

Problem-based learning

The search for a better learning and teaching experience in biology



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- **The main talking point at PBL conferences these days:** How and why to apply PBL to non-medical subjects based around the medical experience.
- **The main conclusions:** PBL can be applied to any subject but may need modification to local need.
- **Meaning?:** Medical School models may not be appropriate to all subjects and needs.
- **Specifically:** The open-ended nature of problems in medicine.

Why consider PBL? – What were our goals

- **Get students interested in the subject.**

Suffers demise within a month of arriving here and students switch into hurdle/exam passing mode.

- **Get students back to reading books and asking questions.**

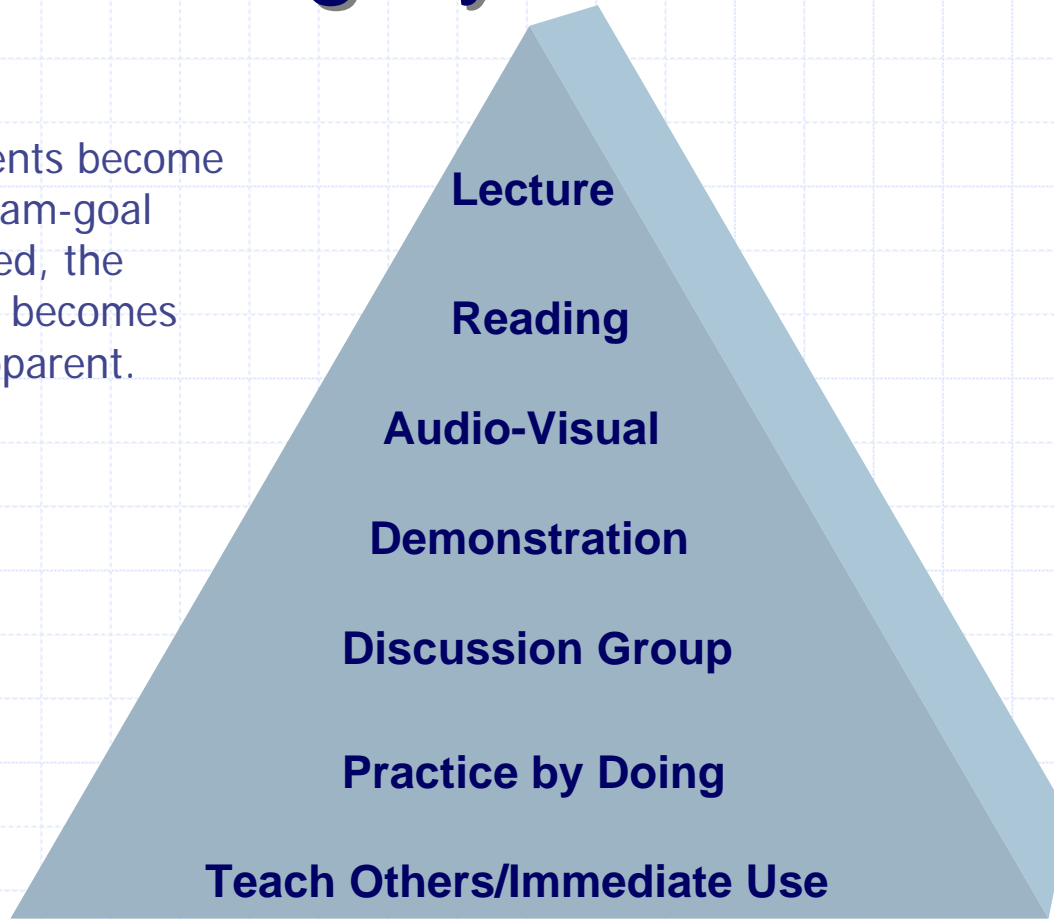
Students are almost entirely dependent on lecture handouts and complain if exams cover other material. QAA also looks for good support material apparently reinforcing this.

- **Get students to see relevance of material taught.**

Lack of context and too much fragmentation. There is no real mechanism to bring different threads of course together except in final year project.

The Learning Pyramid

As students become more exam-goal orientated, the pyramid becomes more apparent.



Average Retention Rate

5%

10%

20%

30%

50%

75%

80%

= PBL

The issues for introduction of PBL from the medical model into a lecture-based course in cell biology at UMIST:

- **How** (access to expertise): **Conference, seminar (medical student experience)** – Big bang approach.
- **Problem design** (key skill in PBL): **Tailor to learning objectives** – No examples available.
- **Costs** (money + time + resources): **Small groups** – lack of academic interest.
- **Facilitation** (role of the tutor): **Seemed to be passive** – student led open-ended (“real life”) problems.
- **Assessment:** **Problem area** – standard exam format.

