Experience of Universidad Autónoma de Madrid in the TUNING project

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TUNING en France: une approche européenne des formations par les compétences

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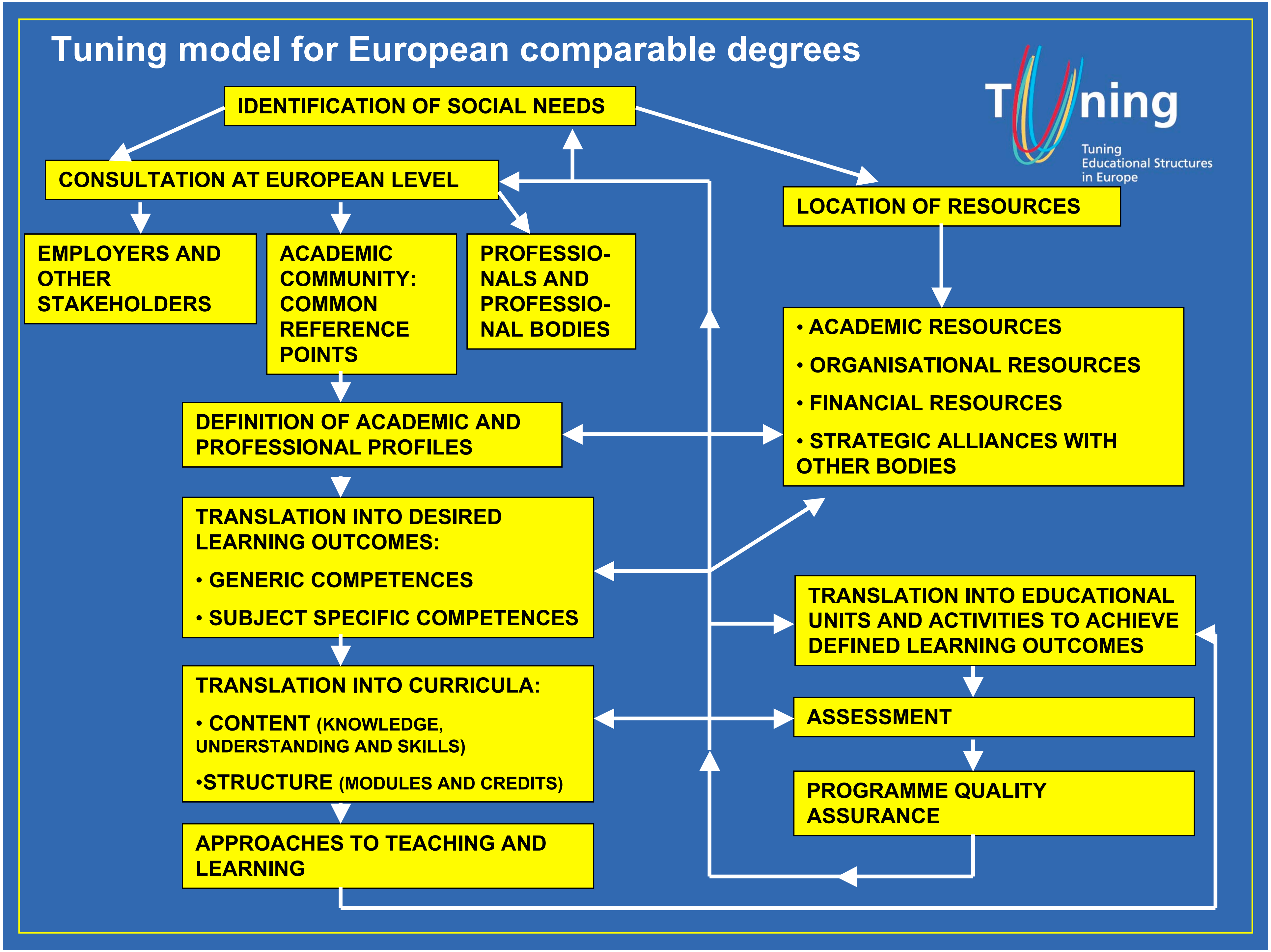
Warnings

- Nothing we have done at UAM [or in Spain] is original.
- Nothing we have done <u>requires</u> Tuning or Bologna.

