

Problem Based Learning

Seminar 1

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Participants of the PBL course

- New employees in the Computer Science Department
- Employees with a background from another university
- Unaware of the computer science studies at Aalborg University
- Have no background in PBL and project work in groups of students

Overview of the PBL Seminars

- Seminar 1: Introduction and the PBL model
 - PBL, projects, and problem statements
- Seminar 1 ctd. (we may need more time)
- Seminar 2: The PBL model and concepts
 - Types of students and supervisors
 - Landscapes of studies in the CS Department
- Seminar 3: Project supervision
 - Bring your own challenges...
- Seminar 4: Exams
 - Exam rules and grading
 - Project group exams

See the seminar programme in Moodle

Problem-based projects in a
group setting

Problem-based vs. group-based vs. project-based

- Problem-based learning does not have to be project-based!
- Project-based teaching is not necessarily problem-based!
- And projects need not be group-based!

Assignments vs. Problems

Assignment	Problem
Precise formulation	Broad and open-ended formulation
One correct solution	Many possible solutions
Controlled by the teacher	Controlled (owned) by the students
Prompted by the course curriculum	Prompted by the student's experience and wondering
Sometimes boring	Highly motivating

Project Progression: Software & Computer Science

Semester	Project description
1	
P0	Analysis and delimitation of a problem
P1	Analysis, delimitation and solution of a problem (small program)
2	Analysis, delimitation and solution of problem (larger program, test)
3	Developing applications – GUI – OOA, OOD
4	Making and implementing a programming language
...	...
10	Contributing scientifically to a research project

PBL Practice

PBL – Project Ideals

- Initial problem
 - Open ended, "real world"
 - Sometimes based on "student wondering"
 - Context – from surrounding society
- The problem needs to be defined and understood
 - Analysis and delimitation
 - Beware: Problems may develop over time
- Problem solving

Where does the problem come from?

- From the students
 - Strengthens student's ownership of the project
 - High degree of motivation – a driving force
- From the potential supervisors
 - Project catalogue
- From "the outside world"
 - Companies or institutions
 - Facilitated by for instance solutionhub.dk

Problem analysis

- The problem analysis will need to analyze the *problem setting*.
- This often requires in-depth studies of existing sources (books, articles, etc.).
- The goal of the problem analysis is to identify a problem worth solving. Components of a problem: Objects and events.
- This problem must be expressed in a *problem statement*.

What is a good problem statement?

(1)

- It *follows from the preceding problem analysis*.
- It demonstrates that the students are able to apply the terminology and taxonomy from the problem analysis in a *precise* way.
- It makes it clear that this is a *relevant* problem; the problem may be *internal to the subject* or it may be *external to the subject*.
- It is stated in such a way that it *justifies the need to obtain new knowledge* (this means that the solution should be neither obvious nor trivial).

What is a good problem statement? (2)

- It is a collection of *Wh-questions* *or* a brief summary of the results of the problem analysis leading up to a *contradiction* between elements of the analysis.
- It *justifies the choice of theory and methodology* of the project.
- It *states the goals and the focus* of the project.
- It *encourages curiosity and creativity!*

A project proposal should contain an *initiating problem*

- It is much easier to find a good problem statement from a good *initiating problem!*
- *A good initiating problem should be a question that makes everyone curious and whose answer is not easily found.*
- *A good initiating problem should facilitate a non-trivial problem analysis.*

Three good examples of initiating problems

(that are all “external” to computer science)

The taxi problem



The taxi problem

- *A lot of money can be saved if transport of patients to and from hospitals in the north of Jutland is better planned. So says 70-year old Leif Lindstrøm from Egense. ... More than half of the time I am the only passenger in the taxi both on my way out and on my way home. ... Leif Lindstrøm adds that he informed the regional transport office of this... The answer has been that transport is planned by a computer and that it is close to impossible to change the plans that are made.*

Newspaper article, 18 January 2012

The initiating problem

- **A contradiction:**
 - The trips to the hospital are planned by a computer. And yet the plans seem inefficient.
- **A wh-question:**
 - What can we do to ensure that the plans make better use of the resources but still ensure that patients get to the hospital on time?

