UNESCO CHAIR
PROBLEM BASED LEARNING
AALBORG UNIVERSITY • DENMARK

PBL and Innovation in learning

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Agenda

- Why change and innovation
- What– PBL as an stratergy
- Aalborg PBL model


HIRTSHALS
FREDERIKSHAVN
HANSTHOLM
AALBORG
KØBENHAVN
COPENHAGEN
ESBJERG

Aalborg at the Fjord – 160,000 inhabitants

Aalborg University

Established 1974

14,000 Students, 1200 Faculty Staff

Faculty of Engineering, Science, Medicine 6,000 Students	Faculty of Social Science 4,500 Students	Faculty of Humanities 3,500 Students

Faculty of Engineering, Science, Medicine — 6,000 Students

Department of

- Civil Engineering
- Building Technology & Structural Engineering
- Chemistry and Applied Engineering Science
- Electronic Systems
- Production
- Physics
- Energy Technology
- Mechanical Engineering
- Computer Science
- Mathematical Science
- Life Sciences
- Architecture and Design
- Development and Planning
- Health Science and Technology

Faculty of Social Science — 4,500 Students

Department of

- Social Studies & Organisation
- Economics, Politics and Public Administration
- Business Studies

Faculty of Humanities — 3,500 Students

Department of

- History, International, and Social Studies
- Music and Music Therapy
- Communication
- Languages and International studies

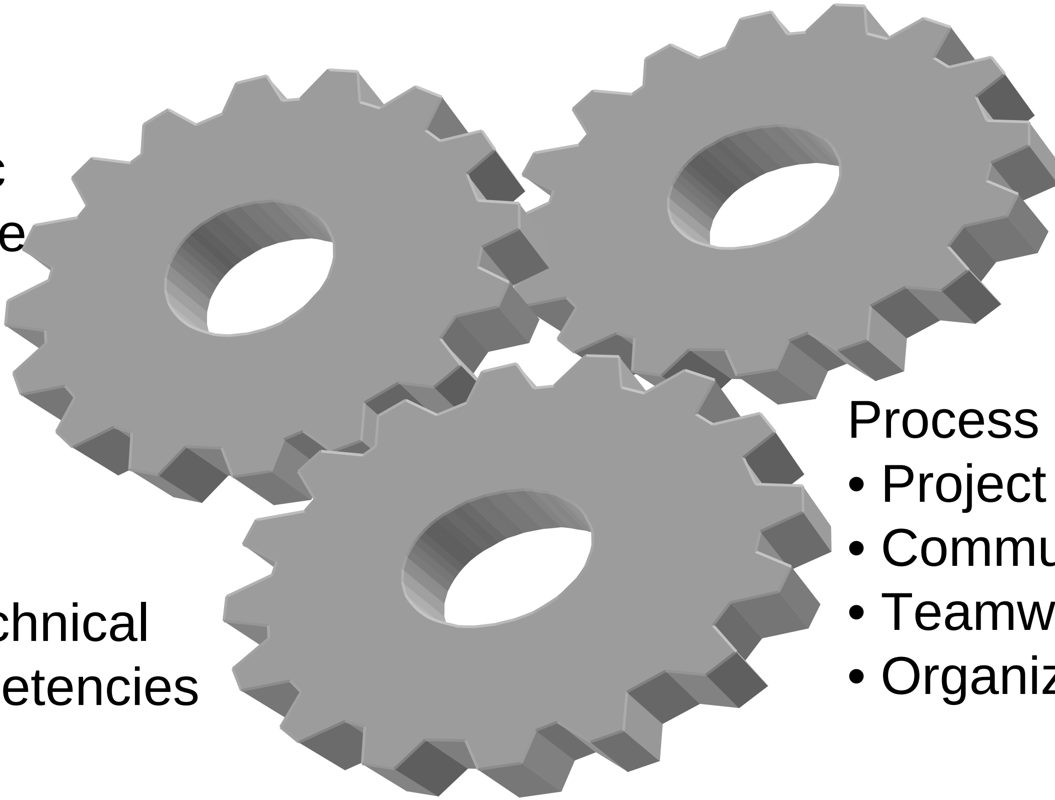
The General Structure of University Studies 3 + 2 + 3

Doctor level
4. Ph.D. thesis – three years

Master level
3. Second specialisation – two years

Bachelor level
2. First Specialisation – two years
1. Basic study Year – one year

