



Effectiveness of problem-based learning

[scored goals and how to play a better second half]

The National Academies, National Research Council, Board on
Science Education

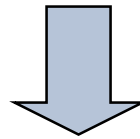
Workshop on linking evidence and promising practices in STEM
undergraduate education october 13, 2008 –Washington DC

Prof. dr. David Gijbels



Main goals of current programmes (what society needs)

- Effective problem solvers
- Graduates with domain specific and general knowledge and skills
- Self-responsible learners (lifelong learners)
- Teamplayers



What kind of learning-environments can lead to the acquisition of these goals?



New learning environments

-such as problem-based Learning-

claim to have the potential to meet today's educational needs...

Effects of new learning environments

Taking students' perceptions, approaches to learning and assessment into account

Studies in problem-based learning

David Gijbels



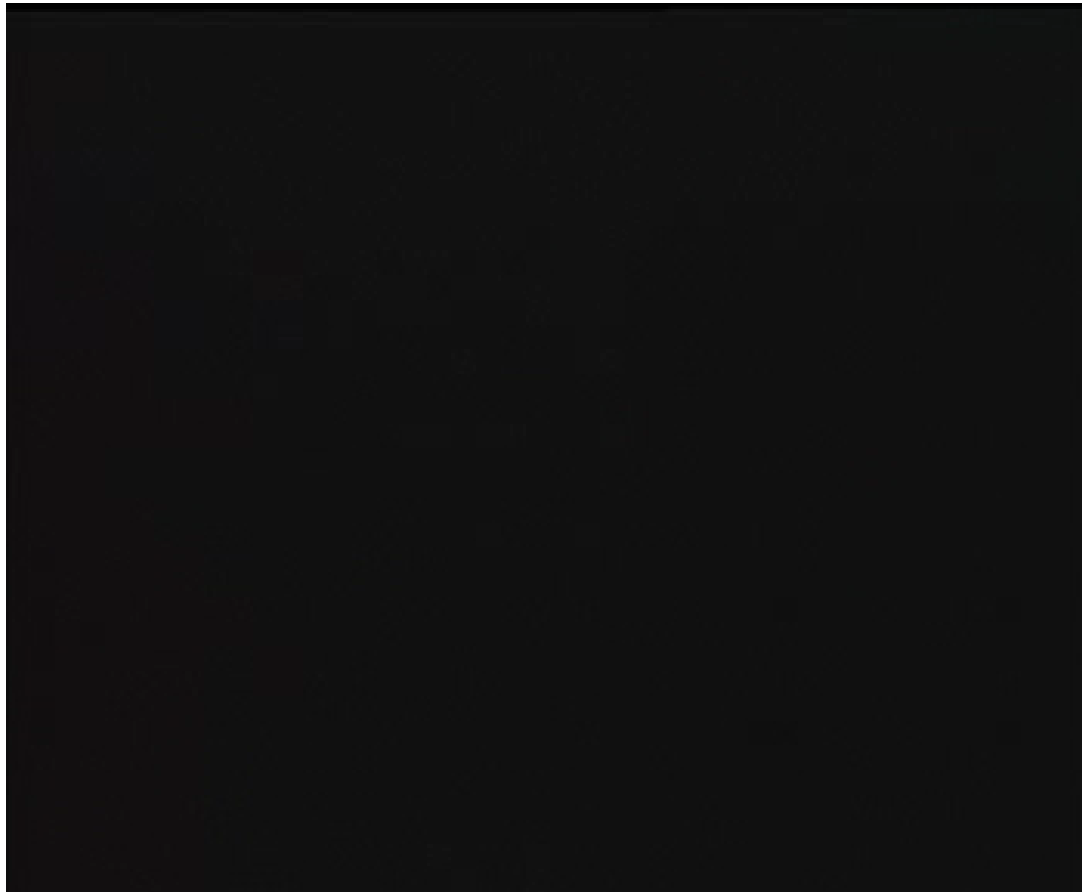
This lecture

- What is Problem-Based Learning?
- Are its claims justified?
- Are the potentials reached?
- Opportunities for Improvement?



