

The Principles and Practices of Problem and Project Based Learning (PBL) at Aalborg University

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Outline

- Aalborg University (AAU) – brief history
- PBL principles and practice at AAU
- Research results about the Aalborg PBL Model

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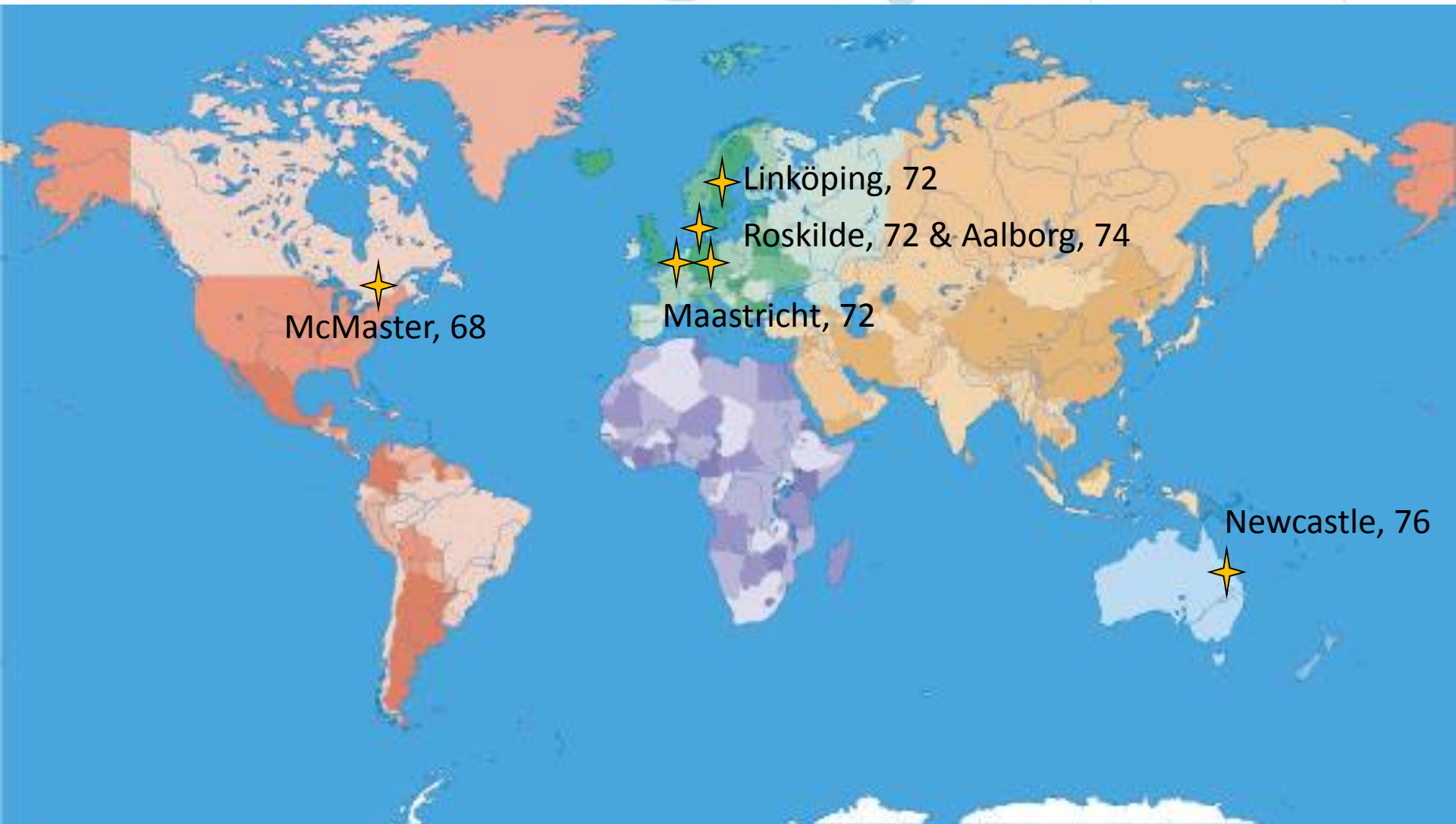
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Some PBL history

- Began in medical education at [McMaster University Medical School](#) in Canada in the 1960s
- Use of real cases about patients to teach the students to think like medical doctors already while at university
- Overall
 - Good problem solving skills
 - Metacognition
 - Collaboration
 - Motivation



The first PBL universities



**UNESCO center for PBL
på AAU 2014**

Different versions of PBL

- Project Based Learning
 - A project provides students with a challenging task that usually requires more than one person to complete
 - Students apply knowledge they acquired before and they learn new knowledge when they need it
- Problem Based Learning
 - The 'problem' could be a description of a natural phenomenon
 - Challenge the group to come up with a satisfactory explanation
- Case Based Learning
 - Present such cases to the students is in the form of a written description
 - A good case description reflects professional practice at a day-to-day level (medicine, law or business administration)



Brief history of AAU

- 1974, 3 faculties: Humanities, Social Science & Technical-Natural Science
 - The Business School Department in Aalborg (1920)
 - Aalborg Engineering College (1963)
 - The School of Social Work in Aalborg (1966)
 - The National Engineering Academy (1967)
 - Copenhagen Business School Aalborg Department (1969)
 - *M.Sc. programme in Surveying and Mapping (1768)*
- 1989, Inauguration of the NOVI Research Park
- 1995, department in Esbjerg, merging of Esbjerg Engineering College (1955)
- 1996, School of Architecture & Design
- 1997, accepted into European Consortium of Innovative Universities (ECIU)
- 2003, department in Copenhagen
- 2007, merger with the Danish Building Research Institute (1947)
- 2010, Faculty of Medicine
- 2014, UNESCO Centre for problem based learning opens

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Number of students and employees

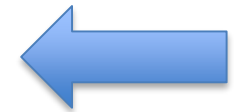
- Number of students: 20,656 (2015)
 - 4,726 HUM
 - 6,005 SOC
 - 1,720 HEALTH
 - 8,205 SCIENG
- Number of full time employees: 3,307 (2015)
 - 424 HUM
 - 456 SOC
 - 273 HEALTH
 - 1,563 SCIENG
 - 592 JOINT