The spellchecker problem



The spellchecker problem

- *Most spelling mistakes that adults make are not simple lexical mistakes but are phonetic mistakes that can be corrected by a syntax analysis:*
 - *I often went their for lunch.*
 - *I have never met you' re wife.*
 - *You should of done your homework.*

The initiating problem

- **A contradiction:**
 - Spellcheckers focus on lexical spelling mistakes. Many actual spelling mistakes are of a different kind, however.
- **A wh-question:**
 - What can we do to improve the quality of spellchecking?

The piano problem



The piano problem

- *Sometimes we need to move large pieces of furniture down a corridor or up a flight of stairs.*
- *Sometimes this is not possible.*
- *It really is quite annoying. Can we somehow predict/prevent this?*

An example of an initiating problem
that is *not* very good

Representing numbers in computer memory

How does one represent integers, floating-point numbers etc. in a computer?

How are the standard arithmetic operations implemented?

Why is this not a good problem?



What is a good initiating problem and problem statement?

- For the initiating problem, possible criteria could include:
 - an initiating problem should be a question that makes everyone curious and whose answer is not easily found.
 - an initiating problem should facilitate a non-trivial problem analysis.
- For the problem statement, criteria could include that
 - a problem statement should set the goals and the focus of the project.
 - it should encourage curiosity and creativity!

Solving the problem (or not)

- Remember: Learning the competences needed to obtain a solution is (always) the goal, the actual solution is (often) not!
- An important competence is always that of being able to *choose* or *devise* and *justify* a specific method (including the theories behind it).

Signs of a good project...

- A good project is *open-ended*; there should always more to say about the project!
- A good project leads to a *non-trivial problem analysis*.
- A good project is *owned by the students*; the students are eventually able to state the problem that they are solving themselves.
- When students talk about a good project, they most often say things like “We are trying to find out if...” rather than “We are writing a report about...”

And now you

Your teaching

- The theme for projects on the semester, where you are assigned as supervisor (from the study regulations)
- Give one or two examples of relevant project proposals for this semester (from the project catalogue for the semester)
- Where do you expect the learning challenges might be for projects on this semester Your personal background relative to this (technical/academic background and teaching experience)
- Your expectations (what do you expect from the students? Where do you think your biggest challenges might be?)

PBL Theory

The history of PBL

- ❖ American pragmatist philosophy (C.S. Peirce, Henry James, John Dewey)
- ❖ According to Dewey, pragmatism places *action* as an intermediary between *thought* and *application*
- ❖ John Dewey emphasizes learning through active inquiry
 - ❖ *We only think when we are confronted with a problem*
 - ❖ *[T]he teacher becomes a partner in the learning process, guiding students to independently discover meaning within the subject area*

Characteristics of PBL

- ❖ Problems are the stimulus for learning
- ❖ The problem setting can be *internal or external* to the subject
- ❖ Working on real life problems develops problem solving skills
- ❖ Interdisciplinary (*characteristic for external problems*)
- ❖ Exemplary learning – insights into one area as basis for generalization
- ❖ Self-directed small student groups
- ❖ Teachers are facilitators/guides

Deweyan Inquiry Concepts

Iterative reflection *and* action

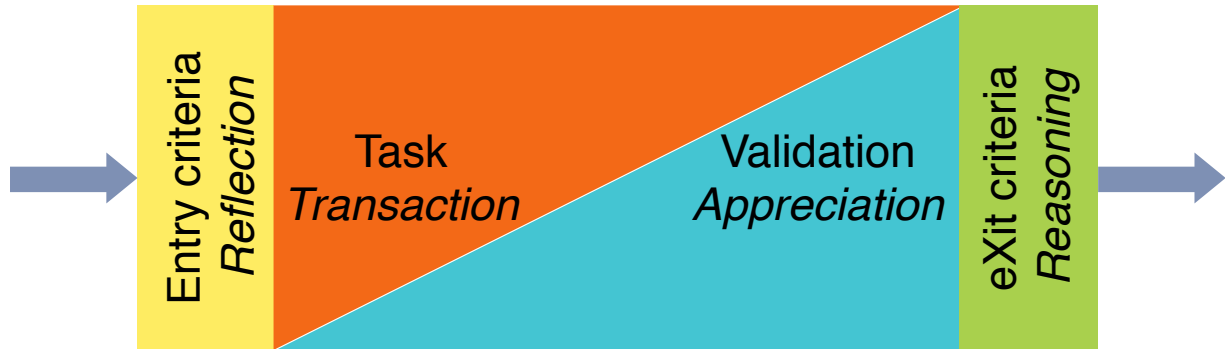
Inquiry	Reflection	Transaction	Reason	Appreciation
	Indeterminate situation			Prescience Patterns
Materials Suggestions Ideas	Problematic situation	Objects (real and ideational) Design	Symbols Reasoning	Valuations
	Determinate situation		Resolution	