However…

- Participation in Tuning has served as a catalyst: without Tuning/Bologna we might not even have talked about all of these.
- The same is true at national level.

Starting Point…


Tuning model for European comparable degrees
Tuning
Tuning Educational Structures in Europe
IDENTIFICATION OF SOCIAL NEEDS
CONSULTATION AT EUROPEAN LEVEL
EMPLOYERS AND OTHER STAKEHOLDERS
ACADEMIC COMMUNITY: COMMON REFERENCE POINTS
PROFESSIO-NALS AND PROFESSIO-NAL BODIES
LOCATION OF RESOURCES
• ACADEMIC RESOURCES
• ORGANISATIONAL RESOURCES
• FINANCIAL RESOURCES
• STRATEGIC ALLIANCES WITH OTHER BODIES
DEFINITION OF ACADEMIC AND PROFESSIONAL PROFILES
TRANSLATION INTO DESIRED LEARNING OUTCOMES:
• GENERIC COMPETENCES
• SUBJECT SPECIFIC COMPETENCES
TRANSLATION INTO EDUCATIONAL UNITS AND ACTIVITIES TO ACHIEVE DEFINED LEARNING OUTCOMES
TRANSLATION INTO CURRICULA:
• CONTENT (KNOWLEDGE, UNDERSTANDING AND SKILLS)
•STRUCTURE (MODULES AND CREDITS)
ASSESSMENT
PROGRAMME QUALITY ASSURANCE
APPROACHES TO TEACHING AND LEARNING

What have we done?

- National level:

All 25 Mathematics Faculties, with help from ANECA [Quality Agency]: "ANECA White Book"

- **Consultation to Graduates & Employers on:**
  - **Employment / Professional profile**
  - **Competences**
- **Agreement on [proposal for a] National Core Mathematics Curriculum.**

- University level

- **Reflection on**
  - **Use of study time [key in ECTS!]**
  - **Teaching and learning methodologies**

Where do Spanish Mathematics Graduates work?

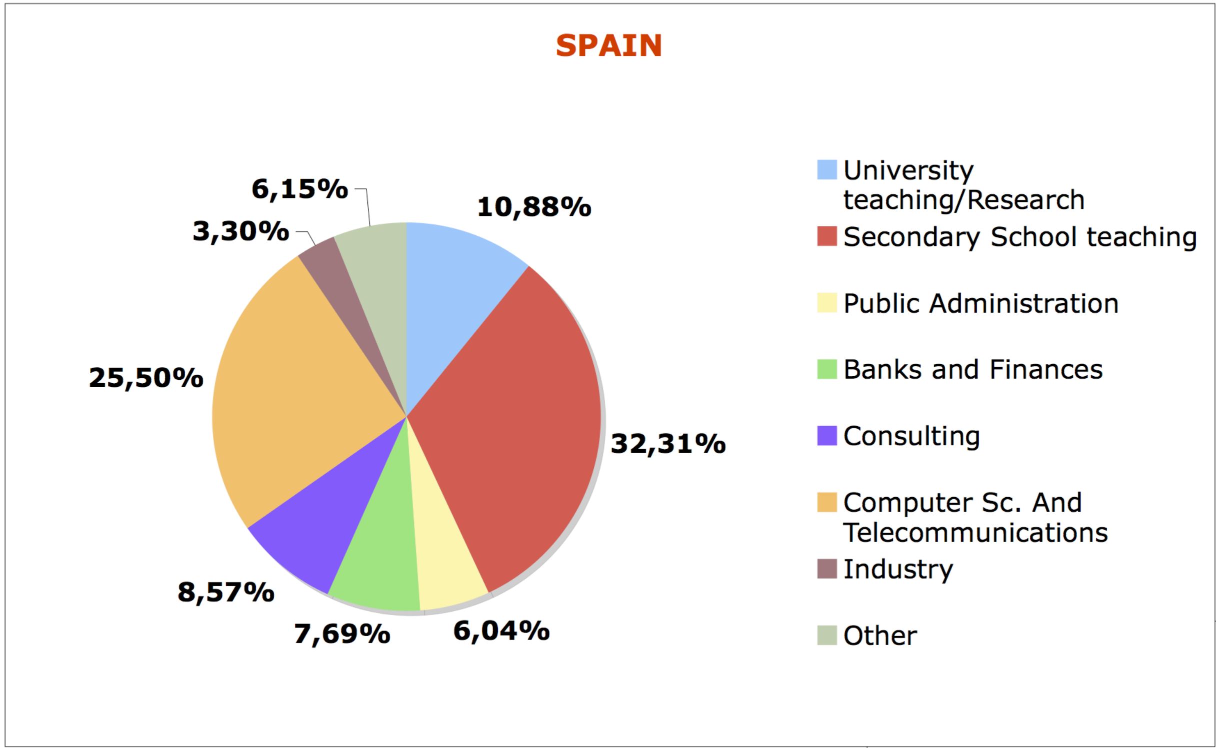
Implicitly (or even explicitly!) we thought all graduates work in the “traditional fields”:

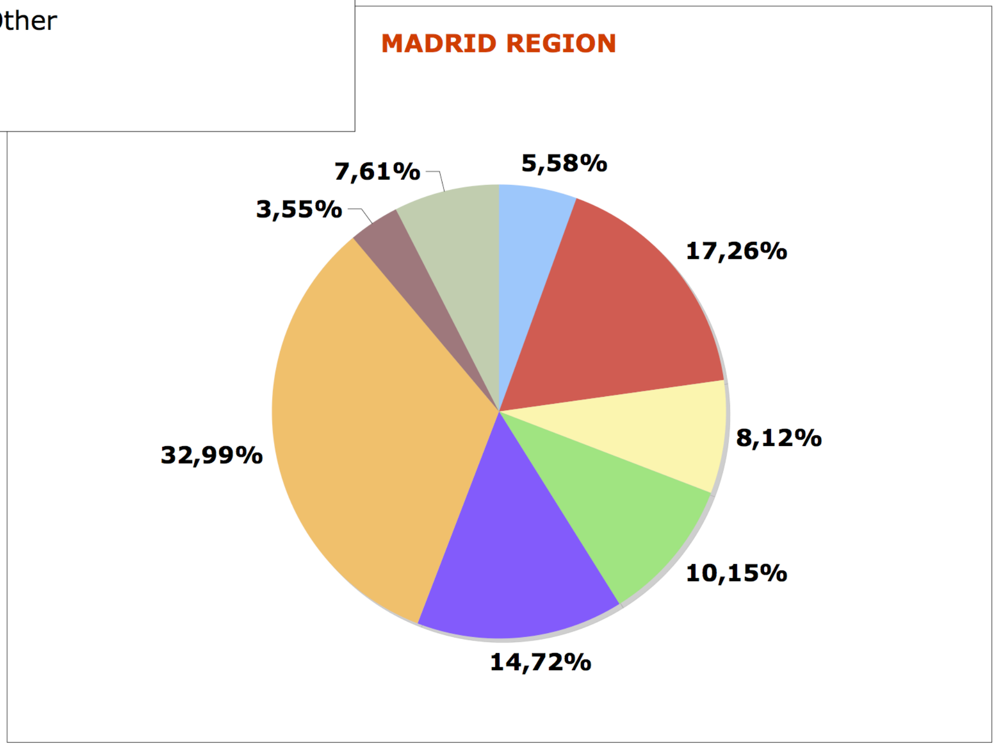
- –Teaching
- –Research

University curricula were directed to train future “pure Math” researchers.