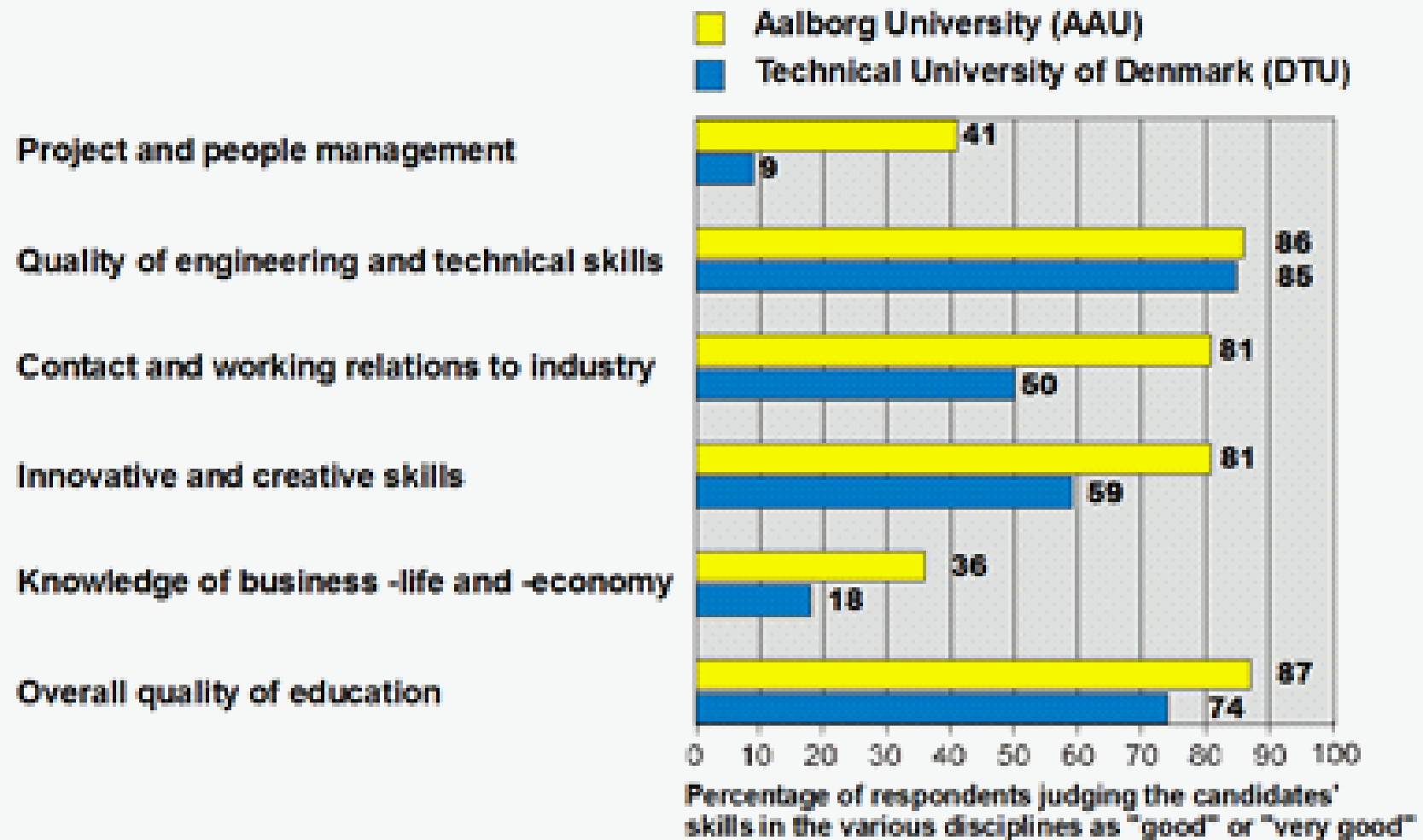
Low dropout and high completion rate

- More than half of the AAU students complete their programmes within the prescribed period of study

| mdr. | 2011 | 2013 |
|-------------------|-------------|-------------|
| KU | 18,6 | 15,4 |
| AU | 14,3 | 12,8 |
| SDU | 11,7 | 10,8 |
| RUC | 17,6 | 14,9 |
| AAU | 1,2 | 1,2 |
| CPH | 13,3 | 12,8 |
| DTU | 10,2 | 14,3 |
| ITU | 11,6 | 9,7 |
| Gennemsnit | 13,7 | 12,1 |



Employers' view of AAU graduates



Source: Nyhedsmagasinet Ingeniøren, nr 13, 2004

Core principles, #1

Problem orientation

- Problems/wonderings appropriate to the study programme serve as the basis for the learning process. The problem can both be theoretical and practical but needs to be authentic.

Project organization

- The project is a goal oriented process limited in time, usually a half semester. The project stands as both the means through which the students address the problem and the primary means by which students achieve the articulated educational objectives.

Courses supporting the project

- The students are presented to a wide range of theories and methods that might be used in the projects. The courses include a high level of student activity and are organised as a mix of lectures, workshops, laboratory work, seminars, and exercises.



Core principles, #2



Team-based approach

- Conducted in groups of 3-8 students. Last semesters often 1-2. They manage the project and support each other in achieving the goals. The collaboration includes knowledge sharing, group decision making, subject based discussions, and feedback to each other. The group may collaborate with external partners such as private companies, public institutions, or other project groups.

Exemplarity

- Exemplarity means that the learning outcome is transferable to other situations which the students might meet in their professional life.

Responsibility for own learning

- A high degree of freedom to choose the projects. Each group gets assigned a supervisor who facilitates the group. However, it is the group who has the sole responsibility for the collaboration, planning of the project, and its results, including their own learning and how to involve the supervisor.



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Teach the students about PBL!

Course: *Problem Based Learning in Science, Technology and Society*

- 5 ECTS, 1st semester, with written exam, graded pass/fail
- *Project management*
- *Methods about collaboration in the teams and with the supervisor*
- *Study methods (we do not wait until students develop problems)*
- *Scientific honesty*
- *The Aalborg PBL Model*
- *Scientific method*
- *How the subject is used in society and relates to other disciplines.*

Reflection paper: "**Process analysis**"

- Group assignment, 3-8 pages
 - Project management
 - Collaboration in the group
 - Collaboration with supervisor
 - Learning process
- After all 1st year projects (P0, P1, P2)
- Students are quizzed about these at the exam
- The quality of the process analysis are part of the grading

Learning theory underpinning the AAU PBL Model

- Knowledge must be acquired by the students in an active way. It cannot be transferred through passive reception
- Knowing and learning is about constructing useful understandings of the world. It is not about repeating explicit knowledge
- Learning and knowledge construction is facilitated by collaboration (dialogue, critical reviews, mutual support)
- Learning is about producing new understandings, solutions, knowledge and methods.
- Some names: Brunner, Dewey, Kilpatrick, Piaget, Vygotski, Kolb, ...



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Learning takes place through the active behavior of the student: it is what *he* does that he learns, not what the teacher does.

Ralph W. Tyler (1949)

Because
You never know for sure
WHAT they learn
WHEN they learn
HOW they learn
WHERE they learn
WHY they learn



Connection between courses and project

- Every semester has a 'thematic framework' presented by the supervisors
- Courses are developed and taught with reference to the theme of the semester or specific external requirements for the study programme
- Students form group themselves (usually)



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Typical components of project work

- The students will have to:
 - Find a problem and case, identify methods on how to investigate the problem (purely theoretical, through interviews, video-observation and analysis, questionnaires, ethnographic observation etc.)
 - Discuss their methods, and why they investigate their problem in a particular manner
 - Identify theories or theoretical concepts that will help them understand their problem
 - (Often) conduct empirical investigations, that are analysed
- All this is done in collaboration with the supervisor, who helps the students to identify relevant methods, theories etc.
- Progression in help