What is Problem-based learning?

An example from the Maastricht Medical School





PBL in a nutshell

problem



small group discussion

- * description of phenomena
- * prepared by a team of teachers
- * directs learning activities

- * what do we already know about the problem?
- * what do we still need to know about the problem?



exchange of information

- * did we acquire a better understanding of the processes involved in the problem?



self study

- * learning resources
- * integration of knowledge from different disciplines





Roles in a tutorial group

- **Tutor:**
 - staff member
- **Discussion leader:**
 - every meeting another student
- **Secretary:**
 - every meeting another student





There are as many variations as
there are implementations of
PBL...



PBL: a core model (Barrows, 1996)

1. Learning is student-centered
2. Small groups
3. Tutor as a facilitator or guide
4. Problems first
5. The problem is the tool to achieve knowledge *and* problem-solving skills
6. Self-directed learning



First half

Effects of problem-
based learning:
review

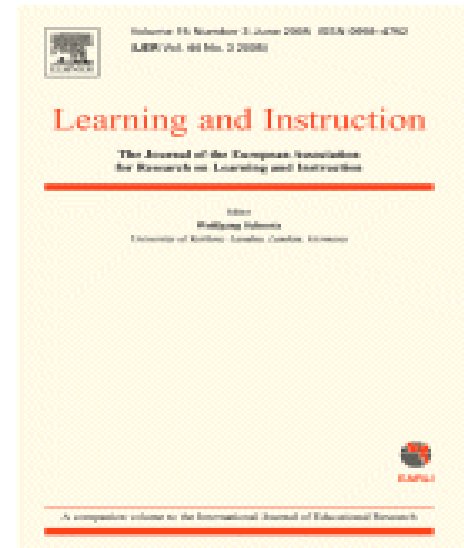
(goals scored up till now)





A review study: research questions

1. Main effects of PBL
 - Knowledge
 - Application of knowledge
2. Potential moderators
 - Design aspects
 - Expertise-level of students
 - Retention period
 - Type of assessment method





just as the definition of PBL is ambiguous, the definition of what constitutes a **conventional lecture-based program** is also ambiguous. For the most part, conventional instruction is marked by **large group lectures** and **instructor-provided learning objectives and assignments** (Albanese & Mitchell, 1993).



Method

- **Criteria for inclusion in the statistical meta-analysis:**
 - Empirical study
 - Comparing PBL with more conventional lecture-based education
 - Measuring knowledge & knowledge application
 - Studies in higher education (bachelors or masters)
 - Real-life classrooms
- **Synthesizing research:**
 - Vote counts
 - (un)weighted effect sizes (Glass' d)



Main results

1. Knowledge:

- A tendency to negative results
- ES= -0.223

2. Application of knowledge:

- Robust positive effect
- ES= +0.460



Moderator results

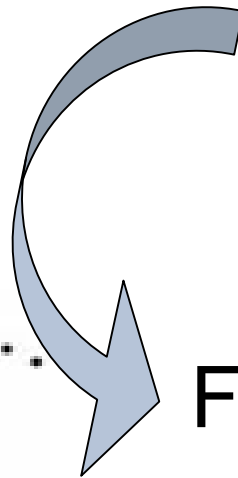
- **Design aspects**
 - Negative effect of PBL on knowledge
 - decreases when quality of research method increases
 - Is more negative in curriculumwide implementation compared to single courses
- **Expertise-level of students**
 - Always positive effect of PBL on knowledge application
 - Negative effect of PBL on knowledge decreases more or less after the first two years
- **Retention period**
 - Slightly less knowledge in PBL immediately after the course but more on the long term



Moderator results

- Type of assessment method

- Suggestion: the more an instrument is capable of evaluating the students' knowledge application, the larger the ascertained effect of PBL



Further elaborated in a new study

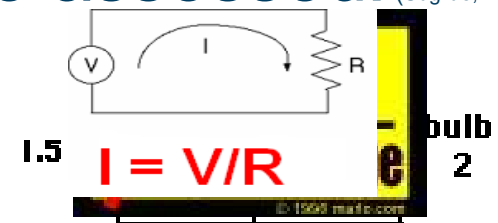


Effects of PBL from the angle of assessment

3 levels in the knowledge structure to be assessed: (Sugrue, 1995)