Means and Ends in Inquiry

Material means	Procedural means	Ends Ends-in-view
<ul style="list-style-type: none"> • Components built • Builds and releases • Platforms and libraries chosen • Objects and events (incl. users) • Data available • Infrastructure, digital ecosystem • <i>Backlog items</i> • <i>Objects and events (incl. users)</i> • <i>Data presumed</i> 	<ul style="list-style-type: none"> • Acceptance criteria • Test cases and results • Evaluation results • Prototypes • <i>Sprint</i> • <i>Planning</i> • <i>Test- and evaluation procedures</i> • <i>Daily stand-up meetings</i> • <i>Refactoring</i> • <i>Retrospectives</i> • <i>Demonstrations</i> 	<ul style="list-style-type: none"> • Sprint goal • Project Vision • Plan • Vision scenario • Requirement • User story <p>(Ends-in-view may also serve as procedural means)</p>

Plain text: Existential, Italics: Ideational

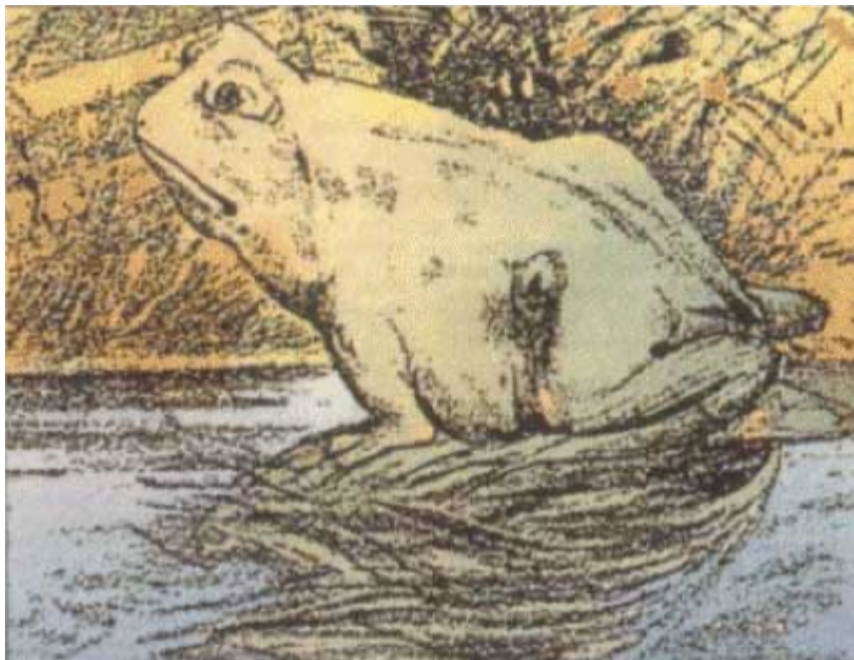
Project as Design by Contract



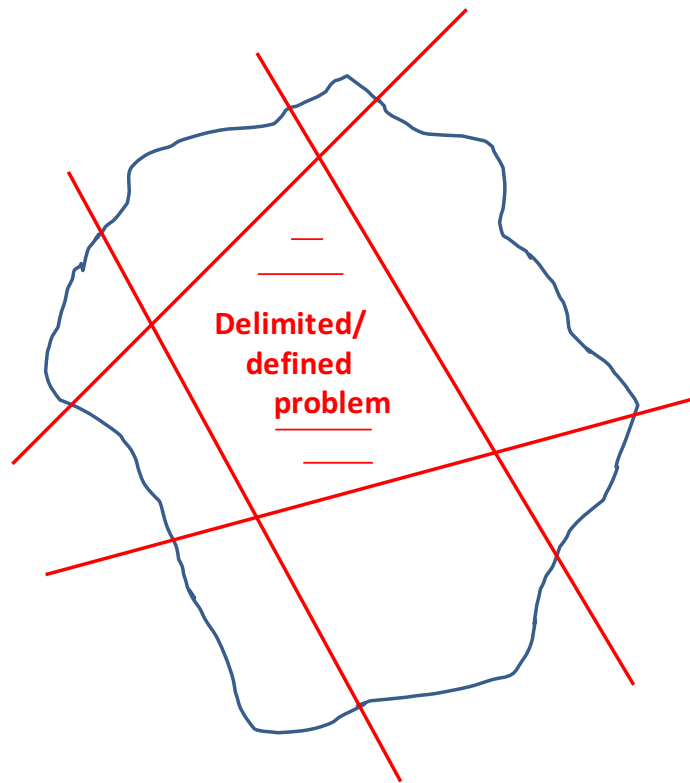
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Appreciating the situation
– identifying objects

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Problem Scope



Semesters, Courses, Projects and Supervisors

A Semester

- ✦ One Project
 - ✦ Done in groups of students (≤ 7 students)
 - ✦ Group-based project exam
 - ✦ Individual evaluation - shared project report
- ✦ Three Courses (almost always)
 - ✦ Done individually
 - ✦ Oral or written exam - individual

Do the courses support the project?
(answers later...)

A Course

- ✦ Lectures and exercises
 - ✦ In auditoriums and group rooms
- ✦ Assignments
- ✦ Mini projects / exam assignments / ...

Course Support of the Project

- ✦ Some courses are not at all related to the project
- ✦ Some courses are tightly coupled to the project
- ✦ Timing of courses in relation to project needs:
 - ✦ Courses too early:
 - ✦ Eats too much project time – students are not motivated
 - ✦ Courses too late:
 - ✦ Blocks the project work – stuff from courses needed in the project work

A Project

- ✦ Typically 15 ECTS
- ✦ Described in the study regulation
- ✦ The project work takes place in groups
 - ✦ Up to 7 students per group
 - ✦ Theme (title)
 - ✦ Learning goals
- ✦ Each group normally has a *group room*
- ✦ Supported by a *project supervisor*
- ✦ The outcome is a documented in a *project report*

Problem solving in companies take place in teams
Companies acknowledge the PBL skills of AAU graduates

Making the Groups: Questions and Issues

- ✦ Social or professional grouping?
 - ✦ Choice of fellow group members – or choice of problem / project proposal?
- ✦ Student influence on the grouping?
- ✦ Duration of the group formation process?
- ✦ Student interests in relation to supervisor interest?
 - ✦ Do the students adapt – or does the supervisor?

Typical group formation: First ⁷ year of studies

- ✦ Project catalogue made by supervisors
 - ✦ Student proposals also possible
- ✦ Professional grouping first
 - ✦ Students choose a problem/ project proposal of interest
- ✦ Subsequent social/ random grouping
 - ✦ Dealing with "residual groups"
- ✦ The entire process takes 2-3 days
- ✦ Supervisors adapt to the choices made by the students

Typical group formation: Last ⁸ year of studies

- ✦ Research groups announces interesting problems – well before the semester starts
- ✦ Seminars - consultations
- ✦ Student proposals are welcome
- ✦ More supervisors than necessary – freedom of choice
- ✦ Students choose an area of specialization
- ✦ Social grouping is involved
- ✦ Groups are finalized at semesterstart
 - ✦ Appropriate supervisors are assigned to the groups
 - ✦ Large groups at 9th semester
 - ✦ Group split possible before 10th semester

