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Prerequisites for high-quality Applied Science Programmes

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Basic Parts of the presentation

- General principles in design of an applied programme.
- Applied vs Academic, how to Best Benefit from these two Streams.
- Different approaches…

Trends

- Many countries have seen declining numbers of students choosing to pursue the study of physical sciences, engineering and mathematics at university.
- For instance, from 1993-2003 the percentage of S&T graduates has fallen in Poland, Portugal and France. The same is true in Germany and the Netherlands.
- In addition, the percentage of graduates studying for a PhD – the most common route to becoming a professional scientist – has dropped in all European countries.
- The consequence is that the supply of scientists to sustain knowledge economies, which are heavily dependent on science and technology, is perceived as a significant problem.
- This predicament was addressed in a major report – Europe Needs More Scientists – which laid out a series of recommendations to address the issue.

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Europe Needs More Scientists

- Data presented in the EU report Europe Needs More Scientists show that the number of researchers across the EU is 5.7 per 1000 of the workforce whilst the comparable figures for Japan and the USA are 9.14 and 8.08 respectively, suggesting that the problem has a pan-European dimension.

- Moreover, if students' attitudes towards school science remain as negative as they are currently, the issue of the supply of scientists, and whether Europe is producing sufficient, will be exacerbated and not diminished.

- Nevertheless, much of the concern is focused around the issue of supply and fails to recognize that science operates in a global context.

Supply of Scientists

Concerns about the future supply of scientists are often stoked by the scientific community who have much to gain from persuading governments to invest in research, development and training in science and technology.

The primary goal of science education across the EU should be to educate students both about the major explanations of the material world that science offers and about the way science works.

Science courses whose basic aim is to provide a foundational education for future scientists and engineers should be optional.

The need

EU countries need to invest in improving the human and physical resources available to schools for informing students, both about :

- careers in science – where the emphasis should be on why working in science is an important cultural and humanitarian activity –
- and careers from science where the emphasis should be on the extensive range of potential careers that the study of science affords.

The need

Societies need to offer their young people an education in and about science – and that this needs to be an education that will develop an understanding of the major explanatory themes that science has to offer and contribute to their ability to engage critically with science in their future lives.

In addition it should help develop some of the key competencies that the EU aspires to for its future citizens.

Achieving this goal requires a long term investment in curricula that are engaging; and in assessment systems that adequately reflect the goals and outcomes we might aspire to for science education.

Academic vs Applied. What this is actually ?

Applied Research used to answer a specific question that has direct applications to the real world.

Basic Research driven purely by curiosity and a desire to expand our knowledge.

These two approaches are the core of the difference.

Academic vs Applied. What this is actually ?

Academic studies *have academic curriculum, which* ***trains students for development and application*** *of scientific, professional and artistic accomplishments**.***

Applied studies *deliver applied curriculum which* ***trains students to apply the acquired knowledge and skills*** *that are needed to* ***enter job market****.*

These two approaches are the core of the difference.

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UNIVERSITY OF WEST ATTICA

Designing Successful Applied Curriculum

1. *Focus on the market needs for scientists in the medium-long term.*
2. *Focus on applied science development and new knowledge.*
3. *Strong scientific background : the key in solving real world problems fast is the strong basic background knowledge.*
4. *Dynamic approach in curriculum creation.*
5. *Applied Sciences required applied skills and knowledge, thus many "hands on training" (laboratory) hours.*
6. *Strong quality assurance approach with measuring results in the market acceptance.*
7. *Always remember that the people with applied science degrees should have adequate knowledge and skill to enter the job market.*

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Challenges

- Continuous and significant changes in applied science create considerable pressure on academic institutions to keep the curriculum current and relevant.

Operationally, it requires frequent revisions of course design and adaptations of new textbooks.

Educationally, it requires measurements and research on how students learn new topics and how these topics impact on the students in both the short and long term.

The need for change

- Given the rate of change, it is difficult to implement these changes, and it is particularly challenging to conduct educational research to assess how students are adapting to the new changes.
- With a systematic method to develop, deliver, and evaluate courses and supplementary activities more students will learn more effectively.
- Furthermore, an approach of delivering these courses that is particularly sensitive to varying educational and experiential backgrounds will further promote attracting and retaining students.

The role of curriculum

A curriculum that can be intrinsically tested, that is modular, and supported by active learning components such as laboratory assignments and multimedia-based learning objects.

Second, we envision that students and instructors can design their own CS and IT courses by sequencing a subset of learning objects and laboratory assignments together, for a variety of educational purposes (e.g. continuing education, distance learning, and post-secondary college preparation).

Such a curriculum must have, within each course

(a) embedded instructional and educational research designs and

(b) effective, flexible, customizable, and modular components.

What Curriculum?

- A curriculum is needed that can be more effectively customized or tailored to individual needs.
- There is also the necessity to deliver different levels of introductory courses, including remedial courses,
- A dynamic curriculum is required evaluated and change every few years targeting up-to-dated high quality knowledge and skills.

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Strategies for Curriculum Development

- Since the introductory course sequence has a significant impact on recruitment and retention, these courses should be revised before other core and upper division courses. This process allows the project to better allocate and manage its resources, evaluate and learn from initial phases, and implement the changes administratively.
- The curriculum should follow authoritative standards set by leading professional bodies in the field proposing core topics for a degree programme so as to better fit technological advances in computing.
- The curriculum should have modular courseware for its courses. This allows curricular modules to be replaced and delivered more conveniently. It also opens up the possibility of customization to fit student needs.

