



# **Problem Based Learning (PBL)**

**– What? – Why? and How?**

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## The Rationale of this Workshop

- UNESCO Chair in Problem Based Learning in Engineering Education (UCPBL) is located at Aalborg University (AAU)
- One objective of UCPBL is to disseminate knowledge about problem based learning (PBL) throughout the world
- This workshop aims to assist in fulfilling this objective



## The presentation outline

1. "Teaching teaching and understanding understanding" a videofilm about teaching and learning (½ hour)
2. What is PBL? – Why introduce PBL? (lecture – 20 min)
3. Introducing PBL in North West University? (team activity - ½ hour))
4. How can PBL be implemented? (lecture – 20 min)
5. Collaboration NWU - AAU?



# Intended Learning Outcomes

**After today's workshop you should be able to:**

- Describe and discuss the what, why and how of problem based learning (PBL)
- Reflect upon and discuss possible ways of implementing elements of PBL in your own teaching



## Dynamic list of questions

Please take a few minutes to think of questions you may have in connection with problem based learning

- Write down the questions
- Strike them out as they get answered
- Add new questions as they pop up
- .... And please do interrupt and ask questions whenever you feel like it
- By the end of the seminar we will make sure that there are no unanswered questions on your list...



# **A videofilm about teaching and learning**

“Teaching Teaching and Understanding Understanding”

Available at:

<http://www.brics.dk/~brabrand/short-film/index.html>



## Follow-up to the video film

Please buzz with your nearest neighbours in small groups of 3 - 4 for 3 minutes about the following question:

- What are in your opinion the main points in the video?

Available at:

<http://www.brics.dk/~brabrand/short-film/index.html>



# 1. Problem Based Learning – what? – why?

- a) WHAT is Problem Based Learning (PBL)?
- b) WHY introduce PBL?





# The Learning Theory - 1

- Based on a **social constructivist** perception of learning and teaching:
  - **Learning** is the student's individual process of constructing knowledge and meaning, based on information inputs from many different sources and in social interaction with others (peers, teachers, experts etc.)



## Is this learning?

*The psychological mistake in learning:*

"We pretend that there is co-incidence between what is being taught and what is being learned"  
(Knud Illeris, 1998)



## The Learning Theory - 2

- Based on a **social constructivist** perception of learning and teaching:
  - **Learning** is the student's individual process of constructing knowledge and meaning
  - **Teaching** is the "setting up of a situation from which a motivated learner cannot escape without having learned" (Cowan) – teaching is not (only) lecturing !!!



*Lila M. Smith*



## Is this teaching?

“Teaching does not mean transferring knowledge but creating opportunities for ...producing and constructing it.” (Paulo Freire)



## Paulo Freire (1921-1997)

- “Education is a way of intervening in the world”
- Freirian Critical Pedagogy is similar to PBL in most aspects



## What is PBL?

- *“PBL reflects **the way people learn in real life**; they simply get on with solving the problems life puts before them **with whatever resources are to hand.**”* (Biggs 2003, p. 232; emphasis added)



## What is PBL?

- “.... *problem-based learning helps students to see that **learning and life take place in contexts**, contexts that affect the kinds of solutions that are available and possible.*” (Savin-Baden 2003; emphasis added)



## What is PBL?

- PBL is **Student-Centred Learning**
- where **motivating** and **activating** students is the prime concern.
- The point of departure for the learning process is an **ill-structured real life problem**





# PBL Learning Principles – 3 Dimensions

## ➤ **Cognitive dimension:**

- Problem based
- Contextualised
- Action oriented
- Experience based
- (Project organised)



# PBL Learning Principles – 3 Dimensions

## ➤ **Content dimension:**

- Interdisciplinary
- Exemplary
- Theory – practice relation
- Critical



# PBL Learning Principles – 3 Dimensions

## ➤ Collaborative dimension:

- Participant directed
- Team organised
- Dialogic
- Democratic



## Conclusion

- Based on the learning theory and the fundamental learning principles PBL can be implemented in many different ways
- Thus, PBL is not a certain prescribed teaching and learning method
- There is no 'right' or 'best' PBL approach – each university has to develop its own PBL model



# Questions and discussion on WHAT?



## **2. WHY introduce PBL?**

- Perspectives from different stakeholders



## **Why introduce PBL? - a student perspective**

Working with real life problems...

- motivates students and therefore enhances learning

It further develops students'

- problem solving skills
- ability for critical thinking
- project management skills
- communication, negotiation and conflict resolution skills
- analytical and methodological skills, i.e. transferable skills
- life long learning skills



## Why introduce PBL?

AAU students on problem based learning:

- *"This way of learning is much better than only attending lectures, because I have to know why I need to learn this. When I know the objective clearly, I learn much better."*
- *"When working on a problem, I am strongly motivated and attracted. We need to solve this problem."*
- *"Working in groups we get mental support from each other; it is also a responsibility so that we won't drop out easily."*
- *"I think that it becomes easier when you learn technical matters in groups. Normally we use the blackboard to discuss things."*







## **Why introduce PBL? - a teacher perspective**

- You learn together with your students – more fun than just lecturing the same old stuff you know by heart ;-)
- Closer relation between teaching and research
- Reduced teaching load (less lecturing, fewer exam papers)



## Why introduce PBL? - a teacher perspective

- *“Once anyone is involved as PBL-tutor working with students and has the opportunity of seeing what the students can do **when given the permission to think and learn on their own, he or she usually becomes a convert.**” (Barrows 1996; emphasis added)*