Being a Supervisor: Obligations

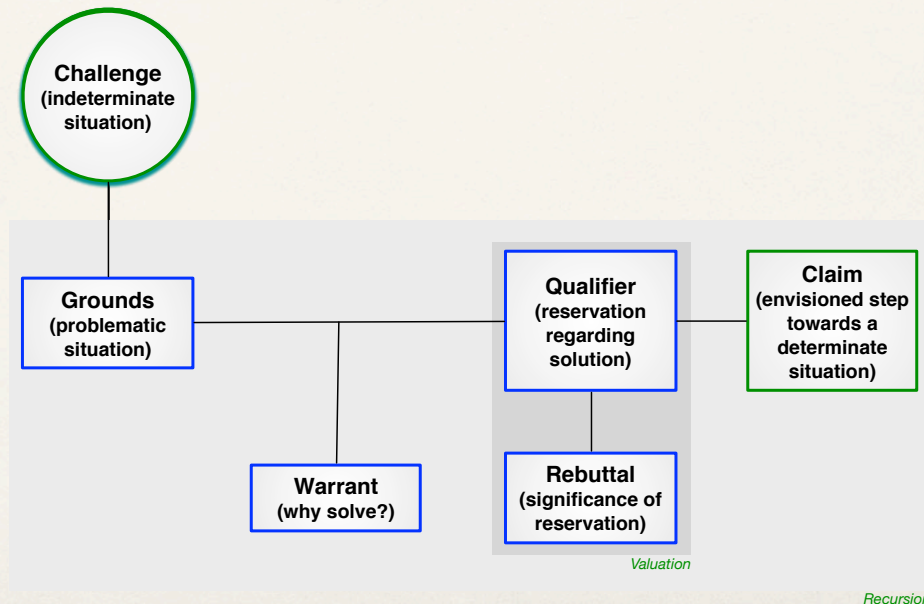
- ✦ **A facilitator:** Contributes ideas and problems, and offers professional and methodological support and advice.
- ✦ **A consultant:** Reads and comments on manuscripts produced by the project group.
- ✦ **A supervisor for each student in the group:** Awareness of the individual students in the group.
- ✦ **A supervisor for the group:** Meets with the group on a regular basis (usually once a week).
- ✦ **An examiner:** Conducts the project exam.

Much more about this in seminar 3 - 4

Beware of these pitfalls

- ✦ Thinking that the goal of a project is to write a report
 - ✦ It is not; the report reports what the students have done and how they have reasoned about and reflected upon the project – telepathy does not exist
- ✦ Thinking that the project is just an excuse for learning specific textbook material
 - ✦ It is not; the problem solving competences are extremely important in their own right
- ✦ Thinking that the project must provide a complete solution to the problem
 - ✦ This is not the case; the goal of the project is one of learning specific competences and skills

A Pragmatic View on Projects



Signs of a good project...

- ✦ A good project is open-ended; there should always more to say about the project!
- ✦ A good project leads to a non-trivial problem analysis.
- ✦ A good project is owned by the students; the students are eventually able to state the problem that they are solving themselves.
- ✦ When students talk about a good project, they most often say things like “We are trying to find out if...” rather than “We are writing a report about...”

What is a good initiating problem and problem statement?

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Presentation of one of your projects

- ✦ Please present
 - ✦ An initiating problem for one of your project groups
- ✦ And
 - ✦ Their current problem statement

Groups and projects

- * Real-life projects involve cooperation: There has to be a division of work, coordination, and joint decisions. Working in groups require mutual respect, understanding and acceptance of differences.
- * This is also true for “Learning projects”. The group process is not trivial and cannot be taken for granted.
- * Very often we discover this when something goes wrong!

Different kinds of groups

	Integrated	Instrumental	Hierarchic	Chaotic
Role casting	All	Some	Some	No
Work sharing	All	Some	Some	No
Control/Leadership	All	Yes	Few	No
Power	Equal	Equal?	Unequal	No
Personal engagement	High	Fair	Different	Low
Group identity	High	Low	Low	Low
Conflict solving	Yes	No	No	No
Members	Students	Pupils?	Pupils?	Pupils
Challenge	Problem	Project	Project	Tasks

Dysfunctional groups

- ✦ Some groups always make up excuses for not honouring agreements, for not turning in drafts and other deliverables, or for turning in poor quality work.
- ✦ Some spend lots of time writing, but get nowhere. The written material represents different lines of thought from meeting to meeting. Little continuity.
- ✦ Lastly, some groups fail to recognize their own responsibility. A group like this will tend to expect that the supervisor provides solutions and answers without the group being precise about questions.