Why change: Diversity of engineering competencies

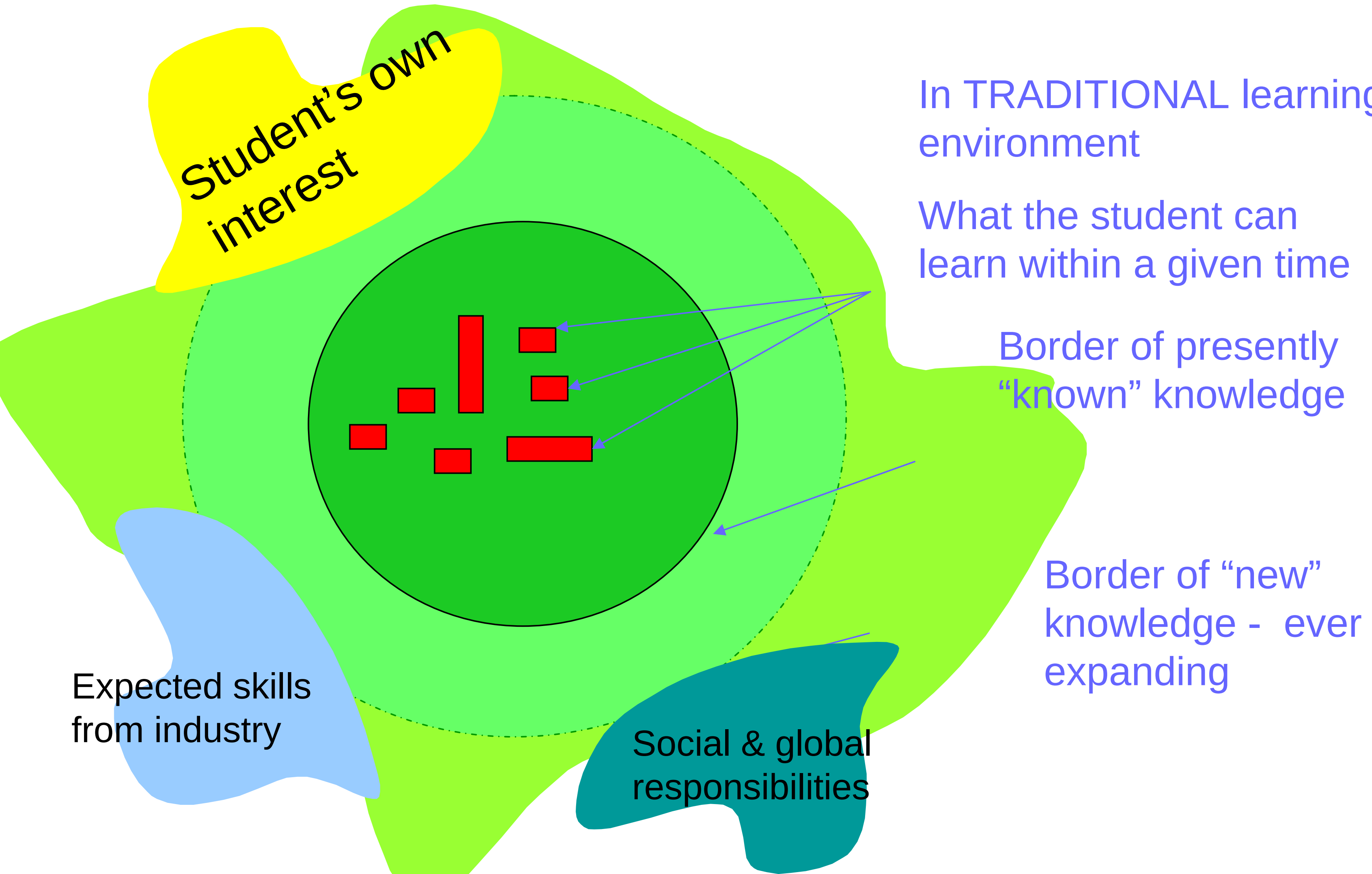


Scientific knowledge

Technical competencies

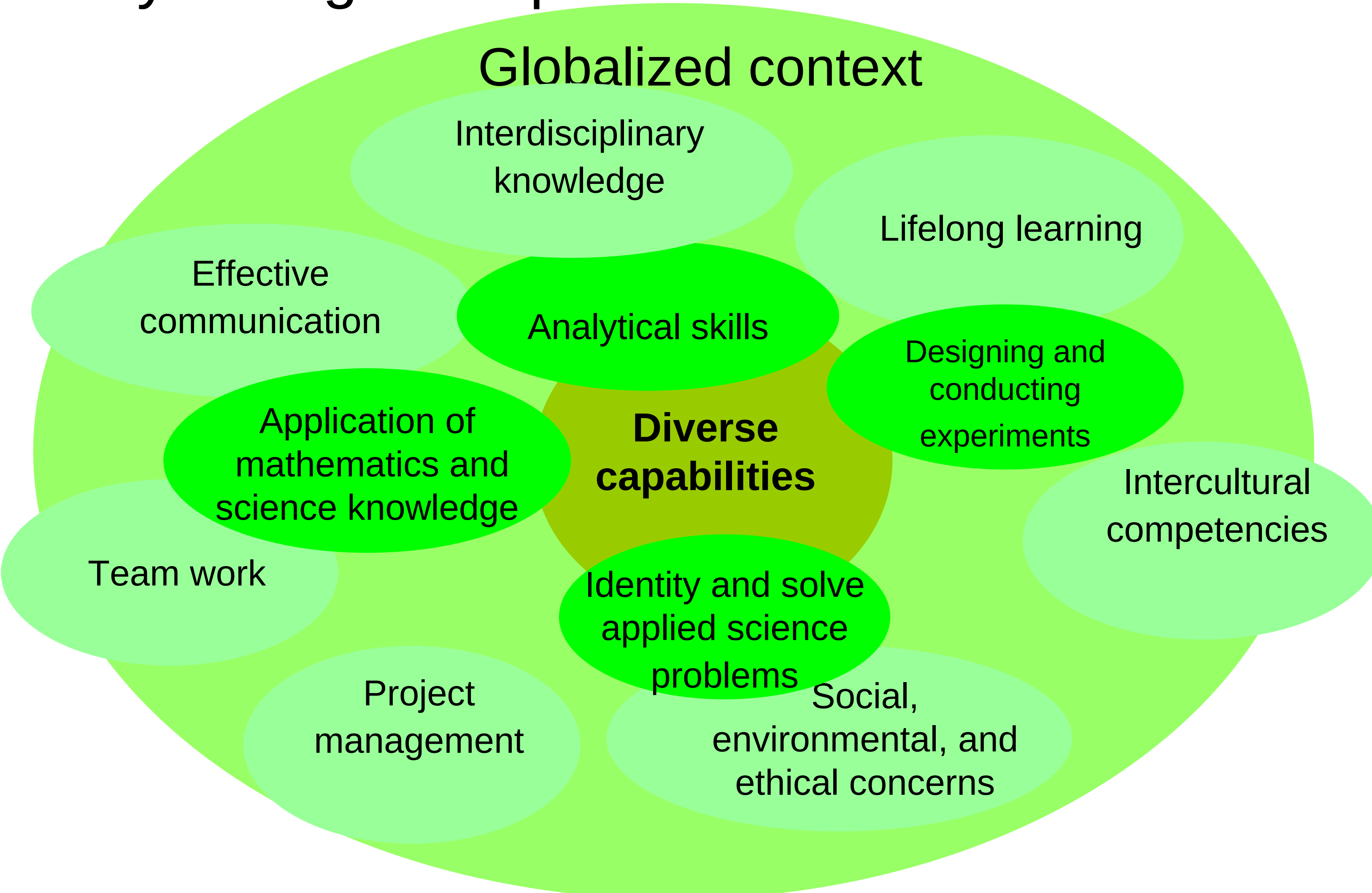
Process competencies
• Project management
• Communication
• Teamwork
• Organization

Why change: Challenges for the curricula



Why Change: overfed students

Why change: Requirements from Accreditation



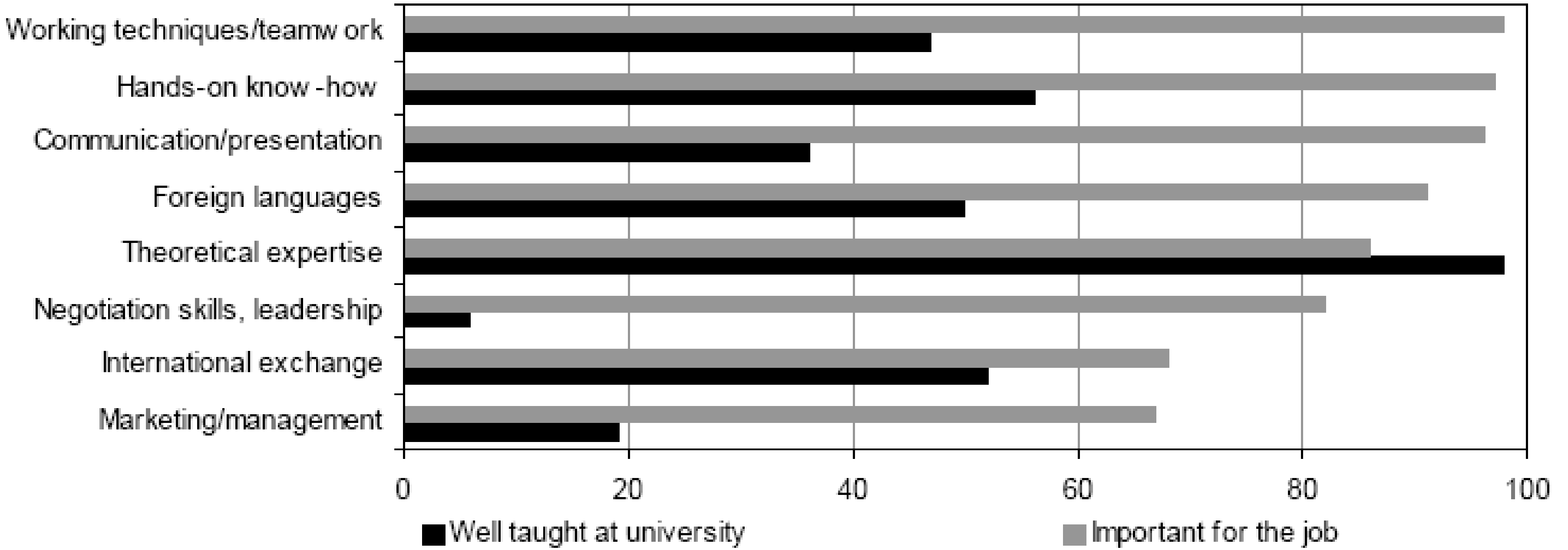
- National Academy of Engineering, *The Engineer of 2020*, 2004
- **EUR-ACE (Accreditation of European Engineering Programmes and Graduates,** http://www.feani.org/EUR_ACE/EUR_ACE_Main_Page.htm
- ABET: http://www.abet.org/

Why change: Requirements from Accreditation

	First Cycle graduate	EUR-ACE: Personal Programme Outcomes for the bachelor level
1.	**Individual and Team work**	Function effectively as an individual, and as a member or leader in diverse Engineering teams.
2.	**Communi-cation**	Communicate effectively on *intermediate* engineering activities with the engineering community and with society at large, by being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
3.	**The Engineer And Society**	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
4.	**Ethics**	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
5.	**Environment and Sustainability**	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
6.	**Project Management and Finance**	Demonstrate an awareness and understanding of management and business practices, such as risk and change management, and understand their limitations.

Why change: expectation from industry

Comparaison of capabilities taught at universities and required in professional life by young profesionals - Germany



igure 4 Comparison of capabilities taught at universities and required in professional life by young professionals [7

(Becker 2006)

Why change: expectation from industry

Ranking of capabilities important in professional life by young electrical engineers five years after graduation - Germany