## **Why introduce PBL? - an institutional perspective**

- More motivated students leads to
- decreased drop-out rates,
- shorter completion times and
- more competent graduates.
- Improved interdisciplinary collaboration between staff members
- Improved collaboration between university and industry
- Better match between industry needs and graduate skills

# PBL and Lack of Resources

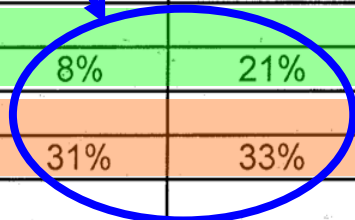
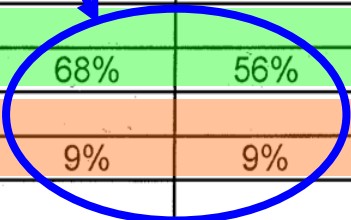
PROCENT, 2005

Universities Denmark:  
Completion information  
categorised into main areas  
of study, 2004 - 2005

Institution	Masters Programmes	3.1 % completion in scheduled time		3.2 % completion in scheduled time + 1 year		3.3 Still active		3.4 Stopped	
		2004	2005	2004	2005	2004	2005	2004	2005
		KU							
HUM				*	9%	*			
SUND				*	51%	*			
AU									
HUM		4%	2%	9%	13%	33%	31%	58%	56%
SUND		*	19%	*	56%	*	22%		22%
AAU									
TEK/NAT		68%	56%	85%	70%	7%	9%	8%	21%
DTU									
TEK/NAT		9%	9%	44%	45%	25%	22%	31%	33%
KVL									
TEK/NAT		6%	7%	43%	43%	48%	43%	10%	14%
DFU									
SUND		15%	21%	56%	59%	28%	17%	16%	24%

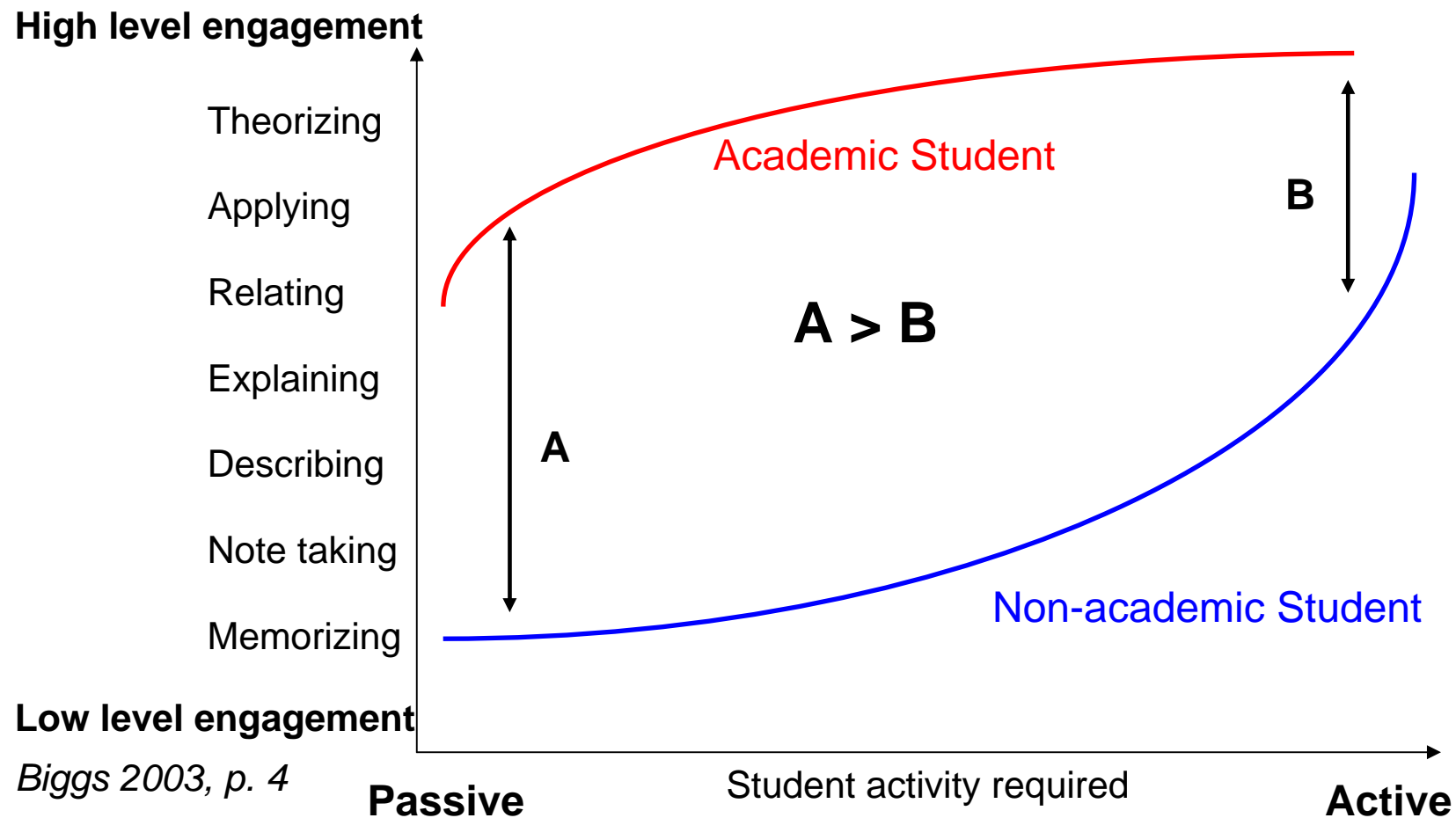
Completion time

Drop out rate



\* Databrud vedr. KU og AU (SUND)