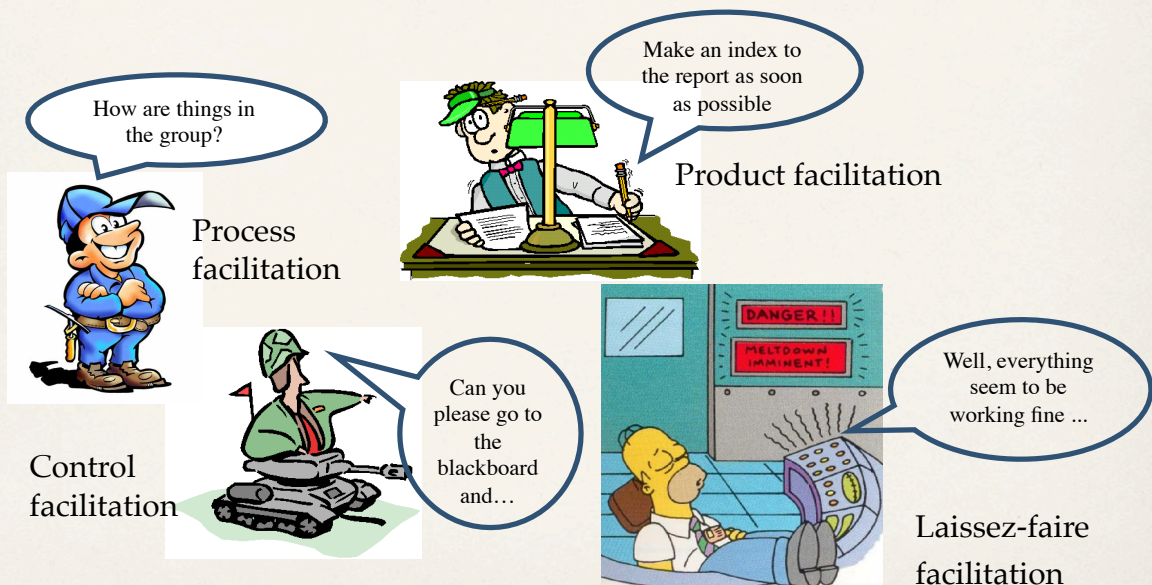
A supervisor is a *facilitator*

- ✦ A guide and sparring partner.
- ✦ Control by participation.
- ✦ Gives constructive criticism and asks relevant questions.
- ✦ Helps structuring the problem setting.
- ✦ Supervises the work process in the group.
- ✦ Makes sure that the formal requirements to the project work and deliverables are adhered to.
- ✦ Supplies relevant material and – if need be – helps making contacts.
- ✦ Danish: vejleder (someone that leads the way)

...and is also an examiner

- ✦ There will always come a time (the oral exam) when the supervisor will be assessing the project.
- ✦ The supervisor needs to make sure that everyone is well-prepared for this – but also to ensure that this does not prevent learning!
- ✦ There is a need for professional presence as well as a certain element of professional distance.

Four rôles in facilitation – and their pitfalls



Process-oriented

- ✦ Lets the students own the project
- ✦ Facilitates the students learning processes
- ✦ More questions than answers
- ✦ Values reflections on the process, the theories and methods higher than a flawless product
- ✦ *Risk: The students may feel that a lack of product orientation results in an unsatisfactory product*

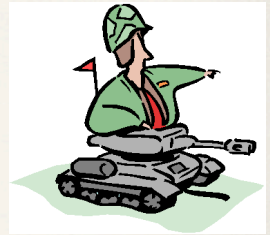


Product-oriented

- ✦ Traditional master-apprentice relationship
- ✦ Focus on the solution
- ✦ Focus on documentation
- ✦ Provides tip-offs and answers
- ✦ Feels ownership towards the project
- ✦ *Risk: The students may not learn to work independently*



Control-oriented



- ❖ Facilitation becomes exam-like, and the exam becomes a main focus
- ❖ Focus is on the individual knowledge obtained during the project
- ❖ Risks:
 - ❖ *The facilitation may seem rather scary, and the students may choose to keep facilitation at a minimum*
 - ❖ *If students feel insecure, this can fragment the group*

Laissez-faire



- ❖ Interferes only by request
- ❖ Praises and encourages the group to be independent and take responsibility for the project
- ❖ Risks:
 - ❖ *The students may feel a lack of engagement*
 - ❖ *Can become an excuse for the lazy supervisor*

Next time...