1997 Introduction of PBL as part of first year core module.

Success was measured as:

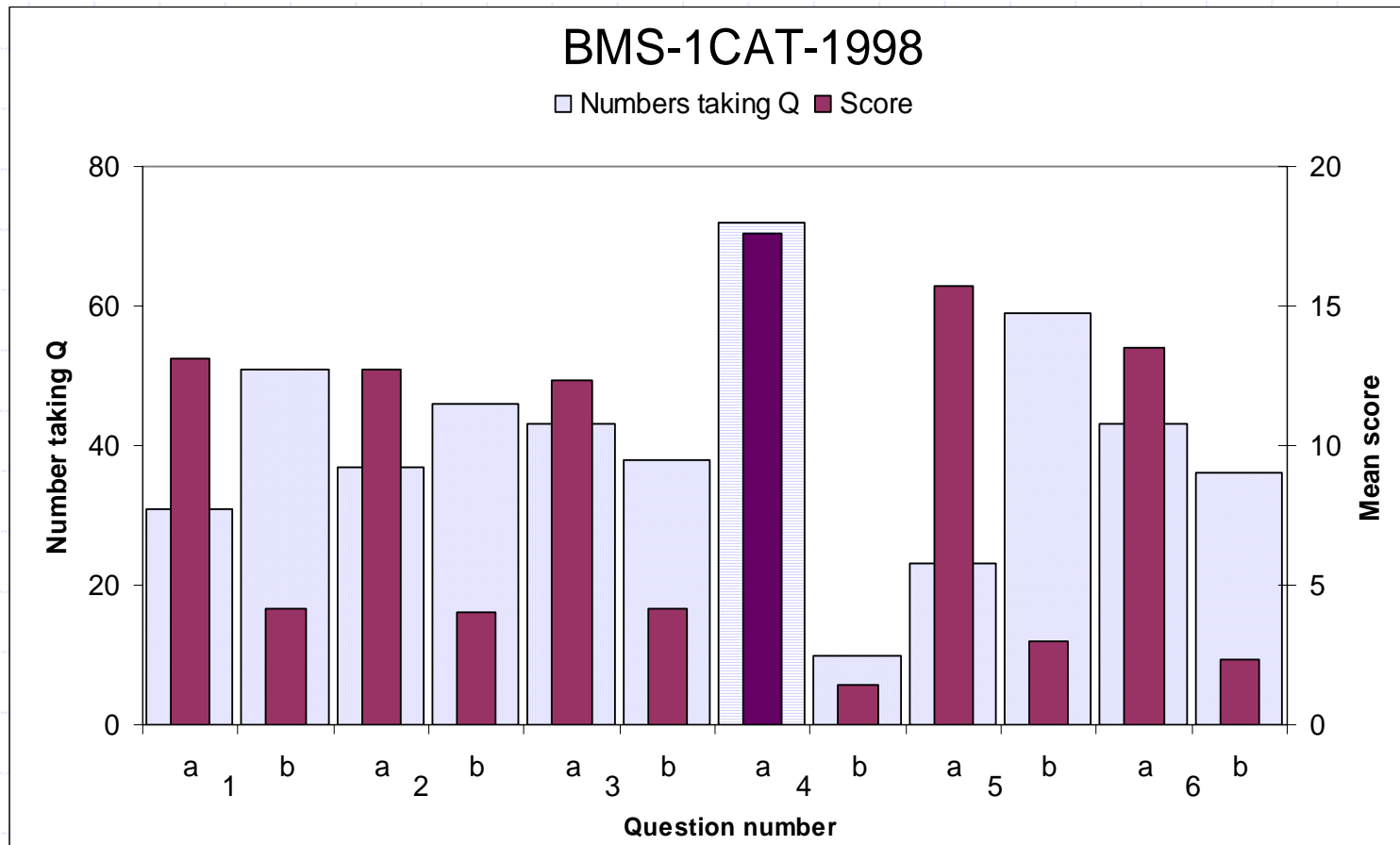
- Significant **improvement in pass rates** of module.
- Significantly **better exam marks** for question(s) related to PBL then to lecture-based questions.
- Almost all students attempted the PBL question compared to around 50% for any other question (**subject confidence and deeper knowledge**).