# Why introduce PBL? - an institutional perspective



Low level engagement

Biggs 2003, p. 4



## Why introduce PBL? - an institutional perspective

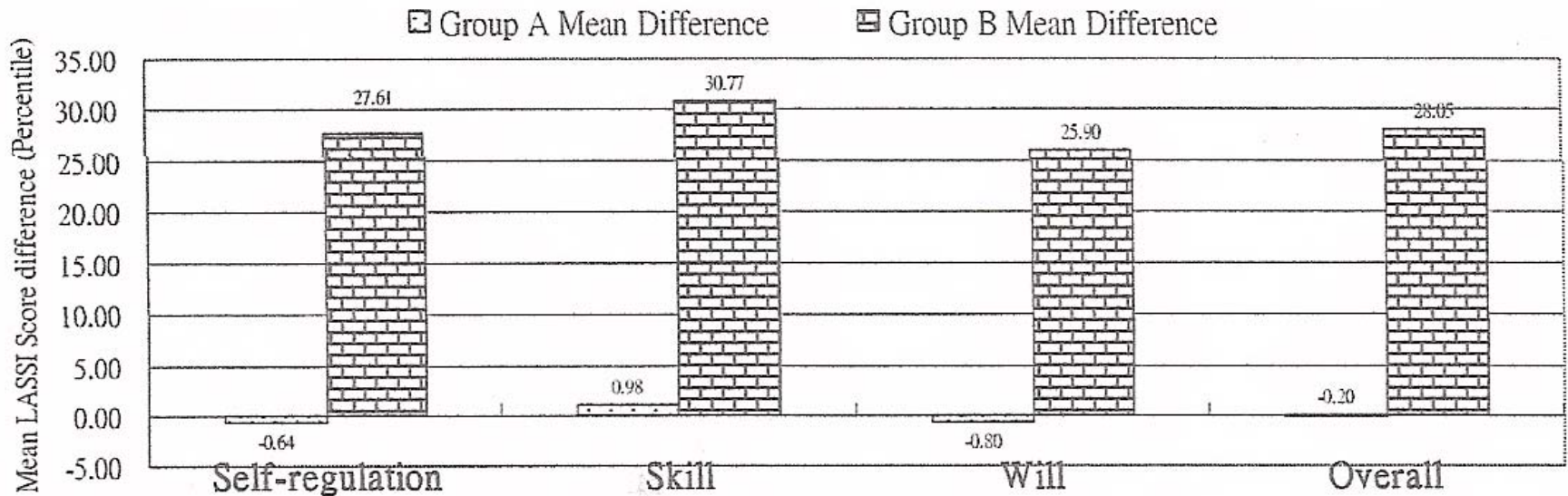
City University of Hong Kong:

After 15 months of study 'non-academic' first year students following a PBL curriculum showed greater improvements in **meta-cognitive processes of planning, monitoring and evaluating their own learning** than a matched group of 'academic' first year students following a non-PBL curriculum within the same discipline of engineering.