But maybe they are beginning to work in ICT, Banking,…

FACTS ON MATH EMPLOYMENT
(from consultation)





Consultation on Generic Competences: Most important

Scale: 1-4 (A-I= Achievement-Importance)	Secondary School teachers	A-I	Banking, finance and insurance	A-I	Employers (non teaching)	A-I	Academics
Instrumental	-Capacity for organization and planning - Problem solving	-0.28 -0.10	-Capacity for organization and planning - Capacity for analysis and synthesis	-0.77 **+0.15**	-Capacity for analysis and synthesis - Problem solving	-0.41 -0.76	**-Capacity for analysis and synthesis** **- Problem solving**
Personal	-Critical thinking -Recognising diversity and multiculturality	-0.35 **-1.39**	-Team work - Critical thinking	**-1.12** -0.23	- Team work - Capacity to work in an international context	-0.51 **-1.02**	-Critical thinking **- Team work**
Systemic	- Adapting to new situations - Autonomous learning	-0.46 **+0.17**	- Adapting to new situations - Autonomous learning	-0.32 -0.18	- Adapting to new situations - Motivation for quality	-0.82 -0.45	**-Autonomous learning** **- Creativity**

Consultation on Specific Competences: Most important

Scale: 1-4 (A-I= Achievement-Importance)	Secondary School teachers	A-I	Banking, finance and insurance	A-I	Employers (non teaching)	A-I	Academics
Knowledge in the Field	- Mathematical Analysis - Algebra	**+0.29** **+0.28**	- Computer Science - Statistics	**-0.55** **+0.31**	- Computer Science - Statistics	**-0.50** -0.09	**- Mathematical Analysis** **- Algebra**
Professional Competences	- Application of knowledge in practice - Visualizing and interpreting solutions	**-0.73** -0.15	- Arguing logically when making decisions - Application of knowledge in practice	-0.19 **-0.66**	-Visualizing and interpreting solutions - Participate in the implementation of computer programmes	-0.66 -0.29	-Visualizing and interpreting solutions -- Solving models using analytic, numerical and statistical techniques
Academic Competences	- Rigorous and clear exposition - Generating curiosity and interest for Mathematics and its applications	-0.14 **-0.92**	- Logical thinking and identification of errors in procedures - Rigorous and clear exposition	**+0.10** -0.05	- Logical thinking and identification of errors in procedures - Rigorous and clear exposition	-0.63 **-0.97**	**- Rigorous and clear exposition** **- Logical thinking and identification of errors in procedures**
Other Specific Competences	- Ability to adapt to new situations	-0.51	- Ability to adapt to new situations	-0.52	- Ability to adapt to new situations	-0.68	**- Ability for abstraction**

How to propose a Core National Curriculum for Mathematics?

- KEY: done by Universities/mathematicians after consultation.
- Take into consideration what we have learned about employment and important competences.
- Take into consideration the European (International?) context / information. For example “Tuning”.
- Talk not only about Contents, but also about competences.
- Example: they should communicate better.

  Make them write and talk! [TEACHING METHODS!!!]
- But we still want to train mathematicians!

  Subject specific competences [learning outcomes] are essential.

Core Curriculum for Mathematics

Tuning Math Group (“light”)	Proposal of Spanish Math Faculties	ECTS Credits/144
Linear algebra	Linear algebra and geometry	16.5
Calculus in one and several real variables	Differential and integral calculus and functions of one complex variable	34.5
Basic complex functions		
Basic differential equations	Differential equations	12
Some probability	Probability and Statistics	**15 [Increased]**
Some statistics		
Some numerical methods	Numerical methods and computer science	**19.5 [Increased]**
Basic geometry of curves and surfaces	Topology and differential geometry	15
Some algebraic structures	Algebraic structures	13.5
Some discrete mathematics	**Discrete mathematics and optimization**	**12 [NEW]**
All graduates will have met at least one major area of application of mathematics […]	**Modelling**	**6 [NEW]**