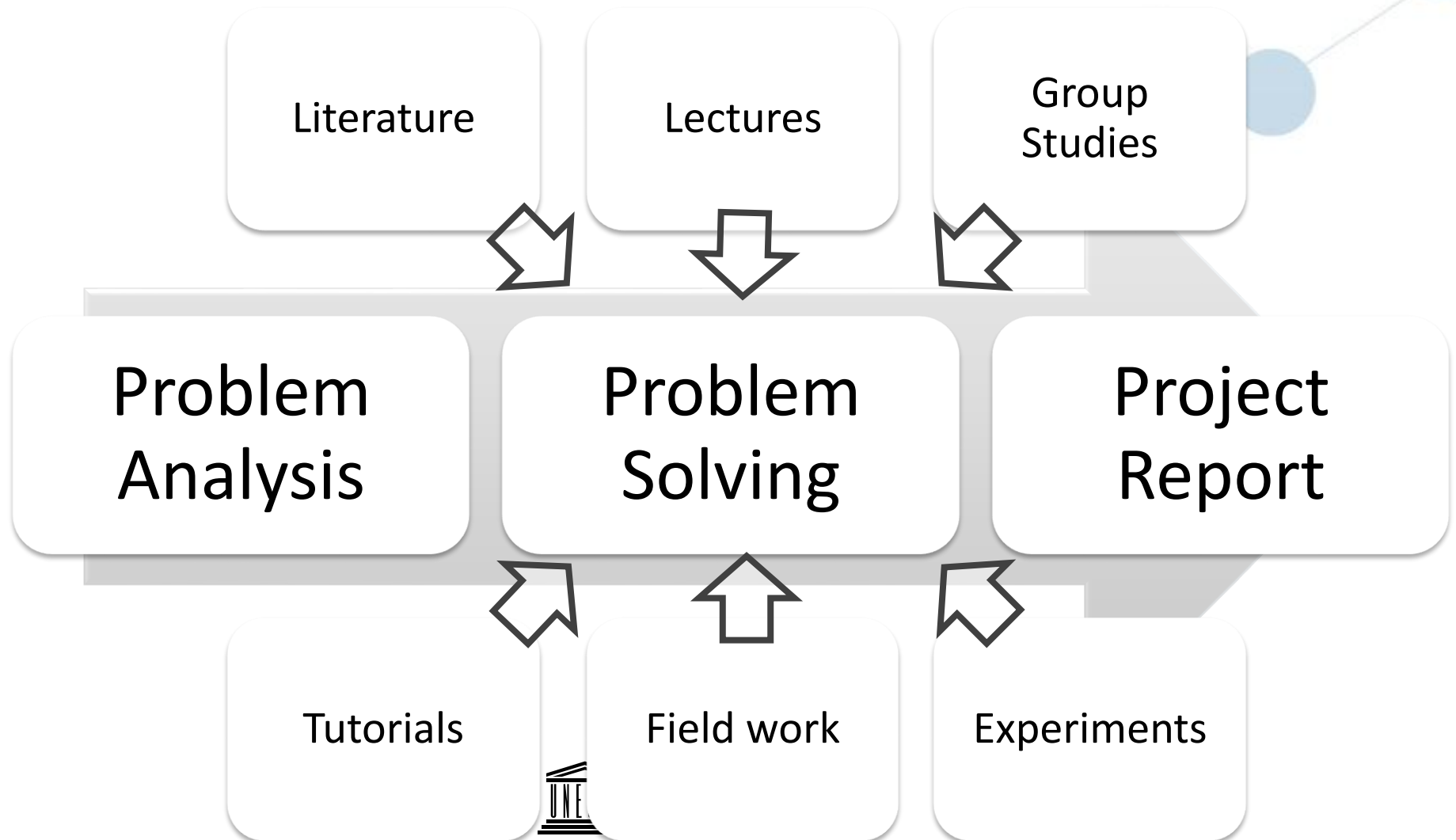
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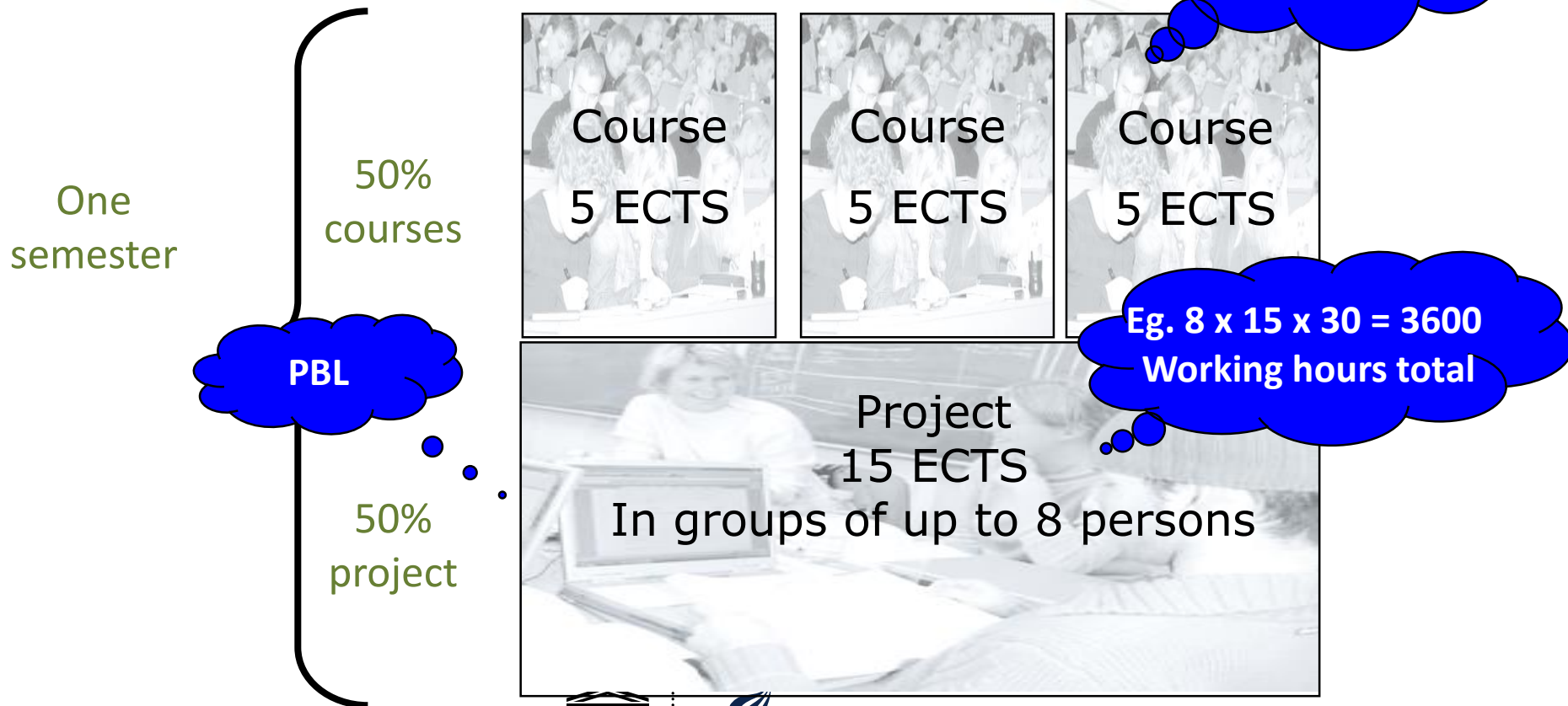
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Problem Based Learning – the Process