# Why introduce PBL? - an institutional perspective

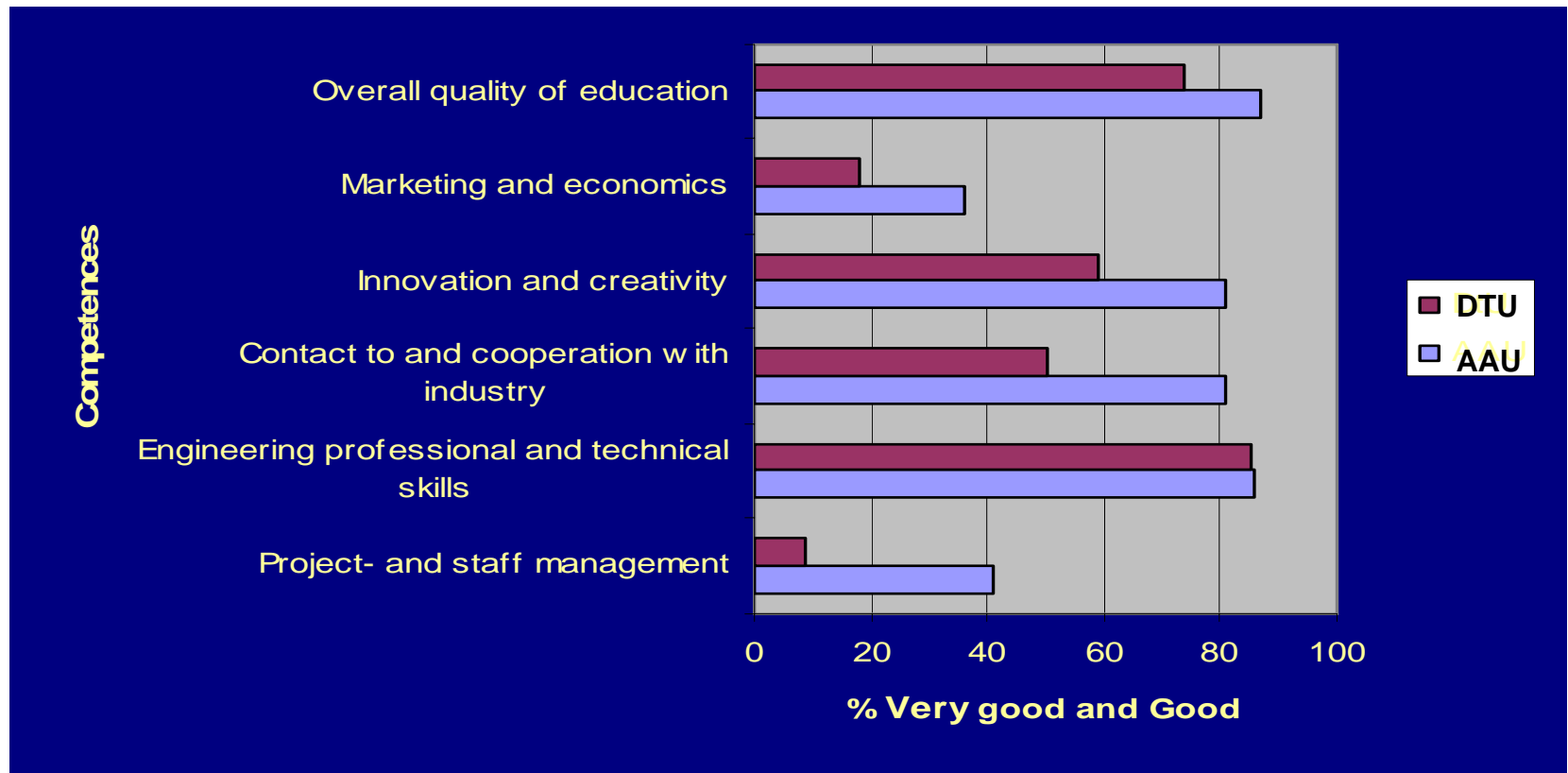
Learning  
And  
Studying  
Strategy  
Inventory

Mean difference LASSI score (3 components and overall)  
Group A (non-PBL) vs. Group B (PBL)





# Why introduce PBL? - an industry perspective





## **Why introduce PBL? - an industry perspective**

- 57% of private employers prefer candidates from AAU over candidates from [.. a more conventional university]. Reasons:
  - good skills in team work
  - innovation skills
  - project management skills
  - ability to acquire new knowledge and skills
  - methodological and structured way of working



## **Why introduce PBL? - an industry perspective**

One respondent in the survey said:

- *“The ones [i.e. the candidates] coming from, for example, Aalborg University, go in and work in projects from the start.”*



# Questions and discussion on WHY?



*Time for a break?? ...*



# **Why introduce PBL in North West University? - a team activity**

- Based on the presentation, what are in your opinion:
- the two most important reasons for introducing PBL in NWU?
- the two most important barriers against introducing PBL in NWU?



## The Tasks in This Activity:

- **Individually:** Write down the main reason for and the main barrier against PBL (3 min)
- **In teams of 3 - 4:** Discuss and agree on the two main reasons for and the two main barriers against PBL (10 min)
- **In plenary:** Please be prepared to present the results to the plenary (10 min)



## **4. HOW can PBL be implemented?**

- a) Republic Polytechnic, Singapore
- b) University of Maastricht, the Netherlands
- c) Aalborg University, Denmark





# Republic Polytechnic (RP) – Visions

Students of RP should be:

- Knowledgeable (understand, share, apply)
- Inquirers and thinkers with ability to reason
- Open minded, risk takers and decision makers
- Communicators and negotiators,
- Teamworkers
- Caring and tolerant individuals with a balanced outlook and good values
- Learning-enabled



## RP – 'one day – one problem'

- 25 students per class – 5 teams of 5 students
- A facilitator assigned for the day for each class
- A problem given in the morning
- Five different but related problems per week
- Daily assessment supplemented by 'understanding tests'



## The daily routine at RP - 1

<b>Sessions</b>	<b>Activities (and actors: f=facilitator, s=students)</b>
<p>First meeting (1 hr)</p>	<p>Presents problem trigger + scaffolding (f)            Analyse problem (f + s)            Identify known – unknown - learning needs (f +s)            Assign research duties (s)</p>
<p>First break out (1 hr)</p>	<p>Search, select, structure information            Make meaning</p>
<p>Second meeting (1 hr)</p>	<p>Discuss progress and difficulties (s + f)            Helps develop learning strategies (f)</p>



## The daily routine at RP - 2

<b>Sessions</b>	<b>Activities (and actors : f=facilitator, s=students)</b>
Second break out (2 hr)	Review resource materials (s) Peer teach each other (s) Prepare presentations (s)
Final meeting (1 hr)	Present outcomes – discuss, justify, defend (s) Presents ‘the sixth outcome’ (f)
Assessment (½ hr)	Do an individual written quiz (self assessment) (s) Write in personal reflective learning journal (s)



# RP: Statistical Methods for Engineering

## Title: Overbooking

### The problem 'trigger':

Budget Hotel Singapore is a newly established 200 room hotel. Last minute cancellations result in many rooms being left empty for the night. Therefore management has decided to allow overbooking. Target is at least 90% occupancy and the risk of more guests than rooms as low as possible.