Description in terms of

OBJECTIVES […]

(minimal) CONTENT […]

(core) COMPETENCES/LEARNING OUTCOMES:

Differential and integral calculus and functions of one complex variable

After [successfully] taking the course, the student should be able to:

- Manipulate inequalities, sequences and series, analyse and draw functions, deduce properties of functions from their graphs, understand and work intuitively, geometrically and formally with limits, derivatives and integrals.
- Calculate derivatives using the chain rule, implicit function, etc.
- Calculate and study extreme values of functions.
- Calculate integrals of one variable functions.
- Set up and solve integrals of functions in several variables, curve integrals and surface integrals.
- Solve problems involving setting up integrals (lengths, areas, volumes, centre of gravity, etc.).
- Use in applications to other fields the concepts of PDE, curve and surface integral and integrals in 2 and 3 variables.
- Use the relation between holomorphic and analytic functions. Calculate residues and use them to determine real integrals.

What is the situation today?

- **June 2003: Work on the White Book starts**
- **March 2004: Work on the White Book ends**
- **March 2004: Elections-->New Government**
- **June 2005: White Book published**
- **April 2006: New Minister, new regulations,…**

- **26/10/2007 (published 30/10/2007): Newest regulation: there are no National Curricula anymore!! [I think this is good]**
- **27/10/2007, Mathematics Deans Conference: The agreements regarding the Core Curruculum for Mathematics are still valid. They constitute a solid basis for students mobility. [I think this is also good!!]**
- **Universities are taking the White Book into consideration when designing their new degrees.**

Some teaching experiences at UAM
Department of Mathematics

We think the Mathematics Degree at UAM is "reasonably" organised

- *4 years, semester structure*
- *No more than 4 subjects each semester..*
- *1st year: 3 subjects per semester with problem sessions in small groups.*

Even so, the "success level" is low.

Why?

- *Level of subjects taught?*
- *Passive students?*

Experience 1: Abstract Algebra with computers (1994)

- *Algebra I (~Group Theory)*
- *Voluntary participation (25 students, good and not so good)*
- *Same content and same exam as "regular sections"*
- *Regular Sections: 4 class hours/week*
- *Experimental Section: 2 class hours+one 2 hour session to "experiment with the computer" (Learning Abstract Algebra with ISETL by Dubinsky & Leron)*
- *2 Instructors.*

Experience 1: Abstract Algebra with computers (1994)

- *At first: passive spectators.*
- *At the end: good results.*
- *More students pass than in the Regular Sections, with better grades and with very few "very low grades".*
- *Reason (according to students): More than the use of computers, the fact that they had to turn in homework every week.*
- *We dropped the experiment because it required too much effort.*

Experience 2: Survey on workload (2004)

	Contact hours	Actual study time (students)	Needed study time (profs.)	Total work (students)	Workload (profs.)	Study time/ Contact (students)	Study time/ Contact (profs)
1st year (-ε)	549	786	730	1335	1280	1.43	1.33
2nd year (-ε)	551	978	852	1529	1403	1.78	1.55
3rd year (-ε)	560	936	816	1495	1375	1.67	1.46
4th year (-ε)	564	973	895	1537	1458	1.73	1.59
TOTAL	2224	3673	3293	5896	5516	1.65	1.48

Experience 2: Survey on workload (2004)