The Curriculum (1/2)

- The curriculum should have flexible and adaptable courseware for students of different aptitudes, motivations, and interests.
  - Modular courseware facilitates flexibility and adaptability.
  - Further, courseware should be flexible in the way that it is delivered and viewed.

- The curriculum should include methods to measure attitudinal variables such as self efficacy and motivation.
- Self-efficacy has been shown to be a key student variable, with high correlations with achievement, ease of learning, use of active learning strategies, and instructional persistence.

The Curriculum (2/2)

- The curriculum should incorporate hands-on activities, teamwork, collaboration, and cooperation in its introductory courses.
- The instructional framework should incorporate educational research.
- Experiments should be conducted to evaluate different methods of instruction.
- Research design should be in place to collect empirical data as well as to draw statistically significant conclusions.

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Teaching Goals

(Applied Science Program) (source Munich University of Applied Sciences)

- Competence promotion, practice and research reference as well as student-oriented teaching methods
- Create learning settings in which students develop problem-solving skills.
- The graduates should be able to take on current and future tasks in their profession and society with foresight, a creative mind and a sense of responsibility.
- The further development and quality assurance of the teaching is an important concern.

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Research Goals

(Applied Science Program) (source Munich University of Applied Sciences)

- Conduction of applied research and development in close cooperation with partners from industry, society and politics, thus ensuring optimal practical relevance.
- The development of a guideline also guarantees a high-quality education of the students.
- The wide-ranging research landscape at the university, which encompasses the areas of technology, economics, social affairs and design make this possible.
- The participation in country's level as well as at the European level with a large number of research projects is ensuring the research targets and goals of the University of Applied Science.

Career Goals

(Applied Science Program Supplementary)

(source Munich University of Applied Sciences)

- The development of a Career Center should be a centralised service facility for students in a University of Applied Sciences. The goal is to help future graduates kick-start their careers, improve their employment prospects and strengthen their ties with the working world.
- It is of paramount importance the organization of events, workshops, talks and information materials for students to attend which focus on the following:
  - Key skills
  - Job applications and starting a career
  - Career qualifications
  - Networking in practice: STUDENT meets BUSINESS events, where students come face-to-face with companies
  - Year-round postings on career, internship and jobs database

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Designing Successful Applied Curriculum Examples for engineering sector (1/2)

1. *Strong background on applied mathematics, applied physics and chemistry.*
2. *Strong background in measuring technics and methods in general.*
3. *Skills and knowledge in measuring quantities in the specific sector, eg. Electric power, mechanical strength, energy, efficiency, etc.*
4. *Focus on the design of products and/or systems in the core of the studies, eg. electrical installation, electronic device, mechanical part, program, concrete foundation, a boat' hall, software, etc, using design tools.*

Designing Successful Applied Curriculum Examples for engineering sector (2/2)

5. *Dynamic approach in core areas such as renewables, smart grids, cloud computing, new vessels design, LNG facilities, embedded systems, IOT etc.*
6. *Many hours in laboratory work and strong emphasis on executing real world experiments.*
7. *Solving small real world problems during courses.*
8. *Strong role of the final thesis related to engineering issues.*
9. *At least 3 months internships in the fields of their studies with supervision in companies.*

Designing Successful Applied Curriculum Example for Renewables in Electrical Engineering

In the former Electrical Engineering Department of Piraeus University of Applied Science for the Renewables courses we had :

1. *One compulsory course with 4h lectures and 2h lab each week for every student. Thus 52h of theory and 26h lab for each student and the successful completion of the course required successful completion of both parts. In this course the students where focused on selected renewable technologies in general with basic calculation (prefeasibility and feasibility scale) and measure in the lab typical characteristics that they must measure in real world applications.*
2. *One Elective Compulsory Course, in the next semester with 2h lectures and 2h lab each week. Thus in total 26h theory and 26h lad each student, focusing on detail calculations in PV and Wind including network connection design and problems solving.*

International Approach

- The basic difference is the number of years for the applied science degrees.
- Depending on the country it is 3 to 4 years to receive the Bachelors degree. According to Bologna minimum 3 years +2 for MSc + 3 for PhD.
- In Greece we have introduced 3,5 years studies +1 semester internship giving strong applied scientific knowledge and working experience of 6 months before awarding the Bachelors Degree in applied Science fields
- In the United States, many colleges offers an undergraduate minor as well as Master of Science and Doctor of Philosophy degrees in "applied science." Courses and research cover varied fields including neuroscience, optics, materials science and engineering, nondestructive testing, and nuclear magnetic resonance.

International Approach

- In Canada, the Netherlands and other places the Bachelor of Applied Science (BASc) is equivalent to the Bachelor of Engineering, and is classified as a professional degree.
- The BASc tends to focus more on the application of the engineering sciences.
- In Australia and New Zealand this degree is awarded in various fields of study and is considered a highly specialized professional degree.
- In the United Kingdom's educational system, Applied Science refers to a suite of "vocational" science qualifications that run alongside "traditional" General Certificate of Secondary Education or A-Level Sciences. Applied Science courses generally contain more coursework (also known as portfolio or internally assessed work) compared to their traditional counterparts.

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