As part of the quality assurance team of the hotel you are tasked to perform a statistical analysis and present recommendations to hotel management, highlighting any risks to be considered.



# RP: Statistical Methods for Engineering

## Title: Overbooking

**Scaffolding:** A total of 12 questions conc. statistics:

- 1) A coin is biased so that the probability of head is  $\frac{2}{3}$ . What is the probability that a tail will happen in the next toss of the coin?
- 4) What is the probability that exactly four heads will come up when the coin is tossed 7 times?
- 8) For Budget Hotel Singapore, is the random variable of overbooking of hotel rooms binominally distributed?
- 11) What is the meaning of allowing the guests to overbook? What problems or risks do you think may happen when you overbook?



## UM – the Maastricht Model

- UM introduced PBL in the Medical School at the founding in 1975
- The PBL approach has spread to other professional programmes, including engineering
- The model is adapted to suit the specific demands of each institution
- In engineering the model is ‘adapted Aalborg’
- The following model is from the Medical School



## The Maastricht Model - Principles

- Learning based on problems and case studies (= real patient records)
- Integration of disciplines and skills
- Interdisciplinarity secured via interdisciplinary teams of teachers responsible for themes





## The Maastricht Model - Structure

- Curriculum structure - thematic blocks of 6 weeks
- One problem per week – 6 related problems
- Study groups of 8 – 10 students
- Regular meetings within the study group
- A non-expert group tutor participates in all meetings
- Self-directed learning + skills training sessions
- Individual block and progress examinations



## Maastricht model

### The 7 steps method – 3 blocks

- (1) clarifying terms and concepts not readily understood;
  - (2) defining the problem;
  - (3) analysing the problem;
  - (4) summarising the various explanations of the problem into a coherent model;
  - (5) formulating learning objectives;
- 
- (6) studying individually outside the group;
- 
- (7) reporting and synthesizing the newly acquired information  
*1) – 5) and 7) in the study group, 6) individually*



# The Aalborg Model –Study Structure

Bachelor programmes		Master programmes
	10. Semester	Master's thesis
	9. semester	Specialisation
	8. semester	
Bachelor project	7. semester	
Specialisation	6. semester	Bachelor education
Bachelor education	5. semester	
	4. Semester	
	3. semester	
Basic education	2. semester	Basic education
	1. semester	

# The Aalborg Model – Semester Structure

Project courses (P) –  
supporting project  
work – min. 25%  
(7-8 ECTS)

Study courses (S) –  
general knowledge –  
max. 25% (7-8 ECTS)

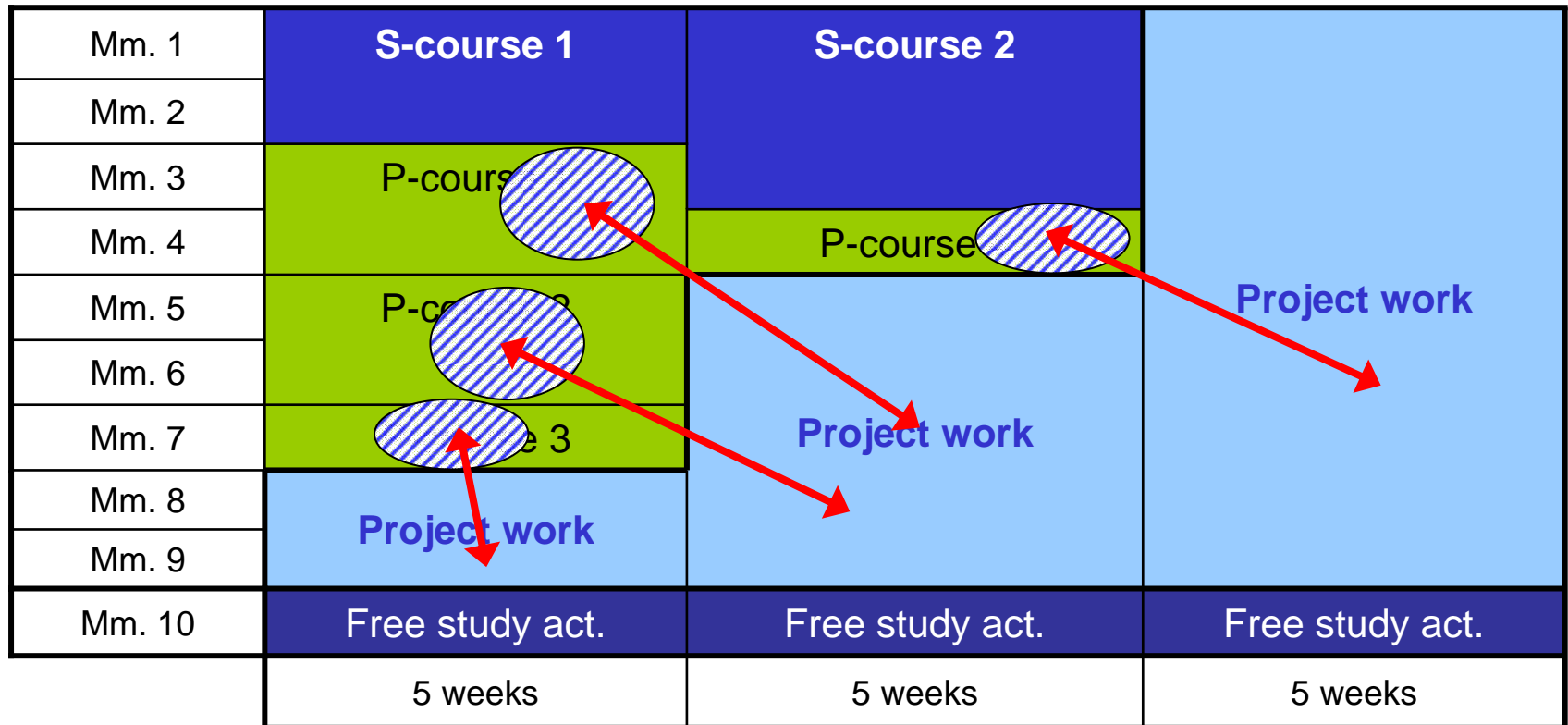
Group project – groups of 4 – 7 students  
– min. 50% (15 ECTS)