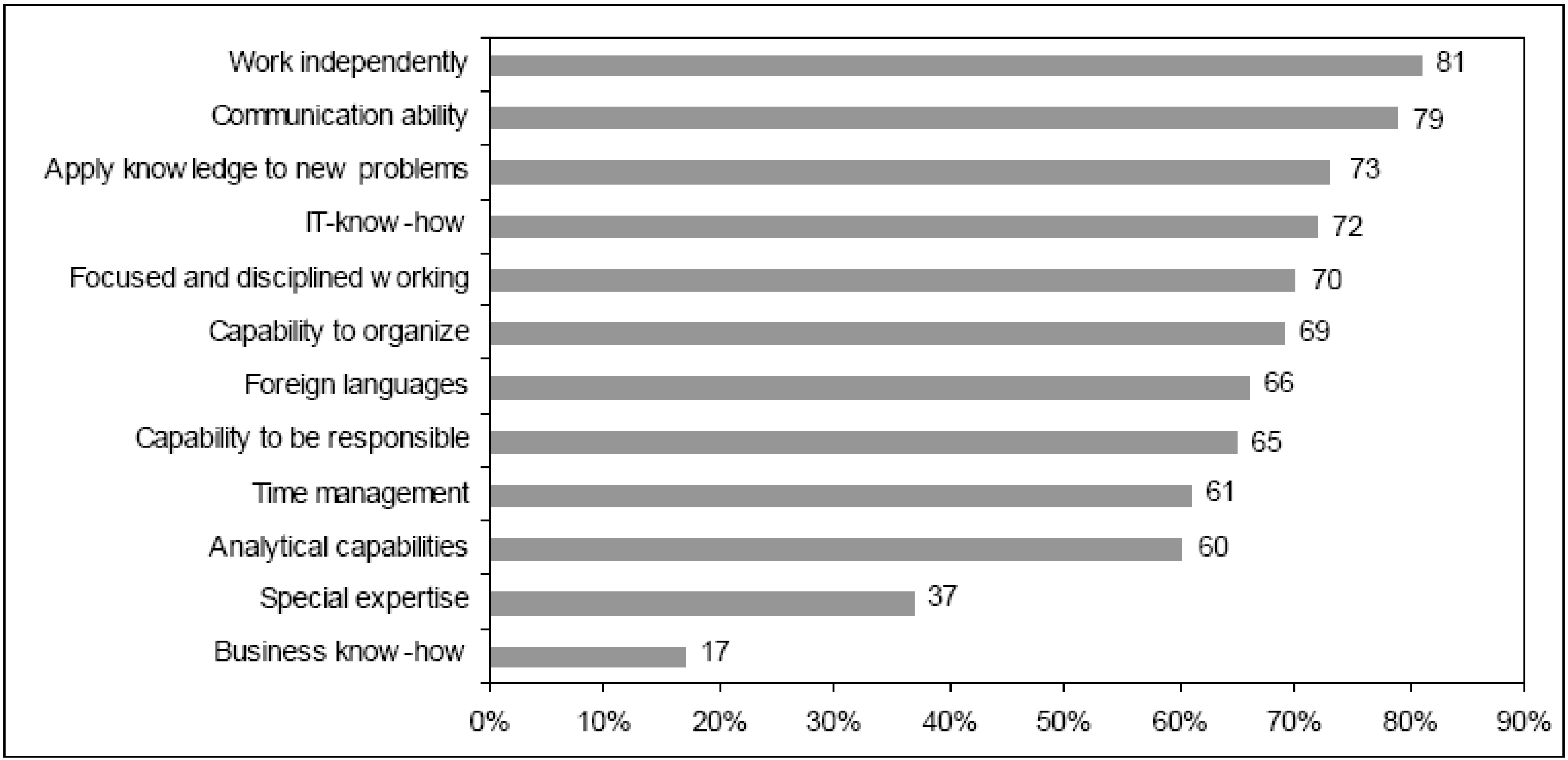
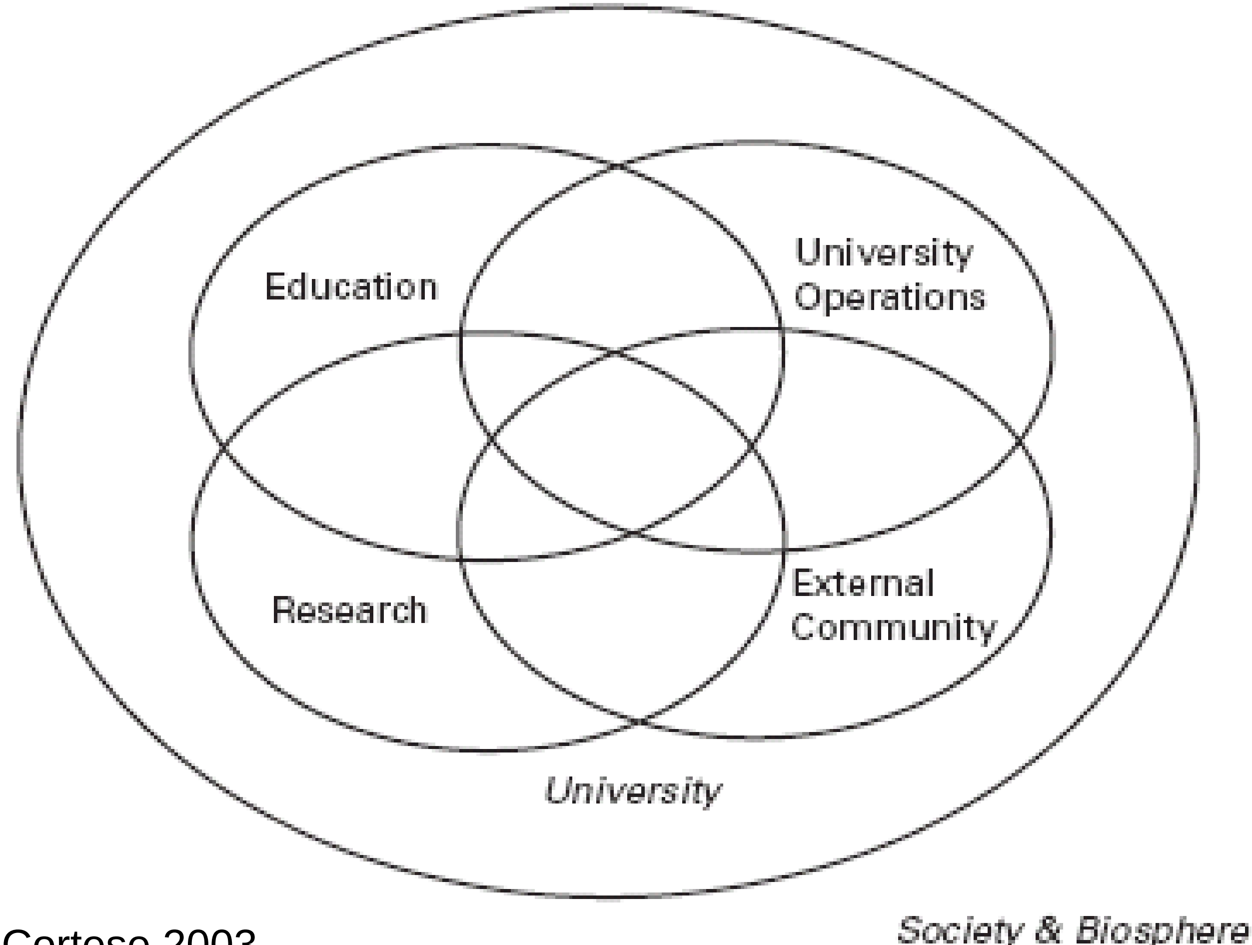


Figure 5: Ranking of capabilities important in professional life by young electrical engineers five years after graduation [3]

(Becker 2006)

Why Change: Sustainable development for HE

Figure 2 **Higher Education Modeling Sustainability As a Fully Integrated System**



Cortese 2003

Trend of change:
From content to competency driven

Content and methods → Outcomes, Objectives

Outcomes, Objectives → Content and methods

Teaching = Learning?

"Teaching does not mean transferring knowledge but creating opportunities for learning…producing and constructing it." (Paulo Freire)