Also in transferable skills (**noted in other modules*):

- Group work
- Problem solving
- Presentations
- Group reports

Seems to be a great success!

Results of standard exam – Q4a on PBL topic



2000-02 Extension of PBL into second and third year PBL-only modules.

Aims:

- Synoptic.
- Develop further abilities to handle unfamiliar subject matter.
- Develop deeper knowledge on specific topics.
- Develop variety of presentation skills:
 - PowerPoint
 - Posters
 - Debate
 - OHP & blackboard skills
 - Written individual and group reports
 - Web page design

Difference between first year and second year aims:

Change from **breadth** to **depth** of knowledge and understanding.

The Problem:

We found *excellent breadth* in student work but a worrying *lack of depth*.

We had two groups of 7 and 8 students.

Group 1 had an interactive facilitator

Group 2 had a passive facilitator who occasionally asked questions.

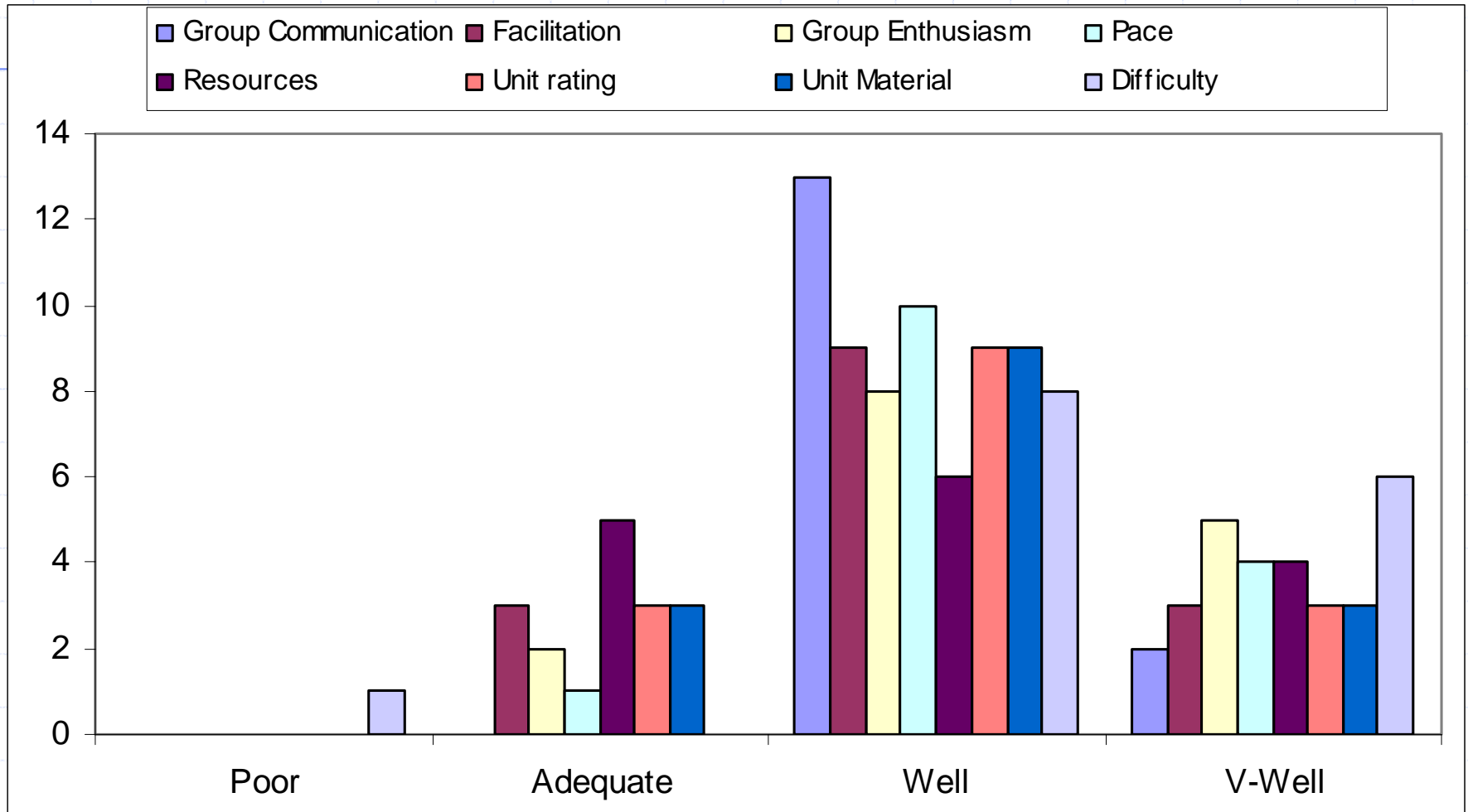
Groups were mixed halfway through module of 6 problems.