1 semester = 15 weeks + 5 weeks = 30 ECTS = 900 hours student work

# The Aalborg Model – Semester Timing

10 Mm/week – 1 Mm = 4 hours = ½ day

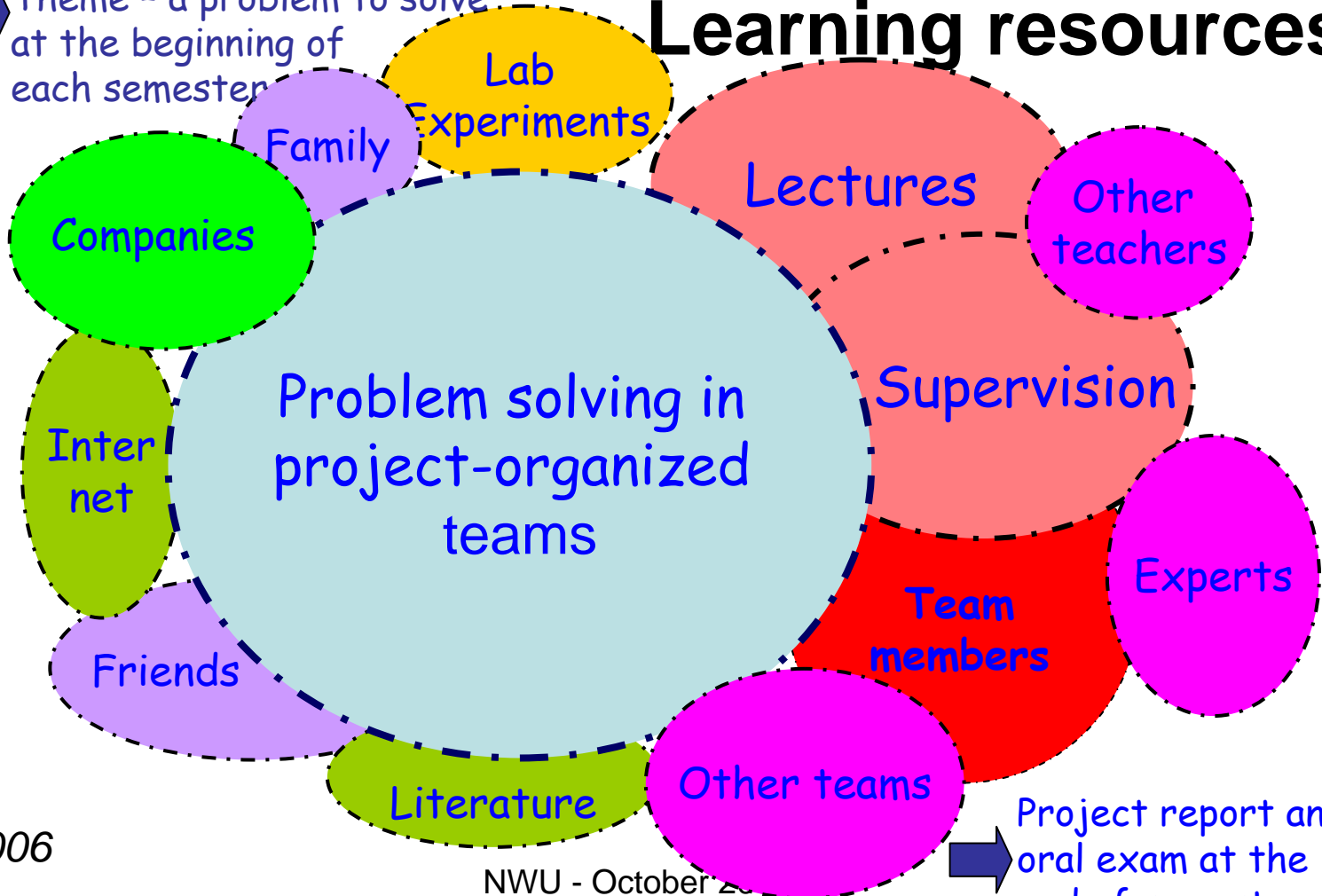
Mm. 1	<b>S-course 1</b>	<b>S-course 2</b>	<b>Project work</b>
Mm. 2			
Mm. 3	P-course		
Mm. 4		P-course	
Mm. 5	P-course		
Mm. 6			
Mm. 7	P-course	<b>Project work</b>	
Mm. 8	<b>Project work</b>		
Mm. 9			
Mm. 10	<b>Free study act.</b>	<b>Free study act.</b>	
	5 weeks	5 weeks	5 weeks