- ✦ Your contribution: Make observations and identify at least one of these problems:
 - ✦ Group problems (type, dysfunctionality)
 - ✦ Students (responsibilities)
 - ✦ Supervision (mutual expectations, supervisor rôle)
- ✦ Share these at the next seminar

Supervising diverse groups and students

Groups and projects

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Much more about this in seminar 3 - 4

Presentations

- ❖ **Your contribution:** Make observations and identify at least one of these problems:
 - ❖ Group problems (type, dysfunctionality)
 - ❖ Students (responsibilities)
 - ❖ Supervision (mutual expectations, supervisor rôle)
- ❖ As input for the discussions you should prepare a presentation, where you characterize your project groups, e.g. in terms of their social structures as well as the projects themselves. Relevant aspects could include social issues, leadership, dominance issues and conflicts, laziness and lack of engagement, mutual expectations within the group, mutual expectations between group and supervisor, plagiarism, planning, etc.

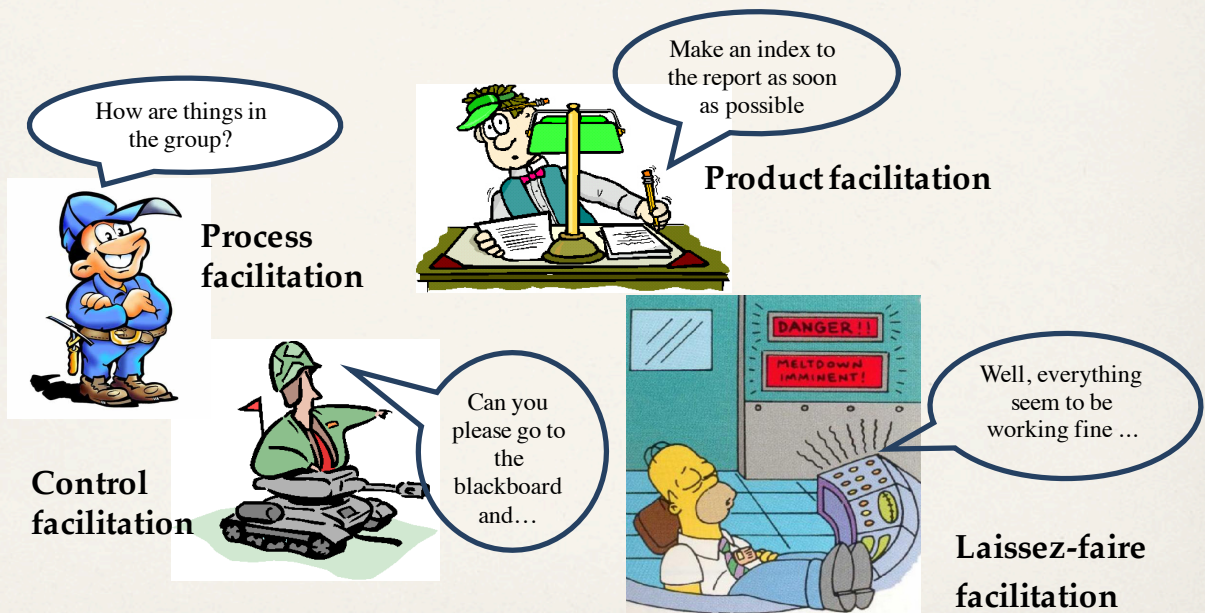
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- ❖ There is a need for *professional presence* as well as a certain element of *professional distance*.

Four rôles in facilitation – and their pitfalls



Next time...

- ✦ The last seminar is about exams. It will include discussion on the oral project exam, and it will give you some advice for your preparation of the exams, and how to involve the students in this process.