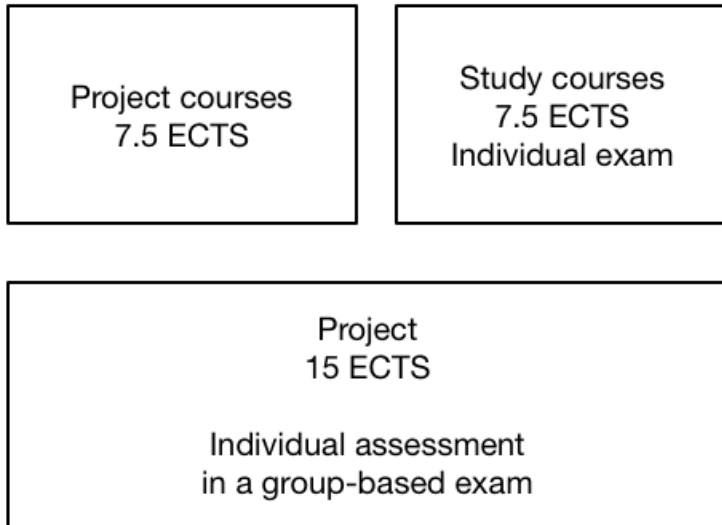
Structure AAU PBL Model

- since 2010



Before 2010 and reasons for change

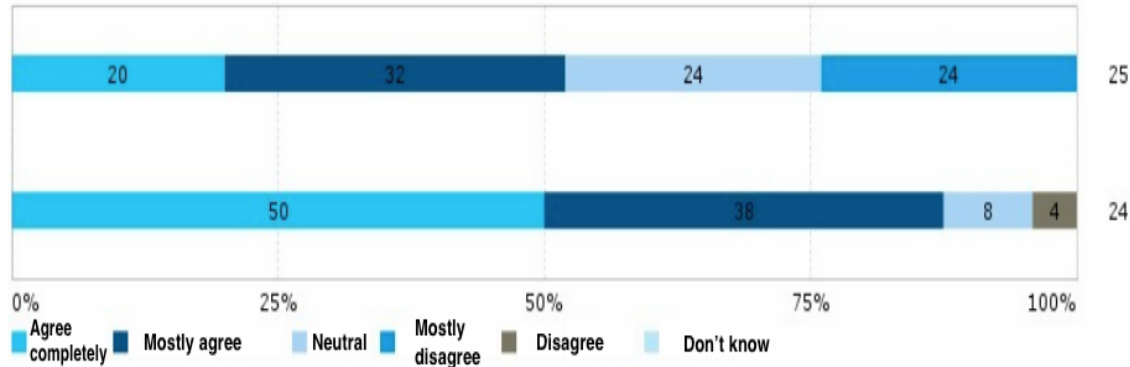
The original Aalborg PBL model



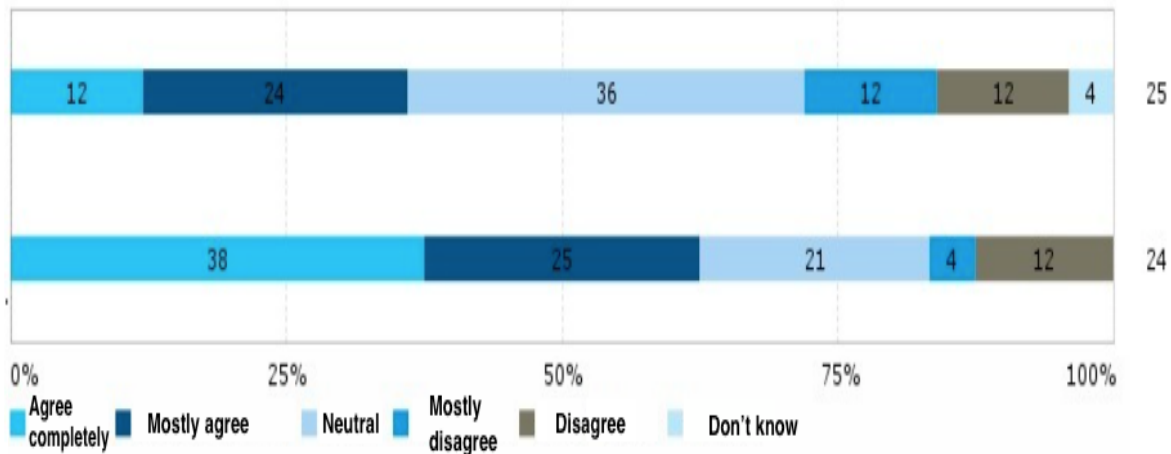
- Problems with the transfer of credits from AAU to other universities as the learning outcomes and credit points were distributed between courses and projects
- Many courses of different size
- The Bologna process required a new grading scale with learning outcomes
- The assessment of the project unit courses became problematic
- Many students did not really follow the project unit courses besides what was needed in the projects

Asking some 10th semester students

- Question: Some (project unit) courses were not used in the projects? Before (top), now (below). ($z = -2.49$; $p = 0.013$).



- Question: Do (single subject) course exams receive highest priority towards the end of the semester? Before (top), now (below). ($z = -1.85$; $p = 0.064$).



Relation courses and project work

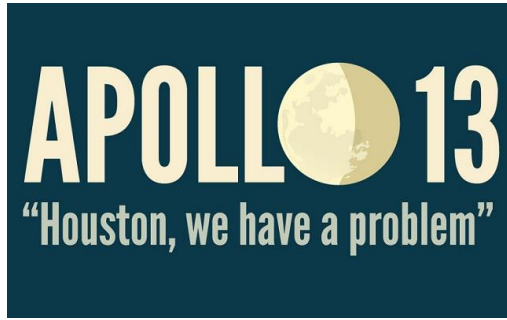


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What is a problem?



- **Unsatisfactory situation (minus/plus)**

- Eg. oxygen depletion in water bodies, noise from wind turbines, newborn babies with too low weight, Robot vacuum cleaner, more effective pesticides, route optimization

- **Consequences unknown (unknown)**

- Eg. effect of airborne nano-particles, radiation from cell phones, maximum flow in a given network

I.e. – not necessarily a "problem"

How do we assess PBL projects at AAU?

- All exams in Denmark
 - Use either internal or external examiner (2/3 vs. 1/3 at uni)
 - Only what happens at the exam day counts towards the grade
- AAU courses assessed in individual exams (oral or written)
- AAU projects assessed in group exams
 - Each student received an individual grade
 - In 2006 the government banned all group exams

www.sjsu.edu



Back to group exams

- Research 2006-07 on AAU group assessment method showed:
 - students and supervisors preferred the group project exams
 - individual exams were seen to be in contradiction to the intentions behind PBL (lack of alignment with the team based and collaborative teaching and learning approach)
 - In assessment of project work, students need to get response to both the **content** and the learning **process**
- In 2012, a new government again allowed the group exams
- From the January 2013, the group project exams re-installed
- At the Faculty of Engineering and Science it is now a requirement that the group exam also has an individual phase.

”Praise and honors to
the non participants”



The structure

Students present the project (1 hour)

break

1. A general question-based discussion with the group (2 hours)
2. Specific questions for each student (1 hour)
(some breaks)