➔ Theme - a problem to solve at the beginning of each semester

# Learning resources

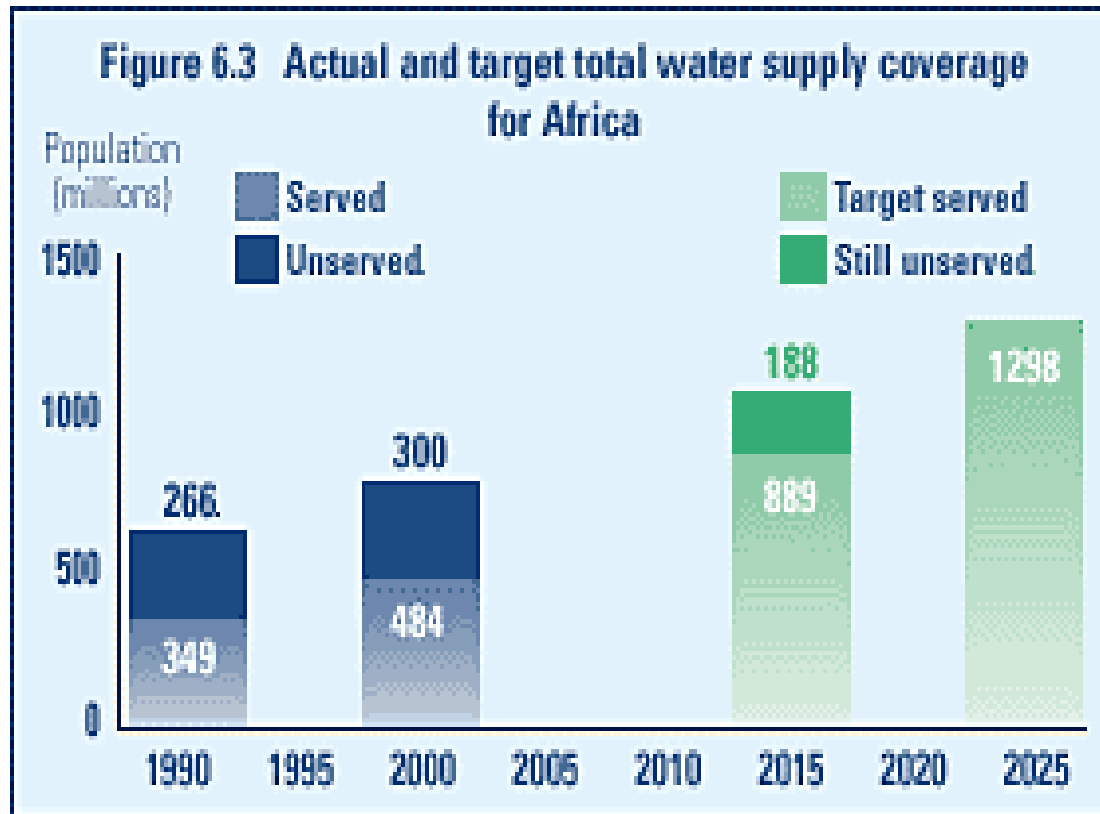


➔ Project report and oral exam at the end of semester



Sengerema, Tanzania

**The problem: Clean drinking water**



..a problem of huge dimensions...

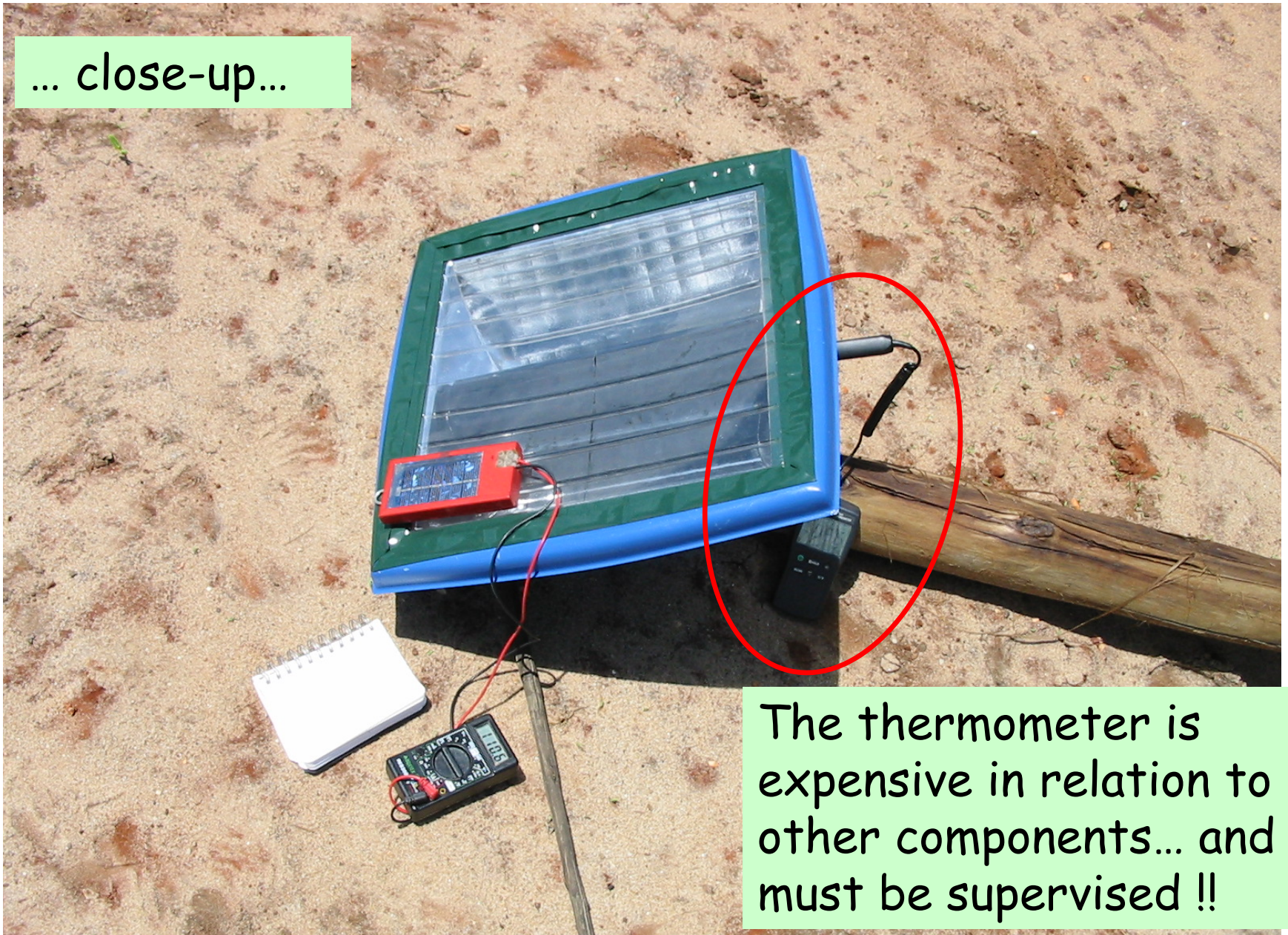
–“Approximately 4 billion cases of diarrhoea each year cause 2.2 million deaths, mostly among children under the age of five (WHO)”