1. Understanding of **concepts**

- e.g. Voltage and resistance are physical **concepts**



2. Understanding of **principles** that link concepts

- e.g. the law of Ohm is a **principle** that prescribes current as a function of voltage and resistance in an electrical circuit

3. Linking concepts and principles to conditions and procedures for **application**

- e.g. The organised level is applied under the appropriate circumstances, for instance to connect up an electrical circuit with bulbs and batteries in such a way that a certain level of current flows through it.



Effects of PBL from the angle of assessment

- Coding the studies:
 - 31 studies present data on concepts
 - 17 studies present data on principles
 - 8 studies report data on application



Results

- No effects of PBL on concepts
 - ES = 0.068
- Statistical significant and positive effect of PBL on principles
 - ES = 0.795
- Small but not statistical significant effect of PBL on application
 - ES = 0.339



Are the potentials reached?

- The positive effects of PBL are **NOT** large when the assessments are more capable of assessing application
- Most positive effects when principles are assessed (second level of knowledge structure)
- More effort or needed for the '3th level' to educate better problem-solvers in:
 - New learning environments such as PBL
 - Its assessment



How to play a better second half?





Potentials of pbl are (not) reached because ...

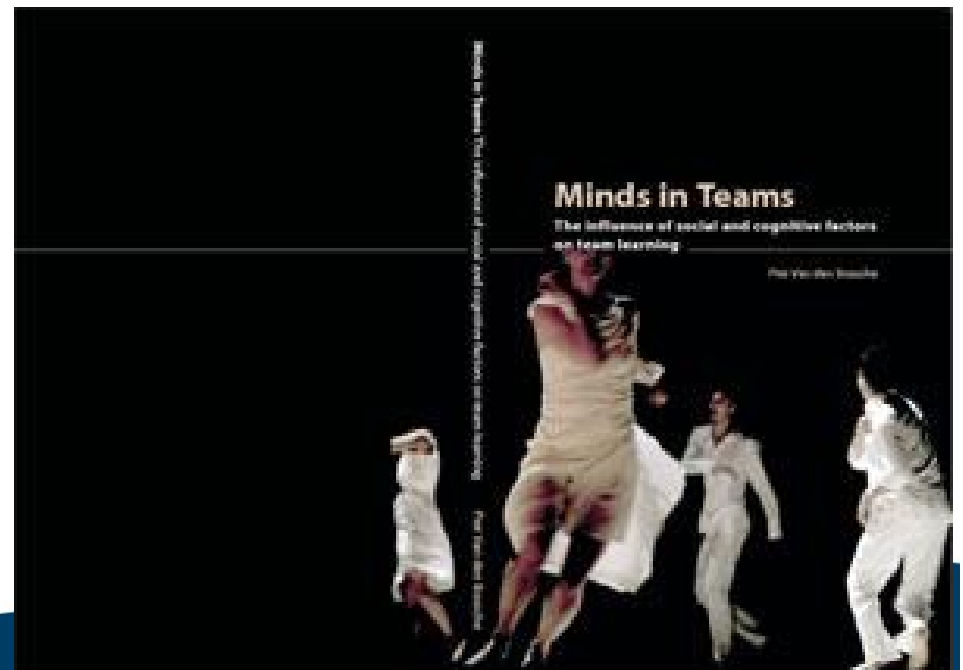
- Opportunities & threats for pbl
 - à ASSESSMENT in PBL...





Task environment


- **Interdependence is lacking**
 - Joint tasks à shared cognition
- **Groups are too big**
 - Coordination problems





Social demands

- **Fostering a beneficial interpersonal context**
(e.g., psychological safety)
 - No (or little) attention is paid to group developmental processes



Thank you for your
attention
Questions?

Sources:

- Dochy, F., Segers, M., Van den Bossche, P., & Gijbels, D. (2003). Effects of Problem-based Learning: A Meta-analysis. *Learning and Instruction*, 5 (13), 533-568.
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