Supervisor Rôle and Challenges: Project examination

Ivan Aaen

Agenda

- Problems experienced in relation to exams
- Exam: Basic views
- Leading the exam

Problems experienced in relation to exams

A small quality study at Aalborg
University

Problems Experienced during Project Exam

- Parts of the report is not evaluated.
- Programming part is not evaluated.
- Analysis/design part covered unevenly.
- Lack of knowledge of assessment criteria.
- Goal ambiguity between supervisor and project group.
- Students may focus on some of the study goals - not all.

Expectations

- Students may not have understood what is essential in the project relative to the study goals. This is a major problem as it will harm their preparations for and their participation in the exam.
- If a group for instance has spent a disproportionate amount of time on coding they should not be surprised if the exam turns out to spend a lesser amount on this topic.
- A dialogue before the exam may prepare them for this.

Questioning

- Superficial questions.
- When groups describe an exam as superficial it may be due to questioning aiming for control.
- Questions may be designed to check if the level of the report corresponds to the level of the students.
- Such questions may hinder the students in demonstrating knowledge beyond the report.
- Balancing the specific and the abstract.
- One group complained that the questions were always very specific.
- Another group deplored that many questions were hard to understand - what were the teachers looking for?

Problems related to grading

- Uneven grading of individuals and groups.
- Uncertainty related to the importance of the oral part.
- Uneven or uncertain grading criteria.
- Poor explanation of the resulting grade.

Exam: Basic views

2 sets of views on exam

- Control - exam is completely separate from teaching. We must check what was read and learned.
- Motivation - exam is the primary motor for students. The prospect of exam is what drives them.
- Guidance - exam guides the student towards achieving the goals of the study.
- Learning - exam cannot be separated from teaching. Exam is a good opportunity for teaching.
- Feedback - exam as a source of insight into how teaching relates to learning.
- Moment of truth - exam as an instrument for insight - as a mirror for the teacher and the students.

Exam as control

- Corresponds to Control, Motivation, and Guidance.
- This view is based on the wish for objective and fair grading. The exam is an opportunity to control if the students have read and learned what we expect from them.
- It is also an opportunity for the student to control him/herself and confirm to be in line with the objectives for the study.

Exam as development

- Corresponds to Learning, Feedback and Moment of truth.
- This view is based on the wish to make the exam more than just knowledge control.
- Ideally the exam should be an opportunity for learning - something that happens in the interactions between other teachers and students.
- The exam should provide an opportunity to discuss and assess the theories and methods of our field. Feedback from others is an important source for personal development.

A holistic assessment

- The depth and breath of the project relative to the goals of the semester.
- The knowledge and models, theories and methods that were used in the project work.
- The professional quality of the project relative to the level of the study.
- Assessing the student's learning as *reflected* in the project.

Rigor vs. relevance

- Teachers that measure knowledge with a high degree of precision, measure fairly meaningless knowledge. To quote a Swedish teacher from an interview:
 - *I valet mellan meningsfulla frågor och frågor som går att rätta objektivt och rättvist, väljer man det senare.*
- Trowald, N. 1996: Uppfattningar om examination – en intervjustudie av högskolelärare. Delrapport nr 1 1996. Högskoleverkets skriftserie, 1997:3S

Leading the exam

Preparations

- Meet the students before exam if possible.
- Discuss procedure and presentation.
- Ask if you should know something beforehand (exam scare).
- Discuss how to ensure everybody gets a chance to talk.

Social aspects

- Students react differently to exams. The teachers should ensure that everybody gets fair conditions during the event.
- Those who are scared at exams need support so they can demonstrate what they have learned.
- In case of severe exam scare the teacher should discuss the situation with the student before the event.
- Bear in mind that the strong student most often requires less time to reveal his/hers level than does the weaker student.
- Provide hints to how questions will be asked.
- Maintain eye-contact with the students during the event.
- Pay attention to introvert students. Offer opportunities to them.

During Exam

- Write notes for each students.
- Your censor should write notes as well.
- Notes are vital for the grading discussion.
- Notes are required in case of complaints or irregularities.