break

The examiners agree on the grades

Announcement and justification of grades

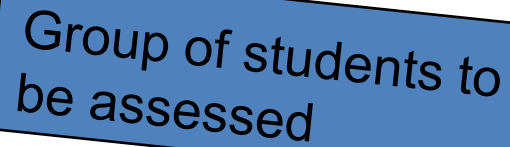
The physical setup



Supervisors and examiners



Blackboard

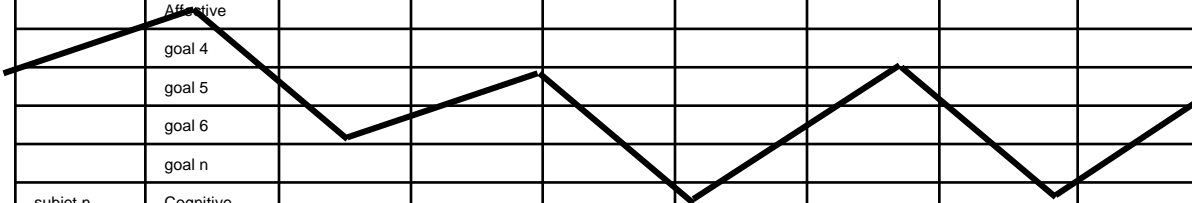


Group of students to be assessed

ASSESSMENT PLAN

| | | student 1 | student 2 | student 3 | student 4 | student 5 | student 6 | student 7 |
|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| subject 1 | Cognitive | 😊 | 😞😞 | 😊 | 😞 | 😞😊 | 😞 | 😊 |
| | goal 1 | 😊 | 😞 | 😞 | 😊 | 😞😞 | 😊 | 😞 |
| | goal 2 | | | | | | | |
| | goal 3 | | | | | | | |
| | Affective | | | | | | | |
| | goal 4 | | | | | | | |
| subject 2 | Goal 5 | | | | | | | |
| | goal 6 | | | | | | | |
| | Cognitive | | | | | | | |
| | goal 1 | | | | | | | |
| | goal 2 | | | | | | | |
| | goal 3 | | | | | | | |
| subject n | Affective | | | | | | | |
| | goal 4 | | | | | | | |
| | goal 5 | | | | | | | |
| | goal 6 | | | | | | | |
| | goal n | | | | | | | |
| | Cognitive | | | | | | | |
| subject n | goal 1 | | | | | | | |
| | goal 2 | | | | | | | |
| | goal 3 | | | | | | | |
| | goal n | | | | | | | |
| | Affective | | | | | | | |
| subject n | goal n+1 | | | | | | | |
| | goal n+2 | | | | | | | |
| | goal | | | | | | | |

etc
etc
etc.



Hours later

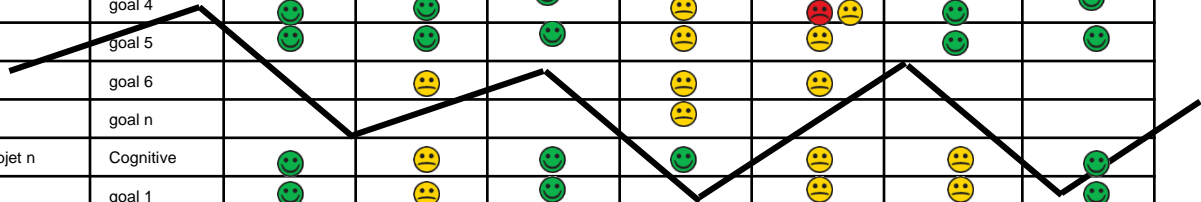


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ASSESSMENT PLAN

| | | student 1 | student 2 | student 3 | student 4 | student 5 | student 6 | student 7 |
|-----------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| subject 1 | Cognitive | 😊 | 😞 😟 | 😊 | 😟 | 😞 😊 | 😊 | 😊 |
| | goal 1 | 😊 | 😞 | 😊 | 😟 | 😟 | 😊 | 😊 |
| | goal 2 | 😊 | 😟 | 😟 | 😊 | 😞 😟 | 😟 | 😟 |
| | goal 3 | | | | | | | |
| | Affective | 😟 | 😟 | 😊 | 😟 | 😞 😊 | 😊 | 😟 |
| | goal 4 | 😊 😊 | 😞 | 😊 | 😟 | 😞 😊 | 😊 | 😊 |
| | Goal 5 | 😊 | 😟 | 😊 | 😟 | 😟 | 😊 | 😊 |
| | goal 6 | | | | | | | |
| subject 2 | Cognitive | 😊 | 😟 | 😊 😊 | 😟 | 😟 | 😟 | 😟 |
| | goal 1 | 😊 | 😟 | 😊 | 😊 | 😞 | 😞 😊 | 😊 |
| | goal 2 | 😊 | 😟 | 😊 | 😟 | | 😊 | 😊 |
| | goal 3 | | | | | | | |
| | Affective | 😊 | 😊 | 😊 | 😟 | 😞 | 😊 | 😊 |
| | goal 4 | 😊 | 😊 | 😊 | 😟 | 😞 😟 | 😊 | 😊 |
| | goal 5 | 😊 | 😊 | 😊 | 😟 | 😟 😟 | 😊 | 😊 |
| | goal 6 | | 😟 | | 😟 | 😟 | | |
| | goal n | | | | 😟 | | | |
| subject n | Cognitive | 😊 | 😟 | 😊 | 😊 | 😟 | 😟 | 😊 |
| | goal 1 | 😊 | 😟 | 😊 | | 😟 | 😟 | 😊 |
| | goal 2 | 😊 | 😟 | 😊 | 😟 | 😟 | 😟 | 😊 |
| | goal 3 | 😟 | 😊 😟 | 😟 😊 | 😟 | 😟 | 😊 | 😊 |
| | goal n | | | | | | | |
| | Affective | 😊 😊 😊 | 😊 😊 😟 | 😊 😊 😊 | 😟 😊 😊 | 😞 😟 😟 | 😊 😊 😟 | 😊 😊 😟 |
| | goal n+1 | | | | | | | |
| | goal n+2 | | | | | | | |
| | goal | | | | | | | |



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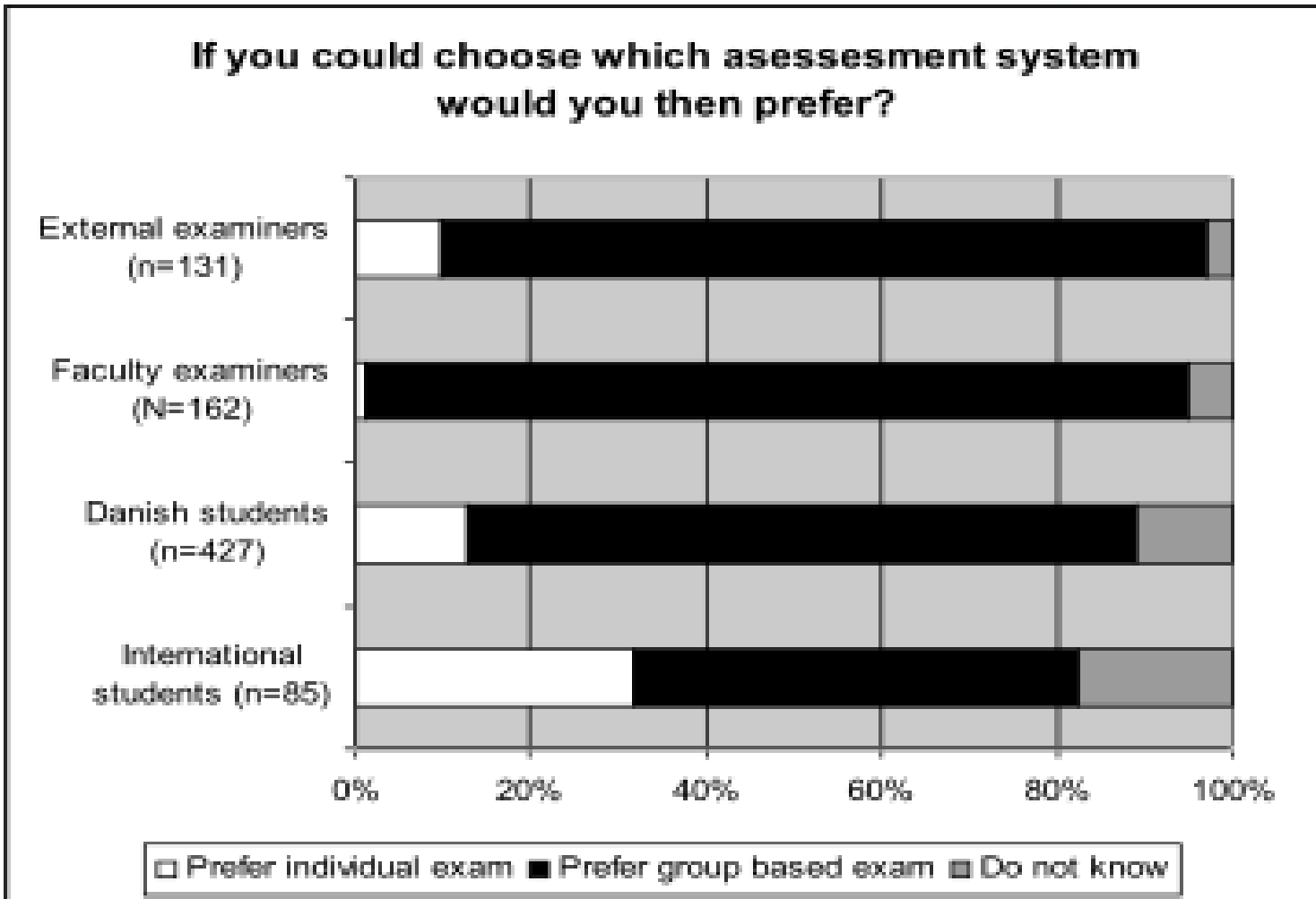
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Why (why not) group exams?