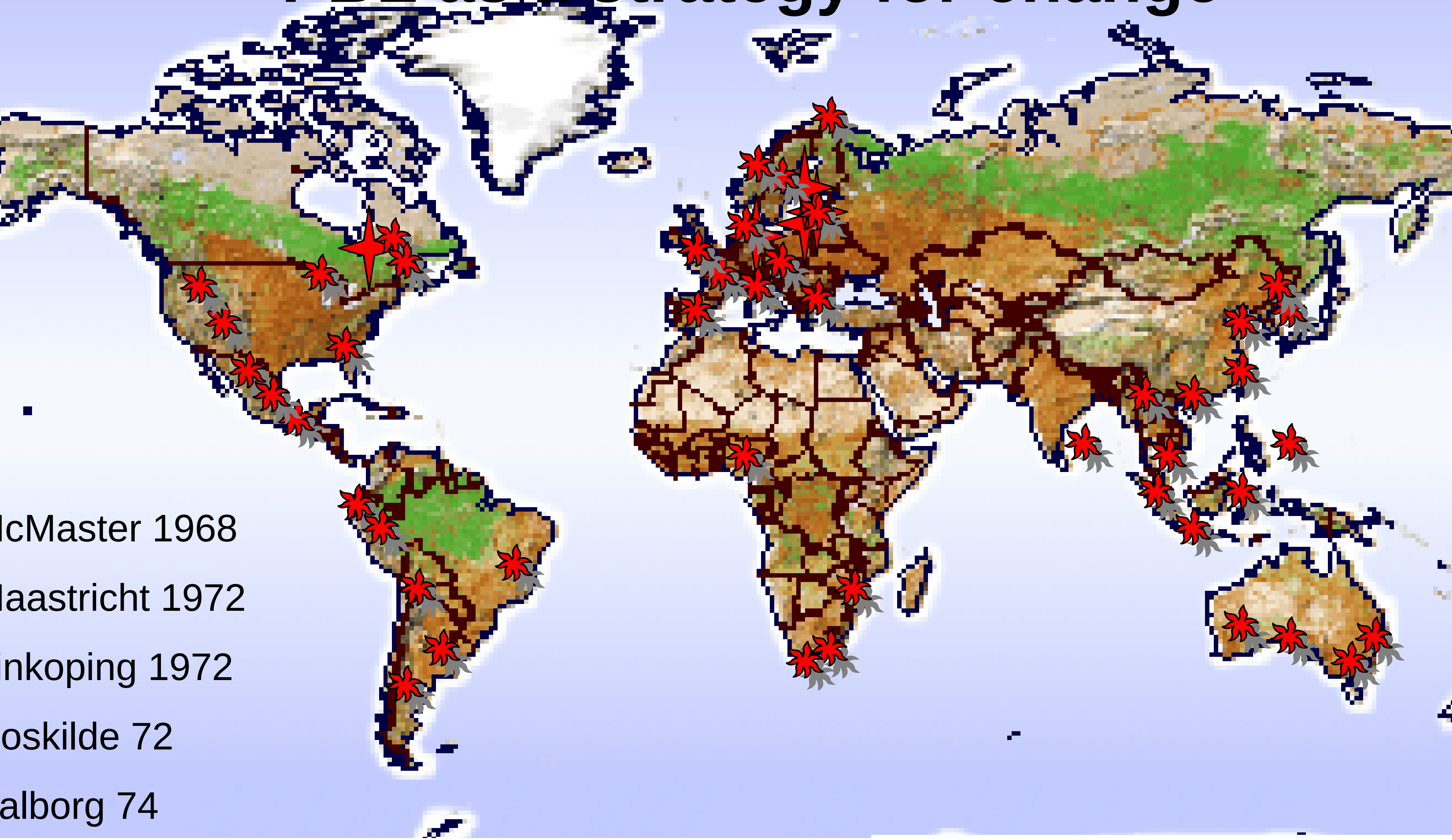
(Karl Smith, UMN)

Educational changes in Denmark

- New study programs: enriched engineering disciplines
- New expectations: broadened engineering skills and competences
- New study forms: implementing student centred and work place-imitated learning environment (for example, PBL as an educational strategy)

New challenges and tasks for educators

PBL as a strategy for change



lcMaster 1968

laastricht 1972

inkoping 1972

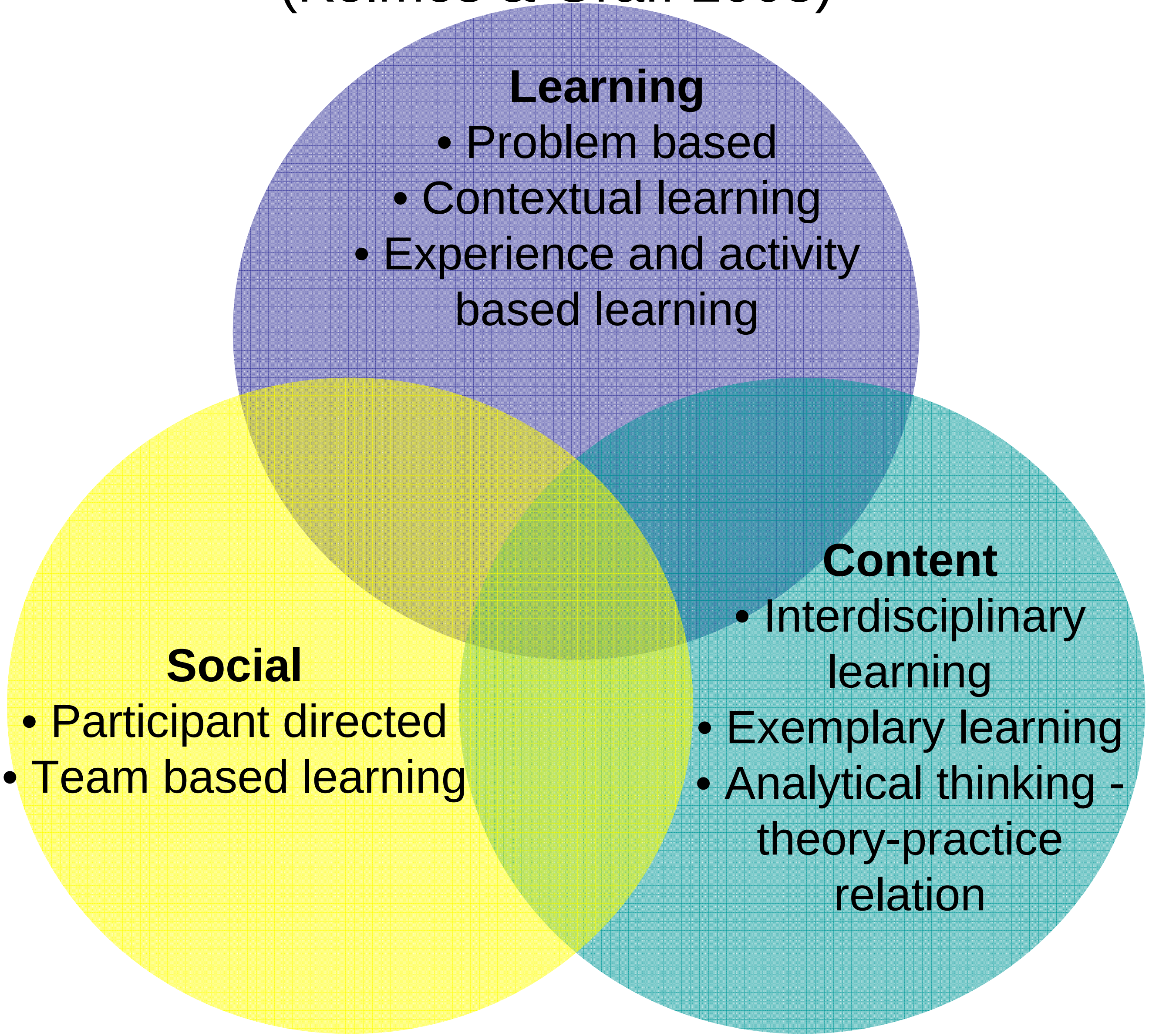
oskilde 72

alborg 74

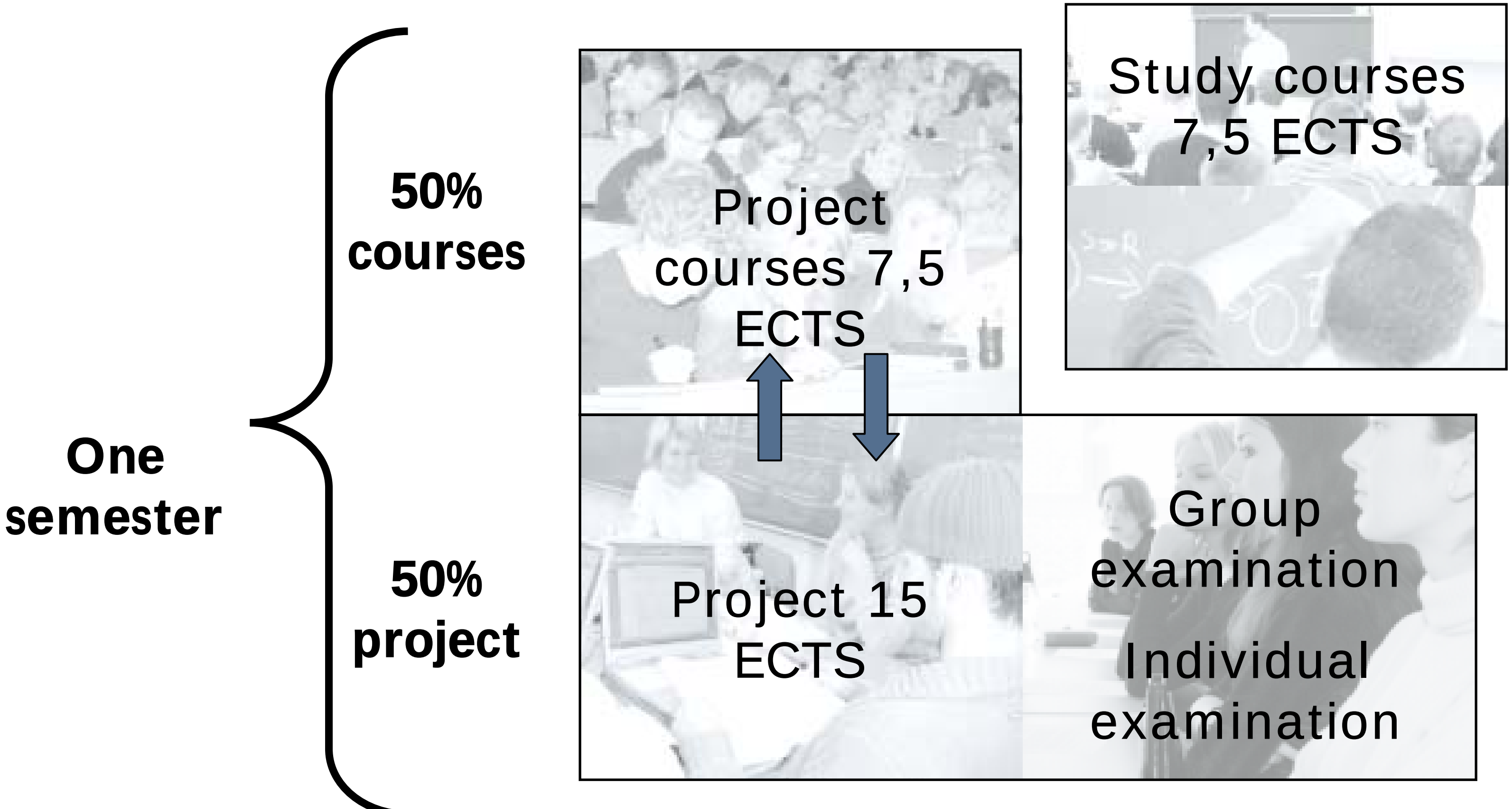
Problems as focus and stimulus for learning
Self directed learning
Student-centred and tutors as facilitators/guides
Team work