At completion of module a feedback session was held with all students.

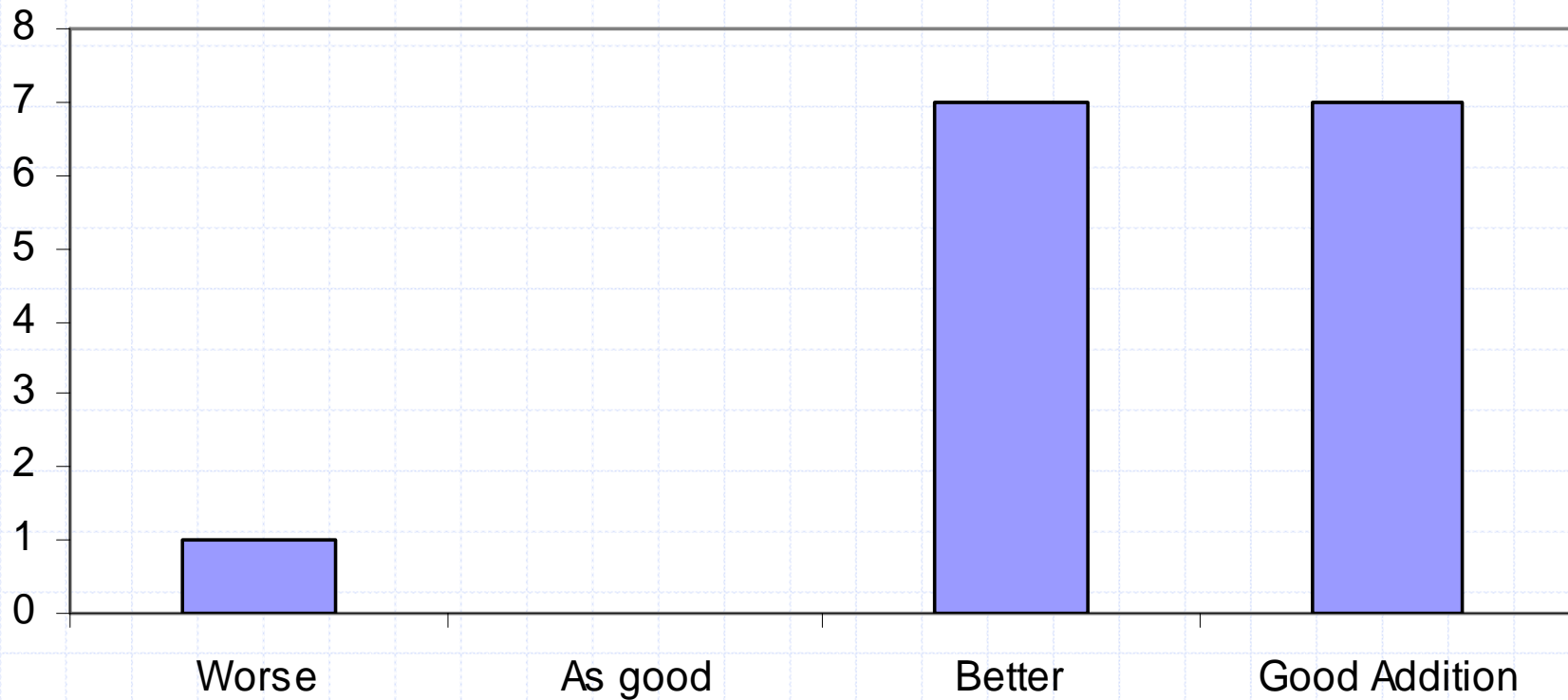
Questions were discussed and feedback forms filled in:

1. How does PBL compare with lecture modules?
2. What was special about the PBL approach?
3. What were the perceived outcomes?
4. How might it be improved?

Overall rating of module.