Here is a  
solar  
heater...



... close-up...



The thermometer is expensive in relation to other components... and must be supervised !!



# AAU: Electronics Engineering

## 1st year, 2nd semester

### **Title: An intelligent thermometer**

#### **Project proposal:**

“Pasteurisation is a heating process whereby water may be cleaned of bacteria etc. to become suitable as drinking water. In Tanzania this heating is most often done using firewood which is in short supply. Using solar energy of which there is plenty it is possible to reach temperatures high enough for pasteurisation of a given fluid, depending upon how the fluid is kept. But a problem with solar energy is that it cannot be controlled.

Thus, there is a need for a simple and cheap device which can monitor temperature and time and in a simple way inform the Tanzanian user (who may be illiterate) when the pasteurisation is successfully completed.”



# AAU: Electronics Engineering 1st year, 2nd semester

## Title: An intelligent thermometer

Technical disciplines  
integrated:

- Temperature transducers
- **Circuit theory**
- **Electronics**
- Microprocessors
- Programming
- Display techniques

Social science disciplines  
integrated:

- Facts about Tanzania
- Development theories
- Waterborne diseases
- Pasteurisation methods
- **Stakeholder analysis**



# **AAU: Electronics Engineering 1st year, 2nd semester**

## **Outcome:**

- A project report
- A process analysis
- A digital temperature measurement setup



## Four tools for AAU facilitators

- Contract of cooperation with project group
- Learning outcomes of the project work
- Regular meetings with the group
- Process analysis



	RP	UM	AAU
No. of stud.	5	8 - 10	2 – 7
Lectures - problem work	No lectures (?)	Few lectures	½ lectures ½ project
Length of problem work	One day	One week	One semester
Pre-structure of problem	High	Medium	Low
‘Teacher’ direction	High	Low	Low to medium
Outcome	Presentation + learning	Learning	Report, product, presentation + learning
Assessment	Individual Daily+‘understand’	Individual Block+progress	Individual S-course+proj.



## Comparison

- Q: Which PBL model is the right / the best??
- A: There is no 'right / best' PBL model – because
- PBL is an idea - not a prescribed teaching method
- There is no 'one size fits all' PBL approach – each university has to develop its own PBL model
  
- PBL is but one of a range of **student-centred learning** approaches





# Questions and discussion on HOW???



## 5. Collaboration NWU - AAU

- Professor Mahlomaholo and I have agreed on a joint research programme: "Creating empowering learning environments" - a critical emancipatory research programme, incl. PBL research
- Furthermore, we have agreed on asking our respective managements to sign a 'Memorandum of Understanding'
- Apart from that UCPBL may assist in introducing PBL by
  - Workshops, consultancy, customised "Train the Trainers" programmes, cooperation in the UCPBL Global PBL Network
  - Staff development through the MPBL programme



## Staff Development

- Master in Problem Based Learning in Engineering and Science (MPBL)
- On-line distance education programme
- Two years part time study
- Exemplary for its own contents
- Offered by Aalborg University and partner institutions



## Internet Addresses

- UNESCO Chair for PBL in Engineering and Science (UCPBL):
  - [www.ucpbl.net](http://www.ucpbl.net)
- Master in PBL in Engineering and Science (MPBL):
  - [www.mpbl.aau.dk](http://www.mpbl.aau.dk)



**...and now is time for the last questions and discussion...**

*...before we round off today's work...*



*Thank you very much for  
your attention and active  
participation*