- The constructive alignment theory underpins studies stating that an **upcoming assessment** is a central factor in the students' motivation and learning
- In a PBL curriculum - the assessment method should be **aligned** with the team based and collaborative teaching method and the intended learning outcomes on process competencies
- Willis et al. (2002) found that when assessing PBL project work, it is important that the students get **response to not only the content** but also the learning process; i.e. the process competencies
- Romberg (1995) discusses the advantages of group assessment and lists the following competencies: “**communication, production, cooperation, arguing, negotiating**” (p. 165).



The preferences, 2006



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Study, 2013

- Some of the questions (Kolmos & Holgaard, 2007) were repeated
 - Response rate of 25%
- February 2013, questionnaires to all 1,358 first-year engineering and science students and all 115 supervisors of these students
 - Response rate: 64% for supervisors and 36% for students
 - Option of personal comments - some transformed into questions
- June 2013, 4,588 FES students, (25% response rate)
 - Questionnaire of 20 overall questions (106 actual questions)



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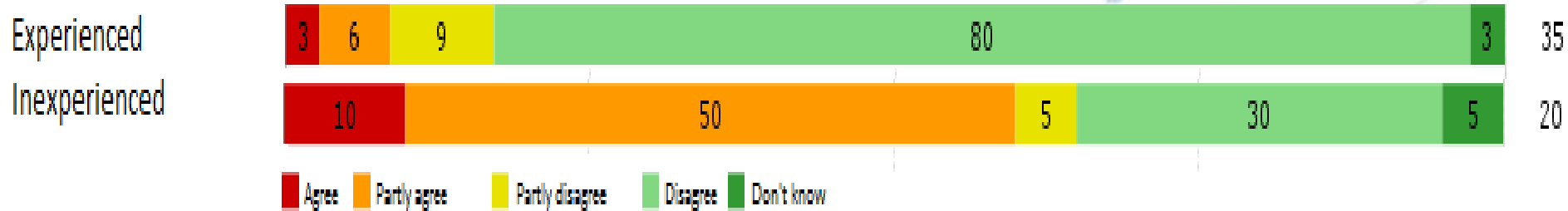


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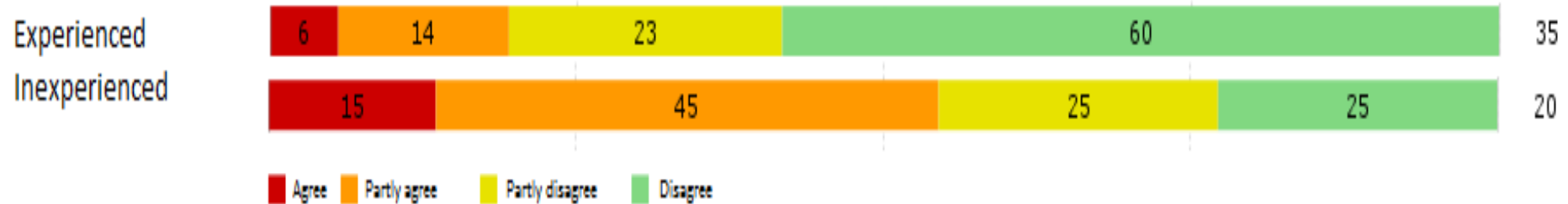
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Supervisors, 2013

- 27% of all supervisors **preferred to have an individual exam**
 - Experienced vs. inexperienced: 9% vs. 60% agreed ($p < .001$)



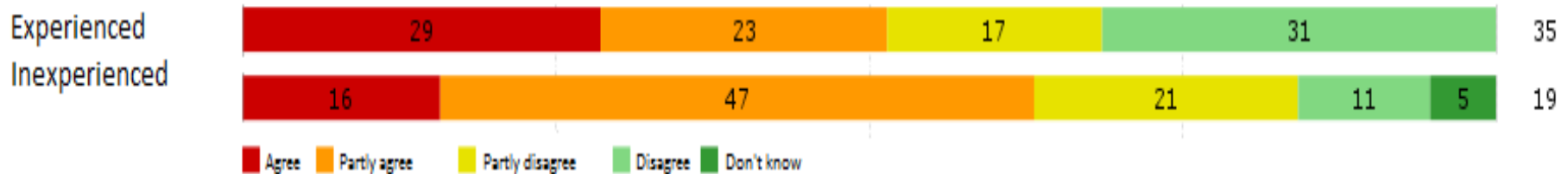
- 31% found it **difficult to perform an individual assessment**
 - A minority – BUT – a too high number



- Experienced vs. inexperienced: 20% vs. 60% agreed ($p = .006$)

Supervisors: Individual part in the group exam, 2013

- The question: *“The individual and the group based part of the exam test important factors that each are important for a correct assessment.”*



- 49% of all supervisors agreed (not seen in figure)
- Not a significant difference between the experienced and inexperienced supervisors ($p = .289$)

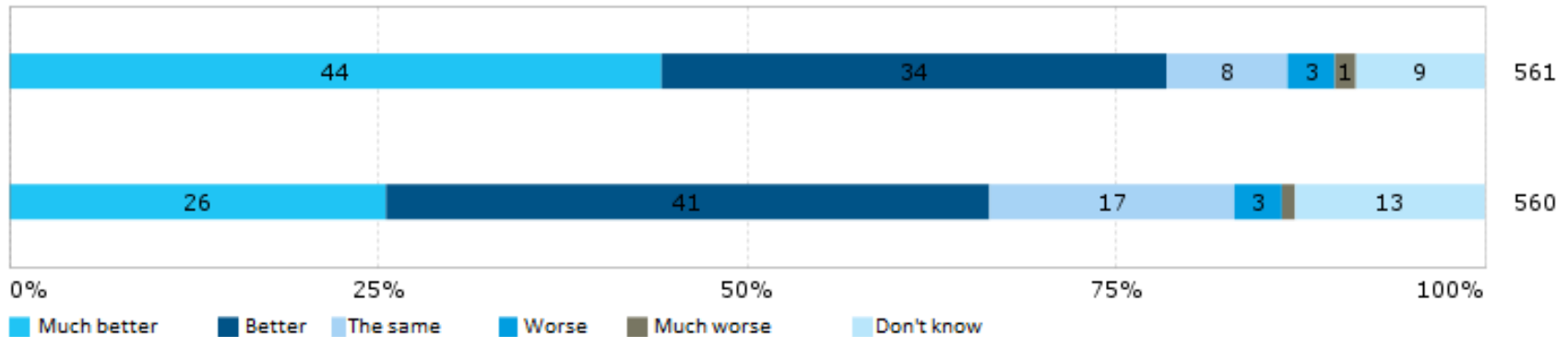
Students: Group vs. Individual on PBL, summer 2013