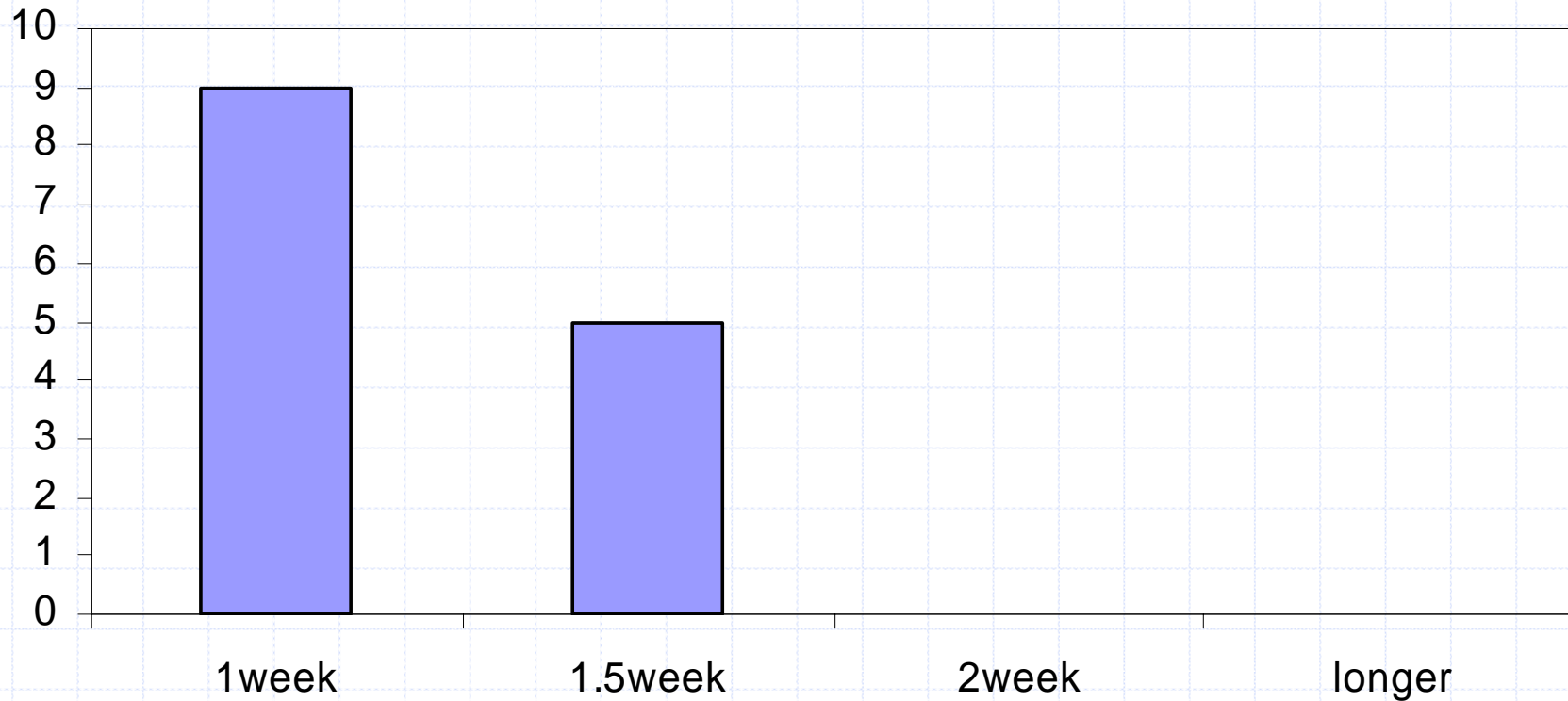


PBL as a learning method relative to lectures