- Problem orientation
- Interdisciplinarity
- Exemplary learning
- Participant directed
- Group work

PBL Learning Principles
(Kolmos & Graff 2003)



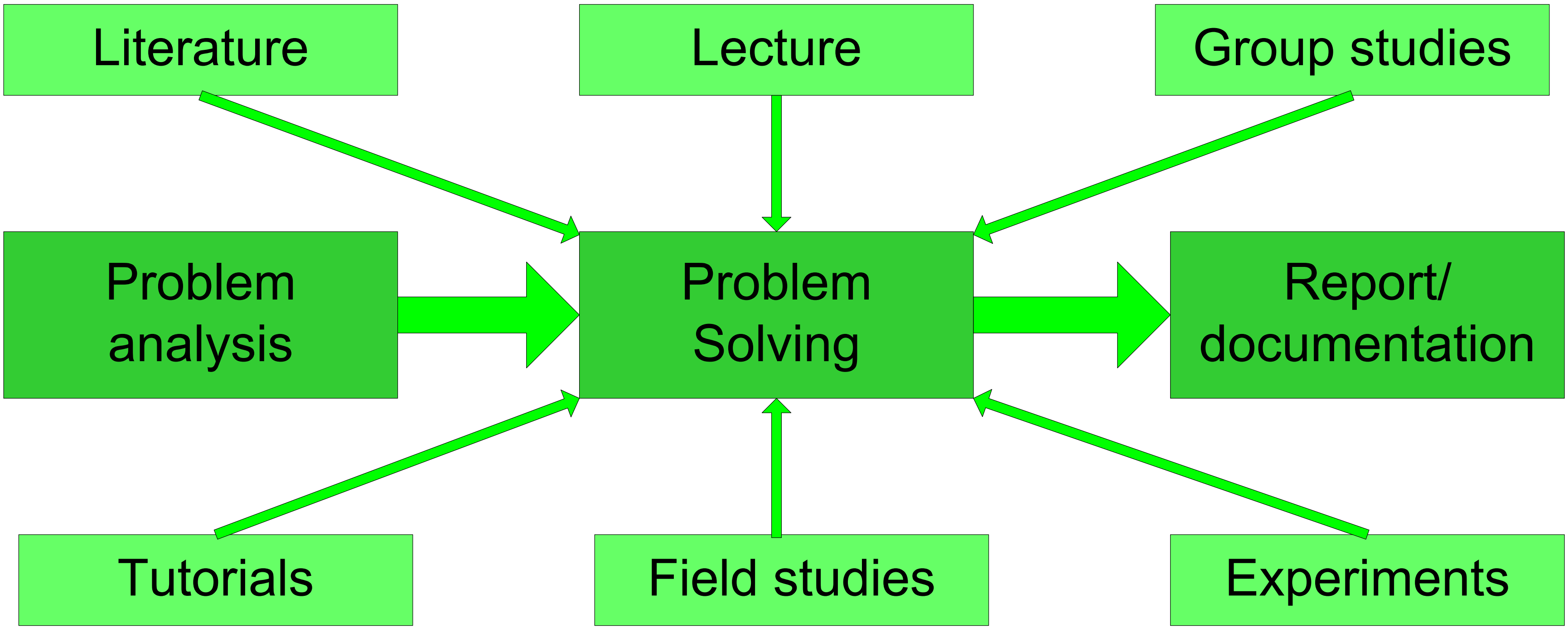
PBL Aalborg Model



Model from *The Aalborg PBL model - Progress, Diversity and Challenges*
Anette Kolmos, Flemming K. Fink & Lone Krogh

1 ECTS (European Credit Transfer System) = 30 working hours

PBL Aalborg Model: Principles



'The Aalborg Experiment – project innovation in university education' - Kjaersdam & Enemark (1994)

Group formation:
(by students based on interest)

Each group a project room

Group size: 6-8 1st year
4-5 middle years, 2-3 later years

Problem
Project
Team work

Problem analysis	Problem Solving + Report writing in group	Exam

Theme - framework

Each group 1-2 facilitator

Lectures

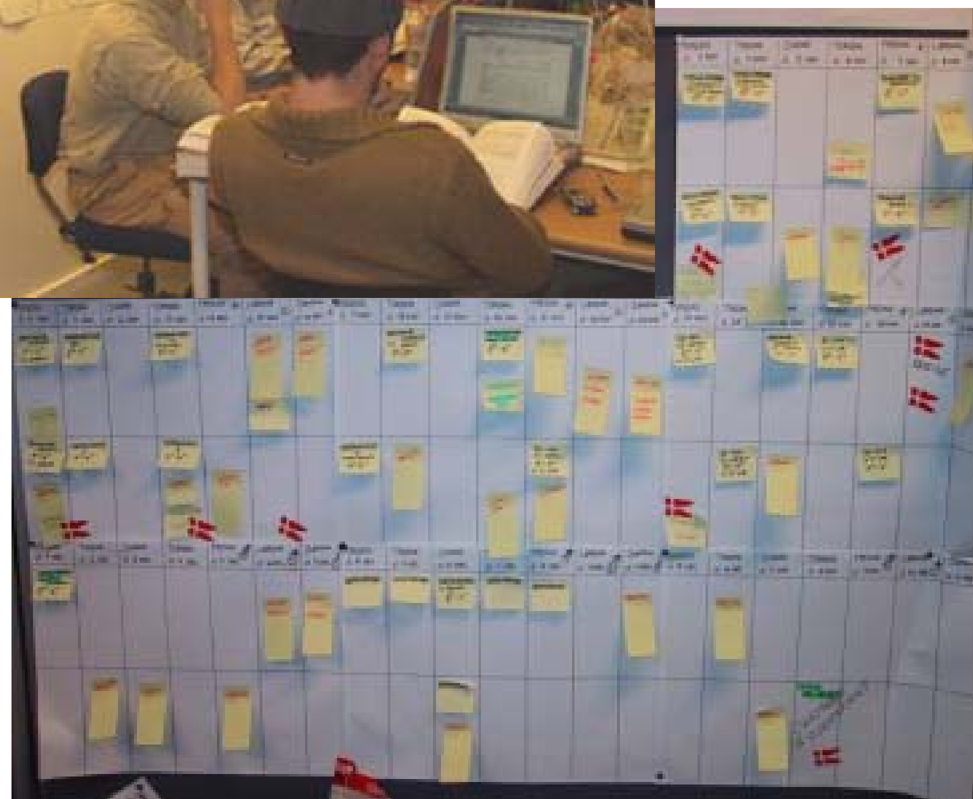
Literature

Experiment

Companies

Other experts

Learning goals,
Knowledge sharing,
Collaboration,
Peer learning



Project management
and planning

Status seminars

Presentation,
Feedback
Reflection
Progression

Diversity – discipline and group aspect

‘It is so exciting to work on this, we solve problems and we see things happen…’ - Students from EE

‘It is boring to only focus on technical things… I don’t want to become nerds by studying engineering. I want to work with technology in a creative way and to do something for people…’
- Students from A&D