Did the group exam give a better/worse opportunity to be assessed on:

(1) 'ability to complement others' answers' (PBL competence)

(2) 'ability to participate in group work' (PBL competence)

- Group exam (much) better (78% and 67%)

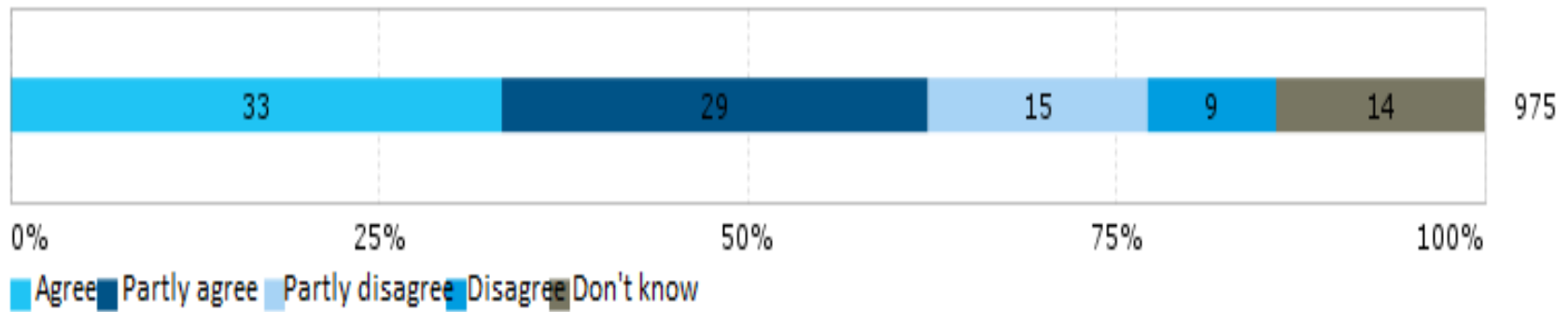


Top (q1), bottom (q2).

Students, new question, summer 2013

“The group discussion during the group exam does not show a group work but instead the individual student’s initiative answering questions”

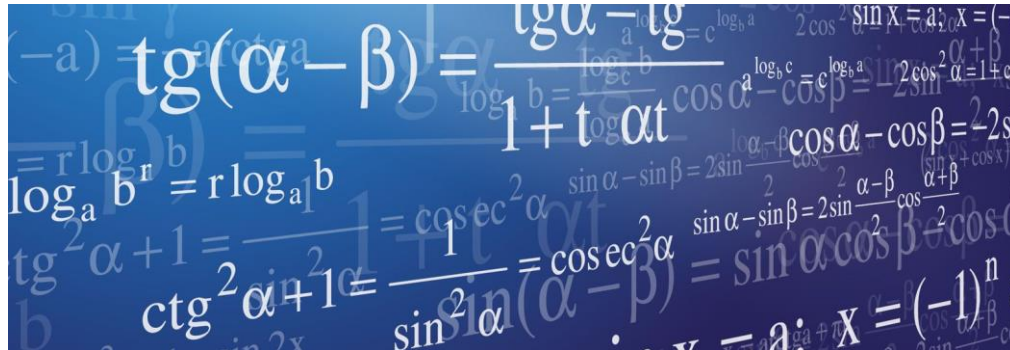
- 62% agree or partly agree



- Contradiction to previous?
- The group exam is not perfect!

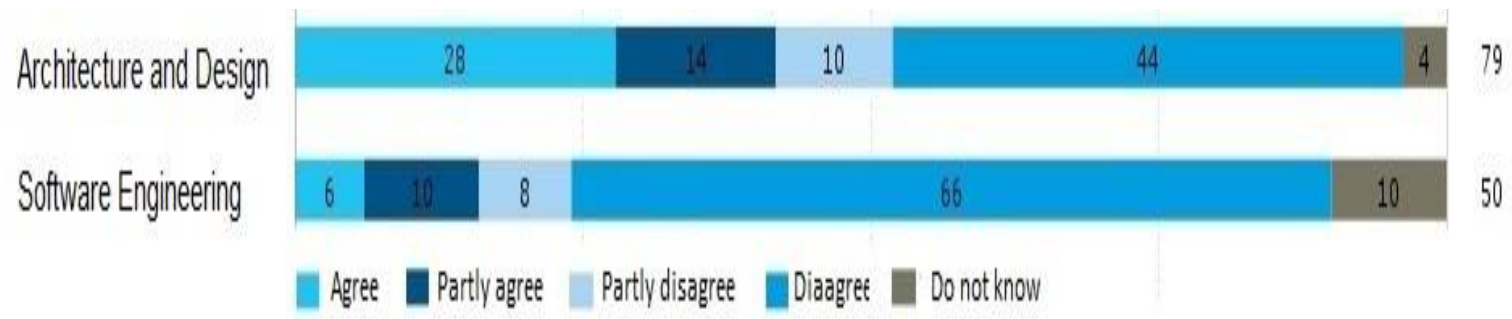
Comments from three otherwise rather positive mathematics students

- Female 2nd semester student finds it very important that students know that they **should indicate when they want to answer**, and not simply answer.
- Male 4th semester student: “I think the old [individual] type of exam was better. In this exam one did not risk being **interrupted by a fellow student**. I see more negative sides with the new [group] exam than positive”.
- Male 8th semester student: “It is odd for the strong students: **Is he to let the weaker group members answer the easy questions and run the risk that it appears to the examiners that he was unable to answer himself?**”.



Engineers are not alike

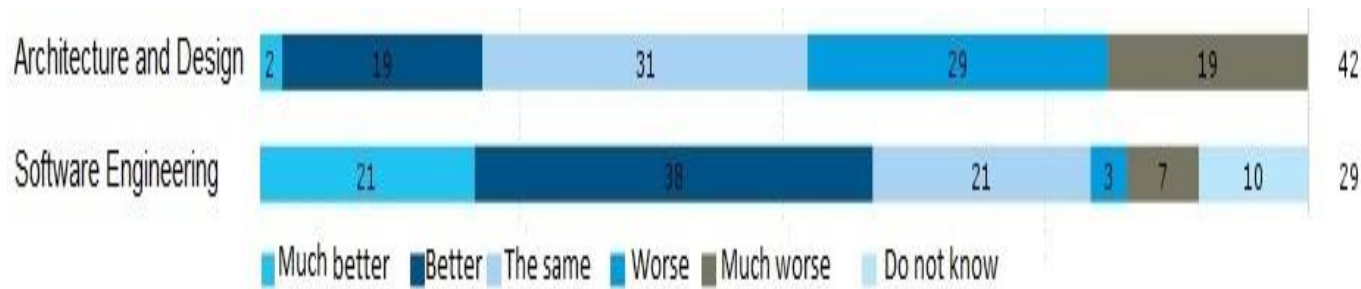
- Compare engineering students from **Architecture and Design** with students from **Software Engineering**, summer 2013
- Answers to the question: “I would prefer to have an individual project exam”, $p = .004$