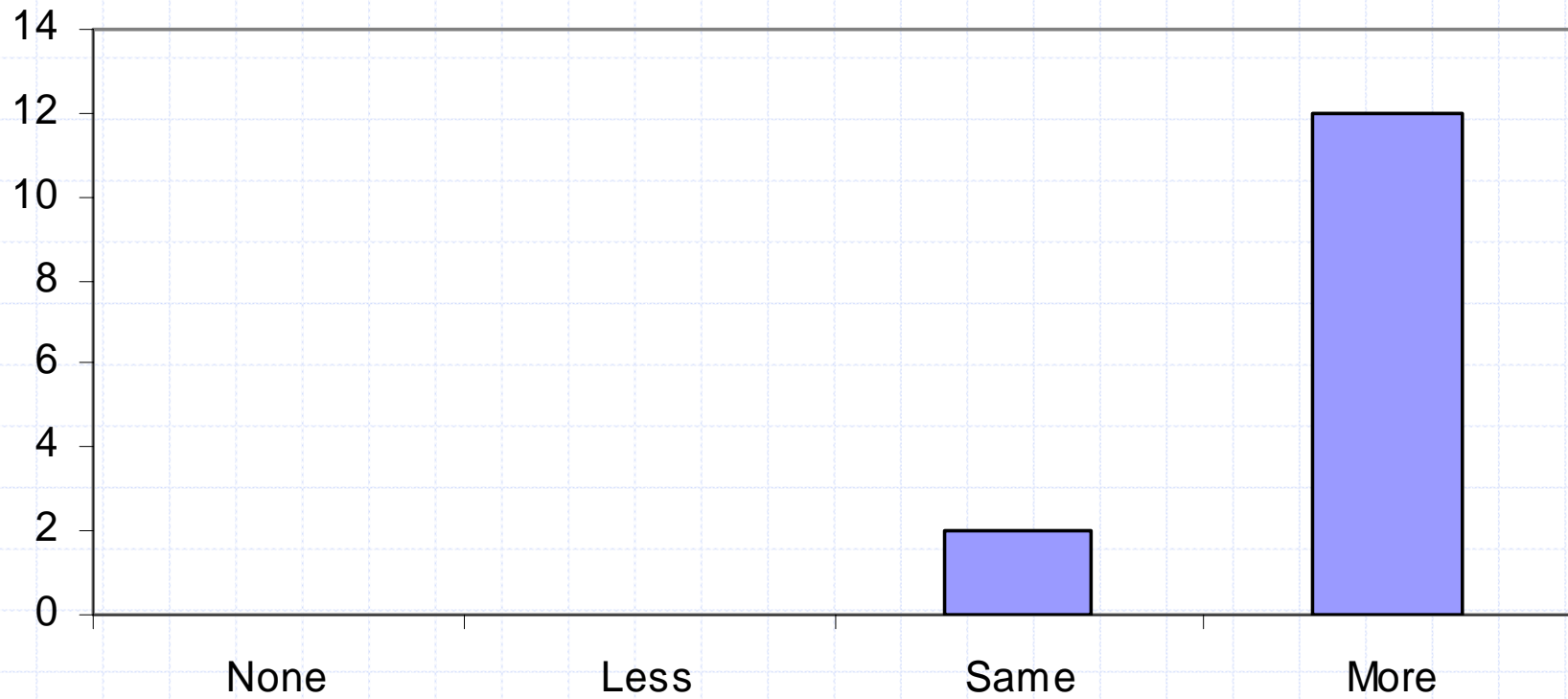


Problem duration: Friday-Tuesday-Friday