Diversity of physical facilitation

Role of teaching in PBL – situated facilitation

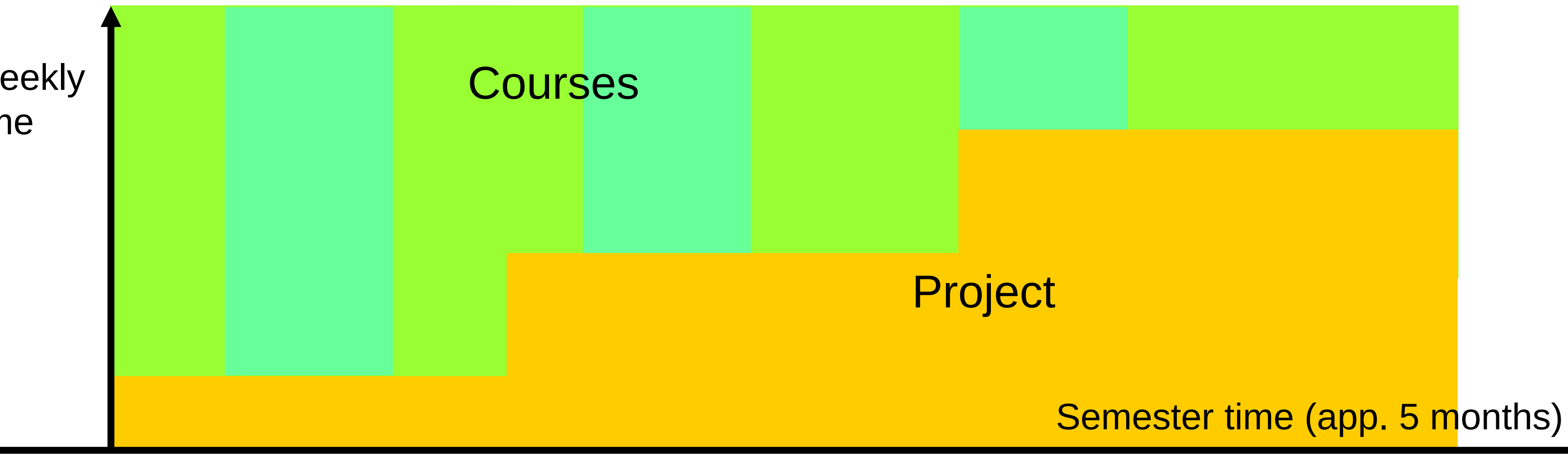
Telling students what they should learn and in what sequence they should learn it

→

Helping students determine on their own what they need to know and how they need to learn it

Barrow & Tamblyn 1980

An example of Aalborg University



efore:
lanning
roject
roposals and
roject courses

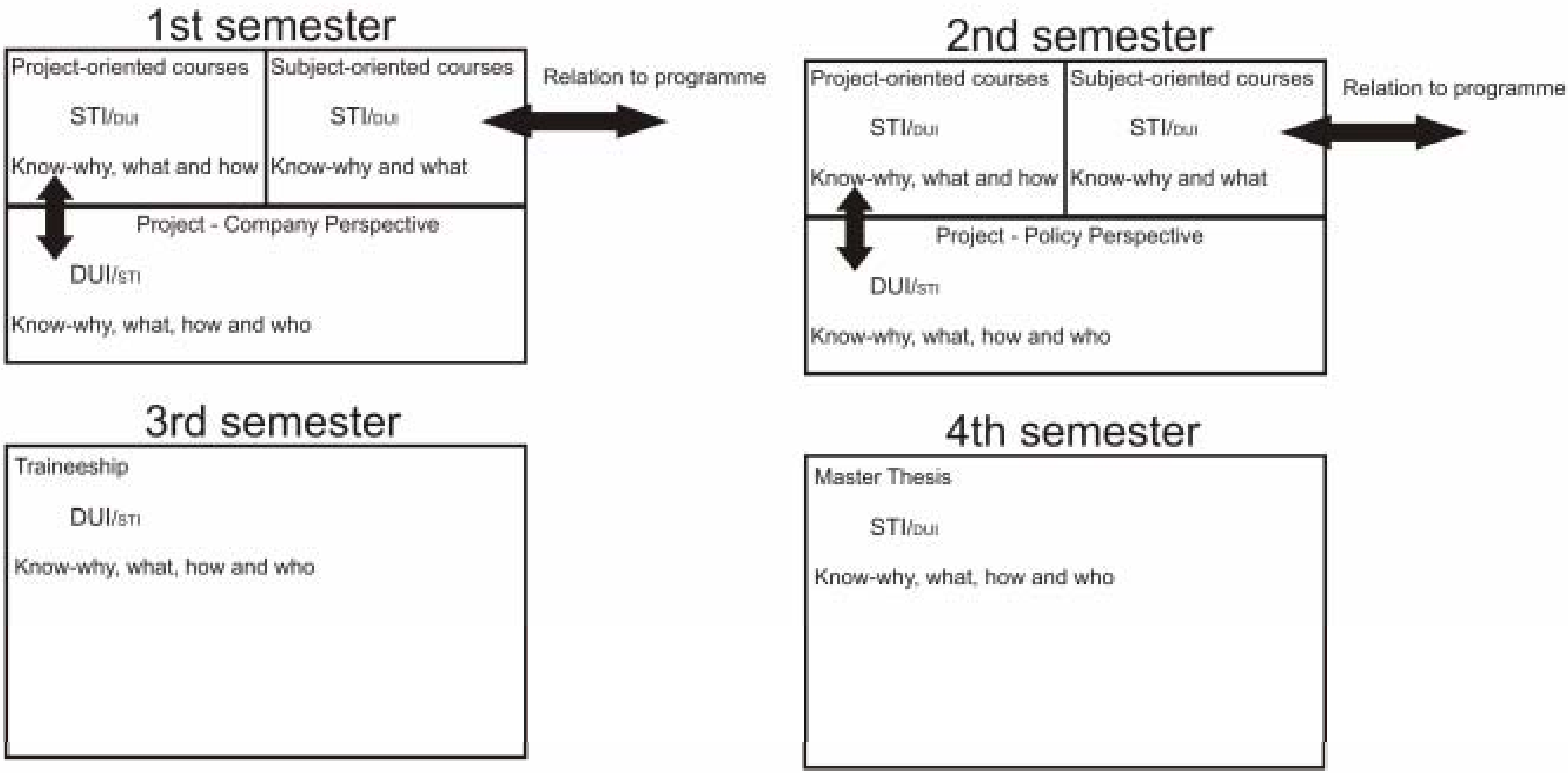
Beginning:
- More direct guidance
- Literature, theories, methods
- Contacts with companies
- Potentials