YEAR	SUBJECT	Contact hours	Actual study time (students)	Needed study time (profs.)	Total work (students)	Workload (profs.)	Study time/ Contact (students)	Study time/ Contact (profs)
1	Linear Algebra	84	132	76	216	160	1.57	***0.90***
1	Calculus I	84	102	171	186	255	1.22	**2.04**
1	Calculus II	84	**115**	136	199	220	1.37	1.62
1	Sets and Numbers	84	77	99	161	183	***0.91***	1.18
1	Geometry I	93	154	97	247	191	1.65	1.04
1	Computer Science	70	156	102	226	172	**2.23**	1.45
2	Calculus III	56	121	171	177	227	**2.15**	**3.05**
2	Numerical Methods I	75	157	125	232	200	**2.10**	1.67
2	Ordinary Differential Equations	56	120	73	176	129	**2.14**	1.30
2	Physics for Mathematicians	56	88	41	144	97	1.57	***0.73***
2	Geometry II	56	105	86	161	142	1.88	1.53
2	Modelling I	56	68	100	124	156	1.21	1.78
2	Probability I	70	107	61	177	131	1.53	***0.87***
2	Topology	56	142	126	198	182	**2.54**	**2.25**

Experience 3: “ECTS in Calculus II “ (03/04)

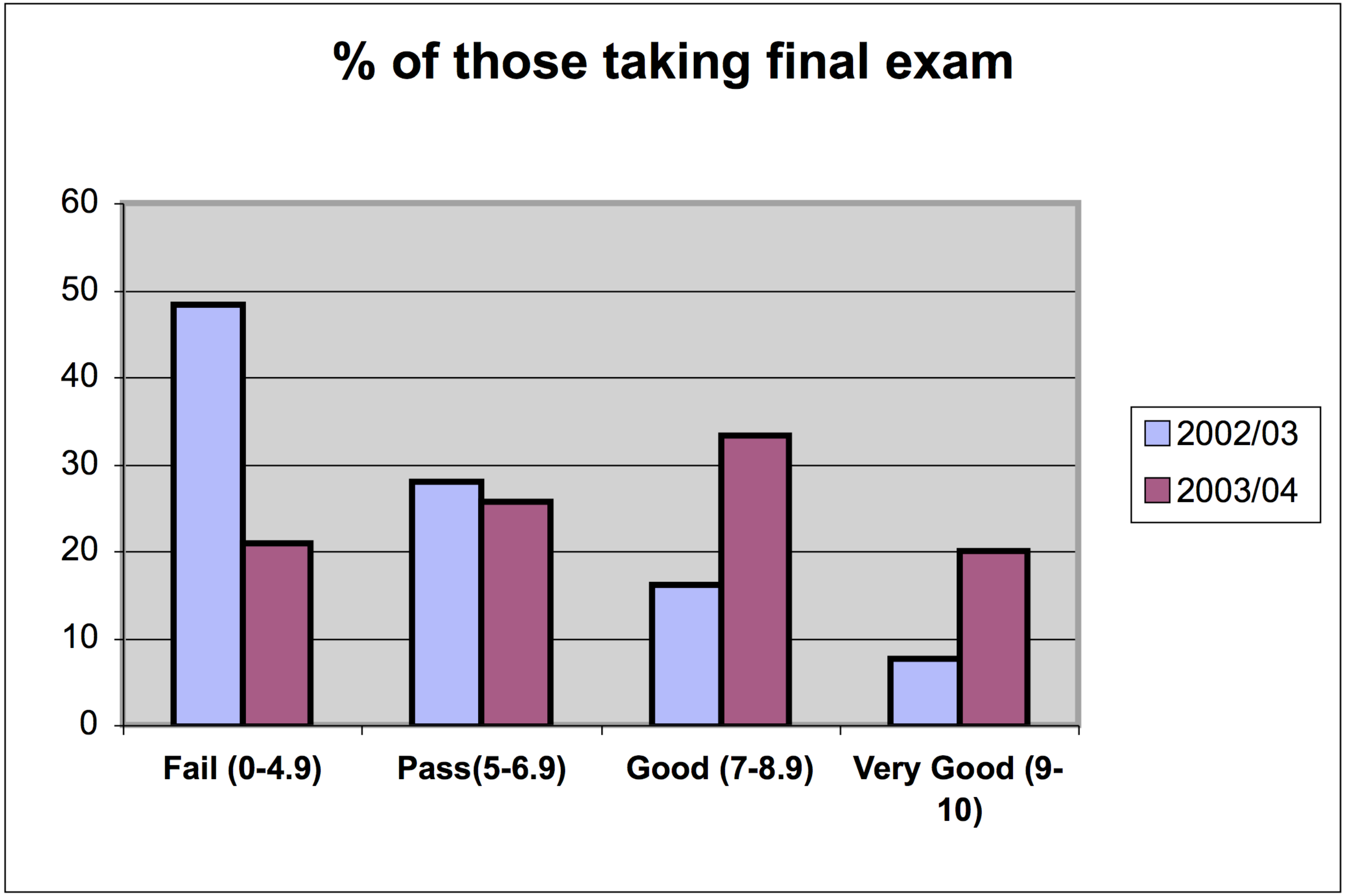
- 136 students, 93 took part (68,38%)
- Homework was collected AND graded 12 times in the semester.
- They were asked how long they worked.