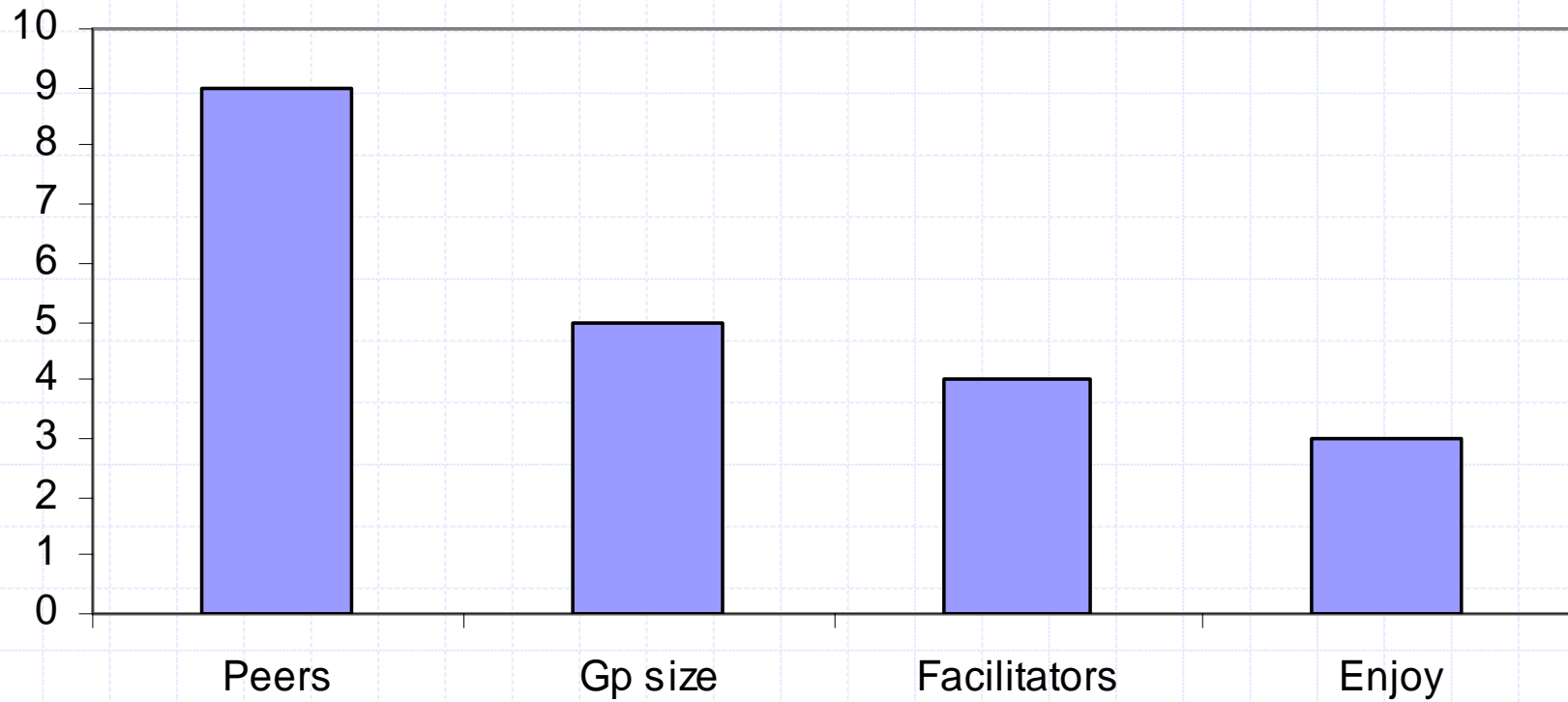
Optimal problem duration



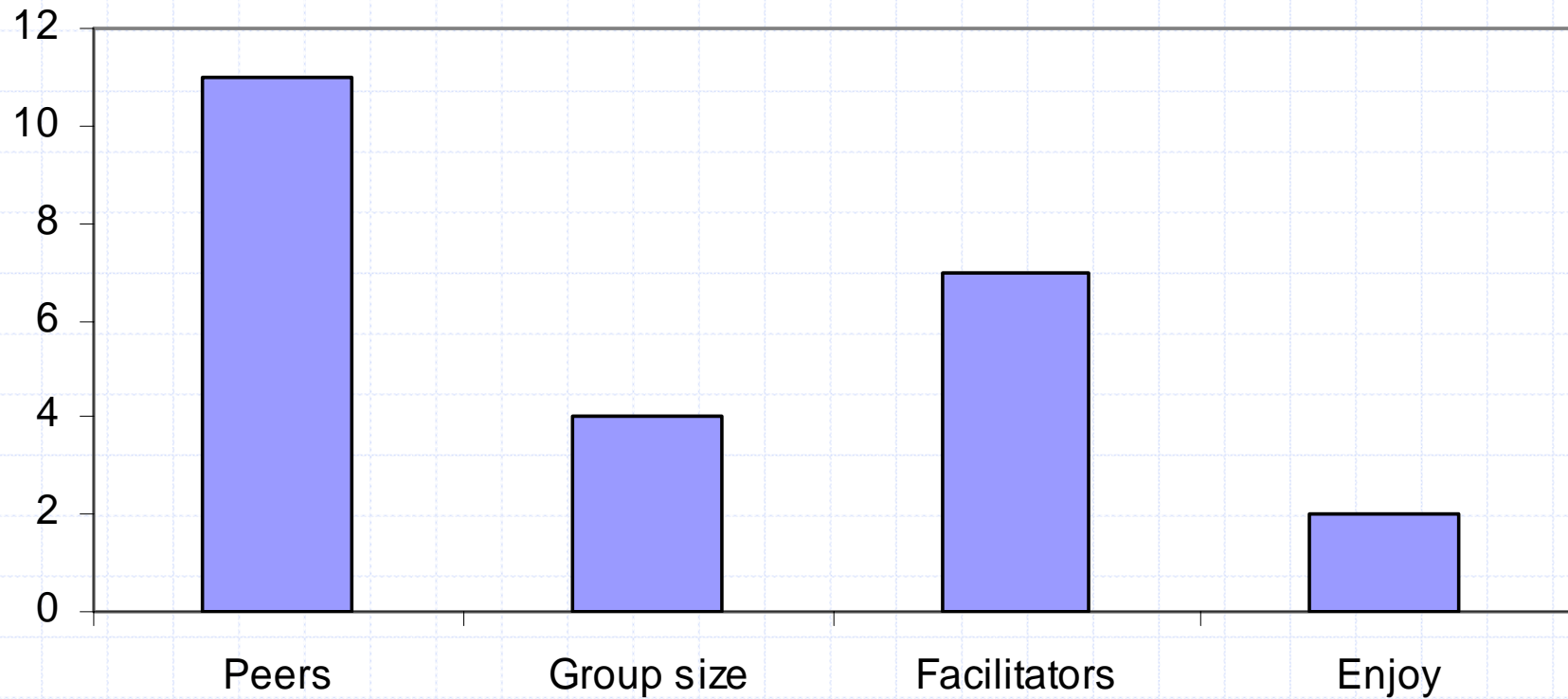