During the process:
- Consultancy
- Comments
- Monitoring

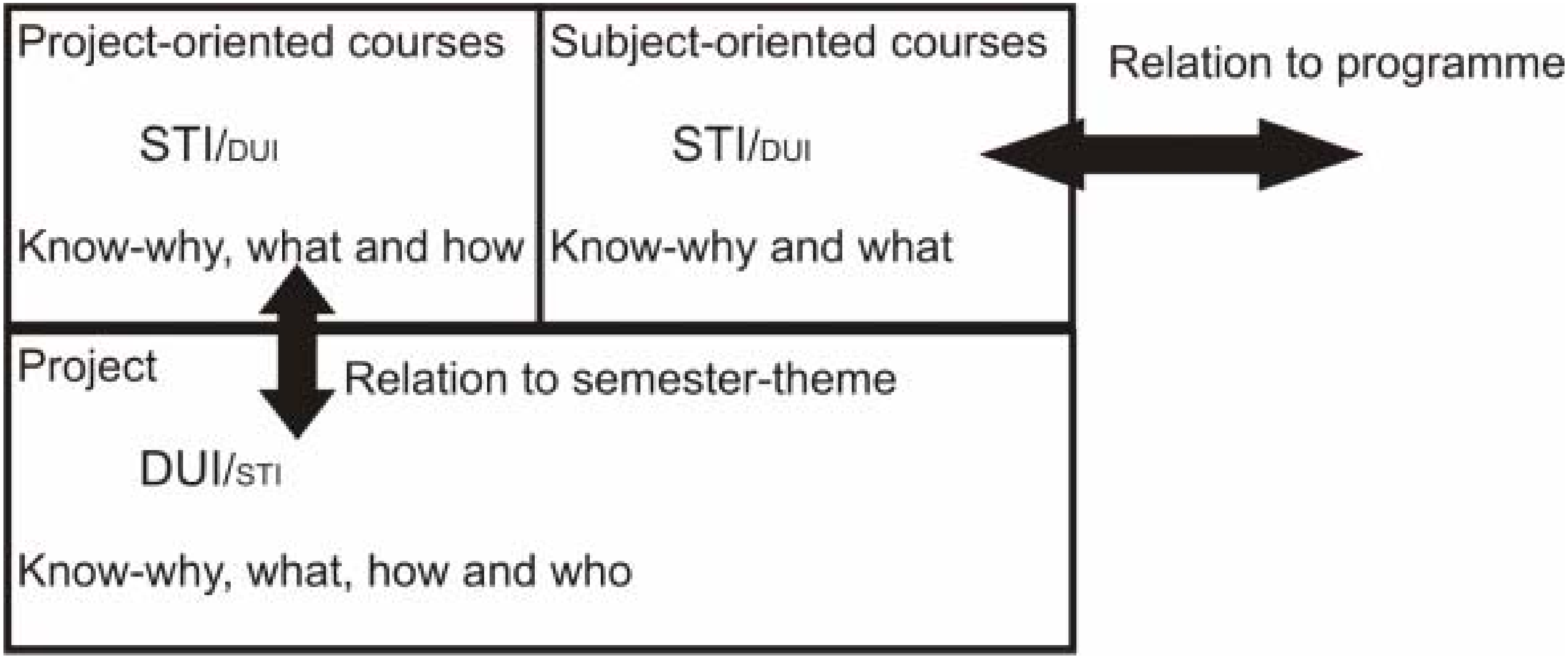
End:
Assessing

Facilitation and group dynamics

Structure - MSc, Environmental Management



1st semester, Company focus



Semester	Courses (examples)
Semester 1 Company Perspective	Corporate Environmental Management; Feasibility Studies; Organisational Theory; Research Methodology
Semester 2 Social & Institutional Perspective	Theories of Science; Policy, Institutions and Discourses; EIA, Politics of Sustainable Development; Technology Transfer, Environmental Governance & Policy Instruments, International and EU Green Policies
Semester 3 Traineeship; alternatively Environmental Assessment	Environmental Assessment; Strategic Impact Assessment, Cost-Benefit Analysis
Semester 4 Master Thesis	No courses

International Master Program of Environmental Management Semester 1 Theme Company perspective – Environmental management industries and cleaner production and products
Project focus In-depth analysis of a company's environmental strategies and performance and suggests improvements in relation to production processes, the product life cycle, or management policies. At the end of the semester, a project report is submitted, presenting relevant theories and an analysis of the case study.
Courses Feasibility Studies 2 ECTS Research Methodology 2 ECTS Organisation Theory 1 ECTS Approaches to environmental problem solving 2 ECTS Introduction to Energy Systems 1 ECTS Sustainable Energy Systems Analyses 2 ECTS Fundamental Investment Theory and Excel 1 ECTS

Group 1: The Green Martin Projects (group 1 report)

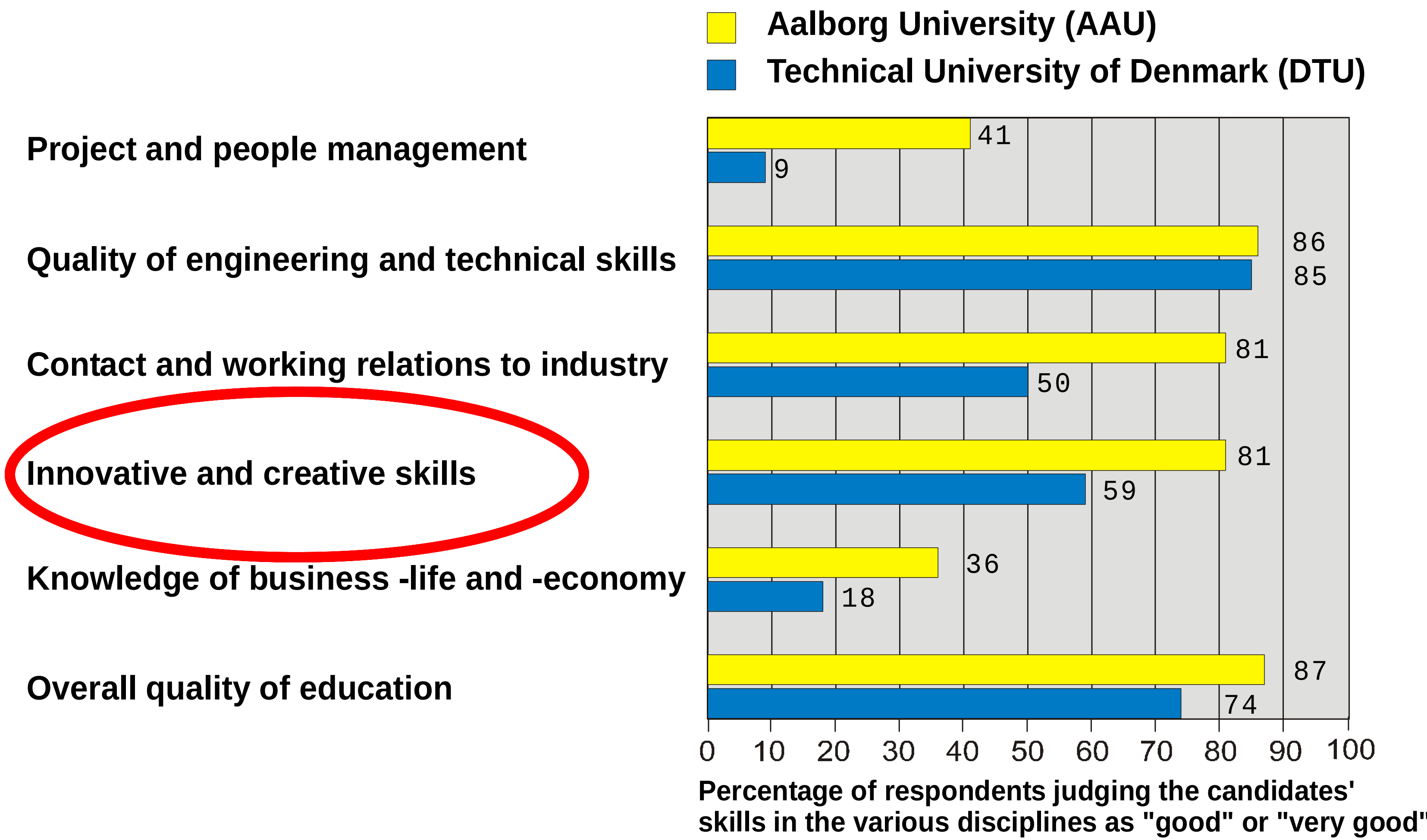
Context and aims	Martin Professional, a producer of intelligent lighting systems seeks to develop a green profile. This project seeks to identify the aspects of Martin's activities and products that impact the environment as well as the gaps existing between Martin's present environmental work and the ISO 14001 requirements.
Research question	What are the gaps between the current environmental work of Martin Professional and the ISO 14001 standards and what are the potentials and barriers for reducing he significant environmental impacts of the company's activities and products?
Theories	The step model, Environmental Management Systems (EMS),
Research methods	• Qualitative approach for data generation – interviews with the company's representatives, on-site tour of the company, literature review of relevant materials from internet sources, scientific journals. • Analysis of interview, Analysis of selected products by Sima Pro tool, Analysis of gap analysis questionnaires.
Results	Martin's activities impact the environment adversely predominantly through the factory's total energy input, emissions to air and even most importantly through the energy consumed in the use stage of the products. Other less significant environmental impacts identified related to hazards, waste, water consumption and nuisances. Compared to the ISO 14001 requirements, the company was found to possess an environmental policy, and had also done some work in relation to operational control and emergency preparedness and response. It however fell short of about approx 90% of the requirements of the ISO 14001 standards

Group 3: Environmental Impacts of Passive Houses (group 3 report)	
Context and aims	To determine how significant the choice of materials is when designing energy-efficient houses in relation to their lifecycle environmental impacts.
Research question	Controlling for energy efficiency and design, what are the estimated costs and environmental impacts related to two energy-efficient houses, conceived in accordance with either a sustainable development or an energy efficiency criteria?
Theories	Life cycle thinking, sustainable development and construction, passive house, passive and active systems, big bale building, LS/EPS Passive house
Research methods	• Case study, interviews • Costs analysis, life cycle assessment
Results	The construction costs were the most persuasive element of the partial results. The BBB is significantly less expensive to construct. The use stage showed an important financial dominance over the two other stages. The global warming category revealed itself to be the most important feature to consider among the environmental categories selected in this study, and at a lesser degree nutrient enrichment. The choice in the materials is of great importance of the other stages especially in relation to the embodied energy due to transport which formed an important feature in LS/EPS impact profile.