Group	ECTS experience hours	Total study hours
11	2.21	5,52
16	2.23	4,13
17	1.67	2,77

- **Workload (outside class)?:**
  ~5hx14 weeks +45h study for final exam = 115h

Experience 3: "ECTS in Calculus II " (03/04)

Took Final Exam: 2002/2003 76,13%
2003/2004 77,20%



Experience 4: We now have an "ECTS Guide", with a description of each course unit

- Course title
- Course code
- Number of credits
- Name of lecturer
- Type of course [Compulsory/Optional]
- Level of course [Bachelor/Master]
- Year of study
- Semester
- **Objectives of the course (preferably expressed in terms of learning outcomes and competences)**
- Prerequisites
- **Course contents**
- Recommended reading
- Teaching methods
- Assessment methods
- Language of instruction

A European example: Physics at Bath (UK)

- **PH10051: Electricity & magnetism [WL]**
- Credits: 6 Level: Certificate Semester: 2
- **Assessment: CW20EX67PR13**
- **Requisites:**

  While taking this unit you must take PH10008 [Mathematics for scientists 2] (or equivalent) and before taking this unit you must take PH10007 [Mathematics for scientists 1] (or equivalent) and take PH10052 [Properties of matter] and in taking this unit you cannot take PH10006 [Electricity & magnetism]

  Students must have A-level physics in order to take this unit.
- **Aims:**

  The aims of this unit are to introduce the fundamental laws of electricity and magnetism and to develop techniques used in the solution of simple field problems, both vector and scalar. A further aim is to develop students confidence and competence in basic laboratory skills.
- **Learning Objectives:**

  After taking this unit the student should be able to:

  * state the basic laws of electricity and magnetism;

  * define scalar and vector fields and represent them graphically;

  * determine the forces due to electric and magnetic fields acting on charges and currents;

  * determine electric fields, potentials and energies due to simple, static charge distributions;

  * determine magnetic fields and energies due to simple, steady current distributions;

  * determine electric fields, e.m.f.s and induced currents due to varying magnetic fields;

  * demonstrate the correct use of a wider range of common laboratory equipment, maintain a scientific logbook and produce a scientific report.
- **Content:**

  Introduction to scalar and vector fields. Electrostatics: Electric charge, Coulomb's Law, superposition of forces, electric charge distribution, the electric field, electric flux, Gauss's Law, examples of field distributions, electric dipoles. Line integral of the electric field, potential difference, calculation of fields from potential, examples of potential distributions, energy associated with electric field. Electric field around conductors, capacitors and their capacitance, energy stored. Magnetism: Lorentz force law, force on a current-carrying wire, force between current-carrying wires, torque on a current loop, magnetic dipoles. Biot-Savart Law, Ampere's Law, magnetic flux, Gauss's Law in magnetism, examples of field distributions. Electromagnetic Induction: Induced e.m.f. and examples, Faraday's Law, Lenz's Law, energy stored in a magnetic field, self and mutual inductance, energy stored in an inductor. Practical laboratory: Performance of experiments designed to develop practical skills and support lecture material.