
  -  [Bases y Coordenadas en V2](#)
  -  [Producto Escalar](#)
  -  [Números Complejos](#)
  -  [Sistemas de ecuaciones lineales](#)

2

## Cálculo

-  [Componentes del grupo de Cálculo](#)
  -  [Funciones](#)
  -  [Derivadas](#)

3

## Estadística

# Example



## Trigonometría

Grados y radianes

Definiciones de las razones

trigonométricas de un ángulo agudo

Los ángulos notables

Razones trigonométricas de los  
ángulos notables del primer  
cuadrante

La circunferencia goniométrica:

Razones trigonométricas de ángulos  
en el intervalo  $[0, 360^\circ]$

Signo del seno y coseno en los  
distintos cuadrantes

Relaciones entre los ángulos en los  
distintos cuadrantes

Ángulos de intervalos diferentes de  
 $[0, 360^\circ]$

Ángulos complementarios

Ángulos suplementarios

Ángulos opuestos

Ángulos que difieren en  $90^\circ$

Ángulos que difieren en  $180^\circ$

Principales identidades

## Trigonometría



### Pre-conocimiento

- Operar con números reales
- Concepto de triángulo
- Clasificación de los triángulo, especialmente los triángulos rectángulos
- Clasificación de ángulos



### Objetivos

- Relacionar la medida de un ángulo en grados sexagesimales y en radianes
- Relacionar las razones trigonométricas con los lados de un triángulo rectángulo

# Example



## Ejemplos

*Pasaremos de grados sexagesimales a radianes:*

$$1. \quad 30^\circ = 30 \frac{\pi}{180} \text{rad} = \frac{\pi}{6} \text{rad} \approx 0.5236 \text{rad}$$

$$2. \quad 60^\circ = 60 \frac{\pi}{180} \text{rad} = \frac{\pi}{3} \text{rad} \approx 1.0471 \text{rad}$$

$$3. \quad 45^\circ = 45 \frac{\pi}{180} \text{rad} = \frac{\pi}{4} \text{rad} \approx 0.7854 \text{rad}$$

$$4. \quad 180^\circ = 180 \frac{\pi}{180} \text{rad} = \pi \text{rad} \approx 3.1416 \text{rad}$$

## Example



## Ejercicio

Expresa en grados sexagesimales

1.  $\frac{3\pi}{4} \text{ rad} = 135^\circ$

2.  $\frac{5\pi}{6} \text{ rad} = 150^\circ$

3.  $\frac{7\pi}{4} \text{ rad} = 325^\circ$

Reiniciar

Mostrar las respuestas



# Conclusions

- Virtual education has some general advantages, such as flexibility, independent learning or the possibility of self-assessment.  
The learning platform allows students to
- develop their ability to work autonomously, assuming responsibility for their learning,
- resolve their math shortcomings when they need and can,
- improve performance in subjects where mathematical knowledge is a prerequisite, reducing their discouragement and therefore the number of dropouts.

**Thanks for your attention**

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