- Both student groups are positive, but not equally positive

Old and new project exam

- Answers to the question: “If you compare the new group project exam with the former individual project exam, to what extent to you experience the opportunity to get a fair grade?”, $p < 0.001$



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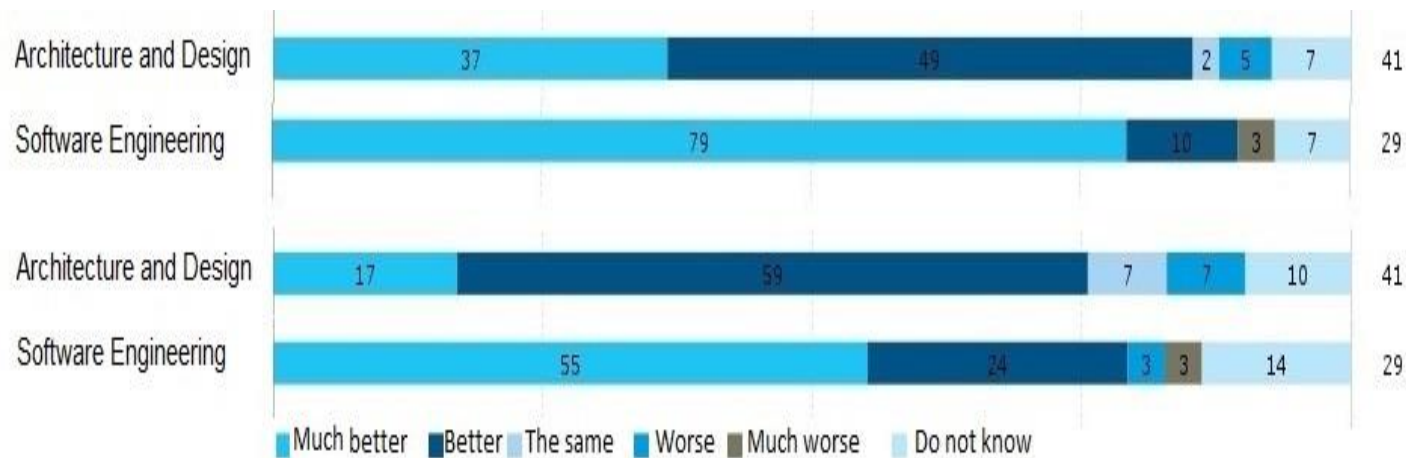


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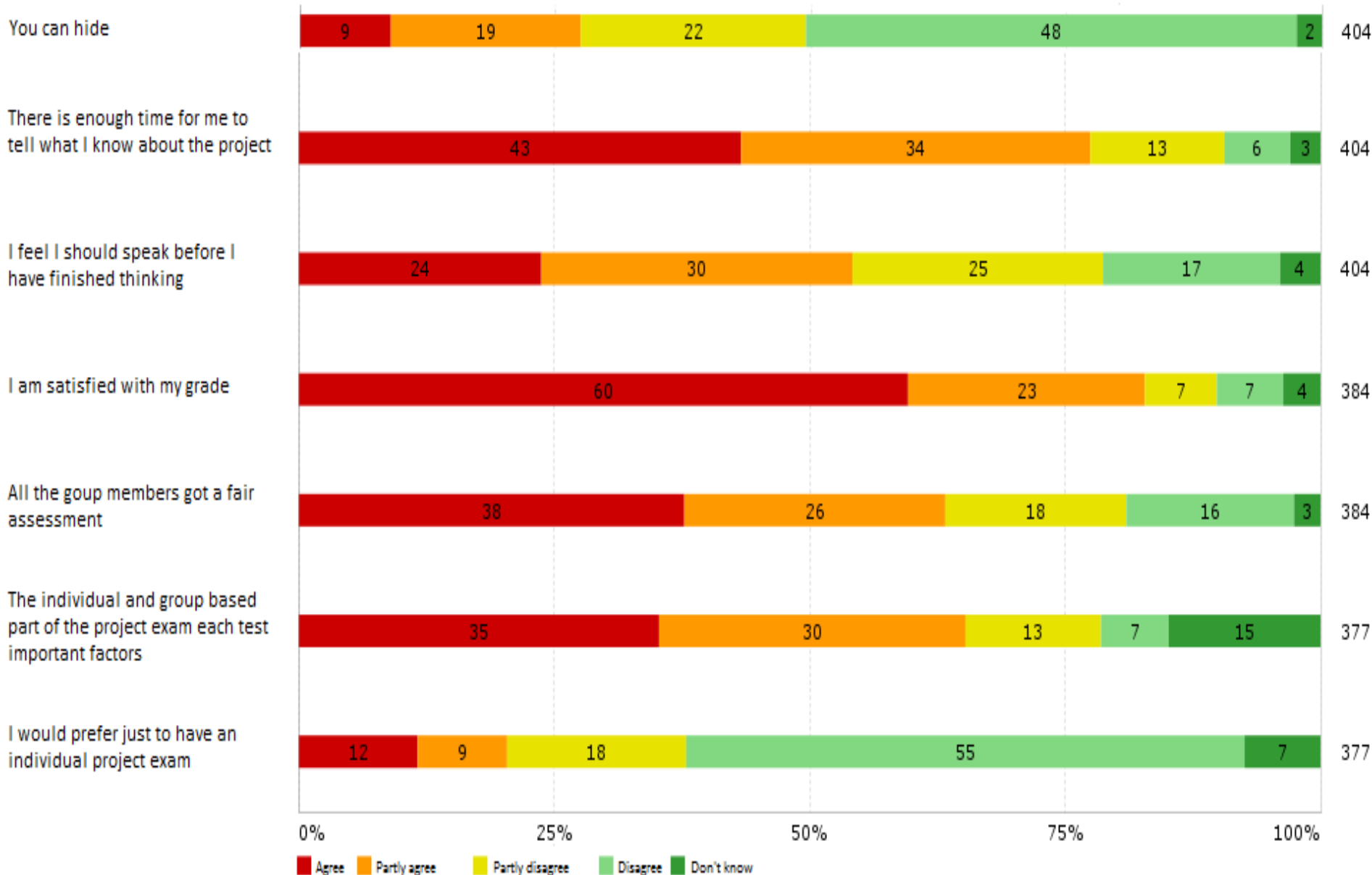
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Compare some PBL-competencies

- Answers to the two questions: “If you compare the new group project exam with the former individual project exam, to what extent to you experience the ‘opportunity to complement and expand on others’ answers?’ (top) ... ‘show ability to participate in a group work?’ (bottom)”, $p > 0.6$ in both cases



The students, spring 2013



Conclusion

- AAU PBL model is one PBL model. It can be done in many other ways
- Small steps, research, adjust, then further development.
- Important to train the students (and staff) in PBL
 - Including assessing them
- Both students and supervisors appear to prefer the group exam compared to a purely individual exam, but different student groups' answered varied and various problems were experienced
- The individual part during the group based exam is judged to be valuable
- Supervisors need to be properly trained to perform such assessment. Otherwise alignment is only “on paper” – not in practice



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In theory there is no difference
between theory and practice.
In practice there is.

---Yogi Berra



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Thank you very much



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