Evidence – students learning

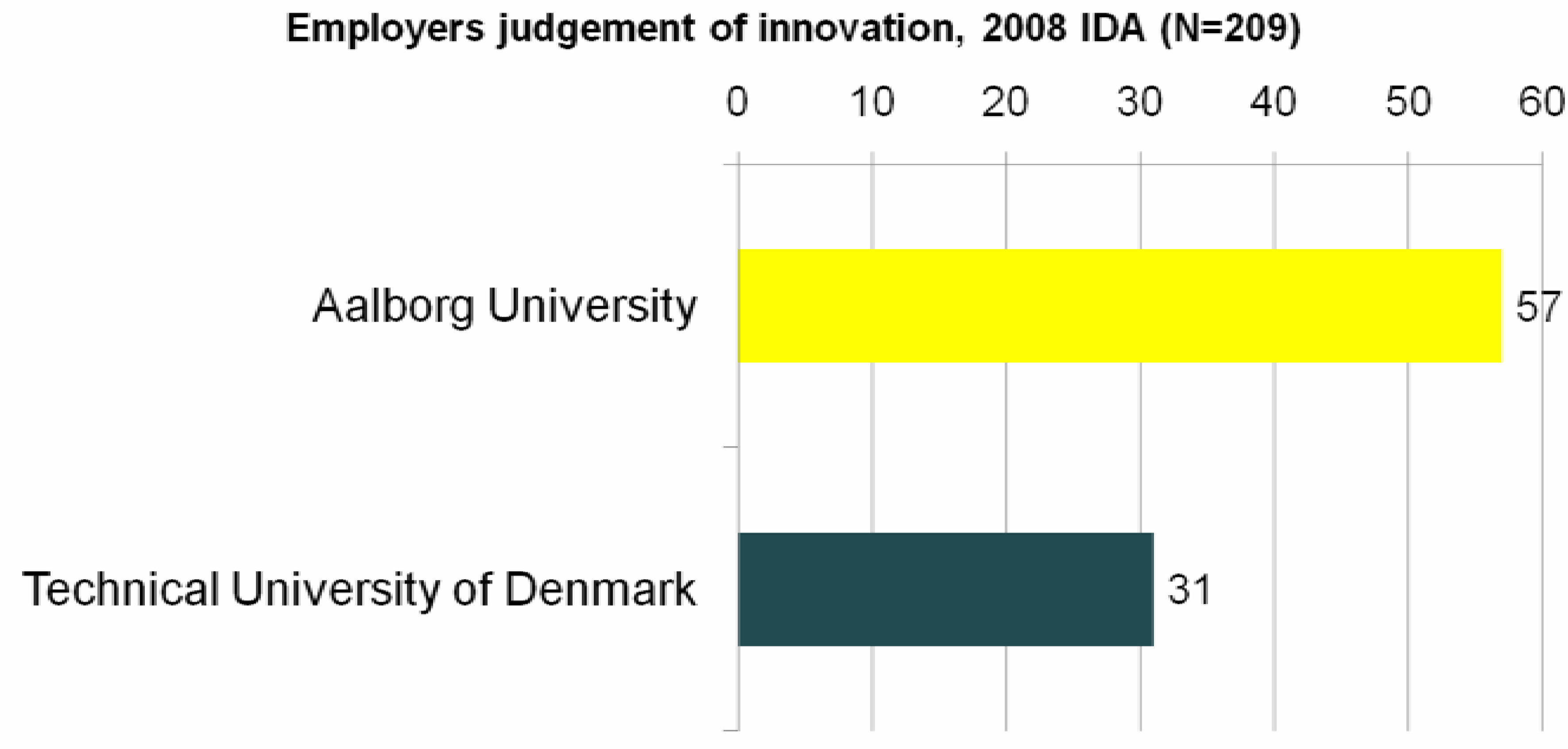
Motivation and engagement	Graff and Cowdroy 1997, Thomas 2000, Kolmos and Du, 2006
Deep learning	Biggs 2003
Self-directed learning	Du 2006a
Criticality of learners	Savin-Baden 2003
Professional Skills improvement	Dochy et al 2001, Frenay et al 2007
Process skills	Kolmos 1996, 1999, Du 2006, Kolmos and Du 2006, Croshwaite, 2006
Interdisciplinary knowledge and skills	Kjaersdam 1994, Graaff and Kolmos 2003
Creativity and designing skills	Schrøder 2006
Professional identity andresponsibility	Hmelo and Evensen 2000, Kolmos 2006, Du 2006a, 2006b
Self-satisfaction and meaningfullness	Savin-Baden 2000, Du 2006a

Evaluation from Danish industry on graduates

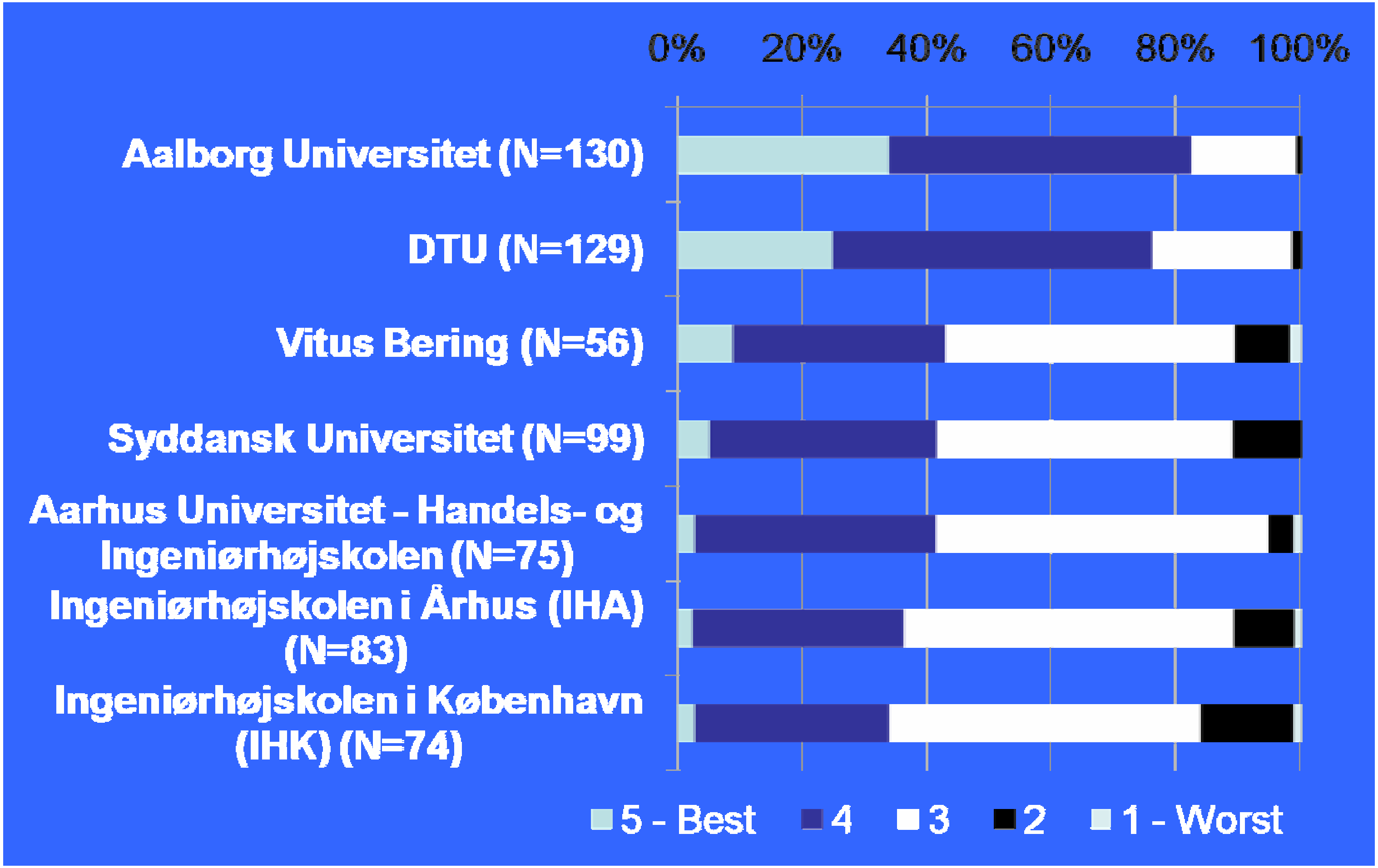


Source: Nyhedsmagasinet Ingeni駝en, nr 13, 2004

Employers judgement of innovation, IDA, 2008 (N=209)



Overall assessment of Danish Engineering Institutions. IDA, 2008



PBL – Regional development

PBL AAU as a good example of linking students with the local economy (OECD 2007, Puukka and Marmolejo 2008)

- Students benefit from
  - Gaining transferable skills and authentic work experiences
- University benefits from
  - gaining feedback and access to instructive cases and ideas for research and teaching
  - Improving graduate retention
  - Higher rate on-time finishing (AAU 87% v.s 38% others in DK)
  - Lower drop-out rate (AAU lowest in DK)
  - Improved interdisciplinary collaboration among teaching staff
- Enterprises benefit from
  - A clearer picture of what the university stands for and how the students might fit in as prospective employees

A walk around AAU Main Campus