PBL work relative to lectures



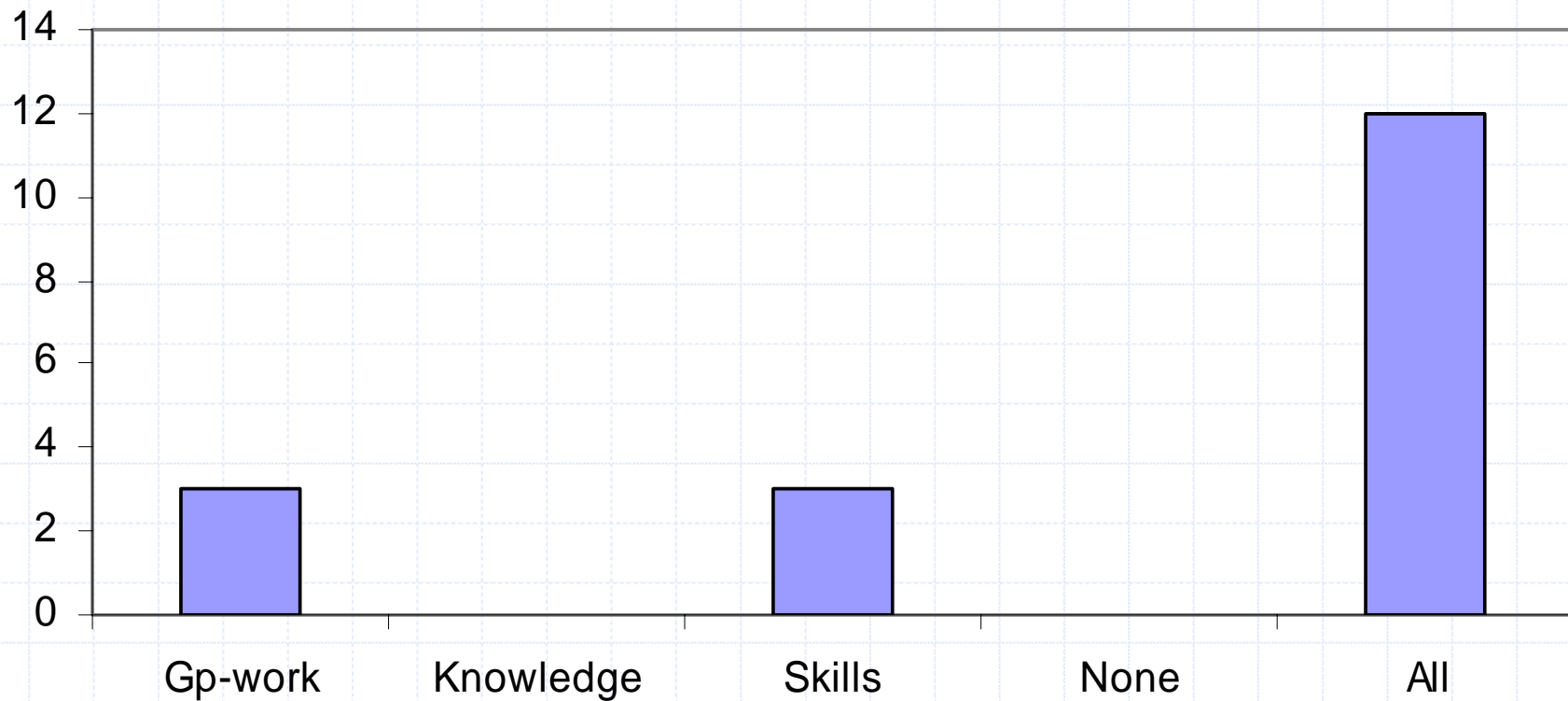
Pressure to work



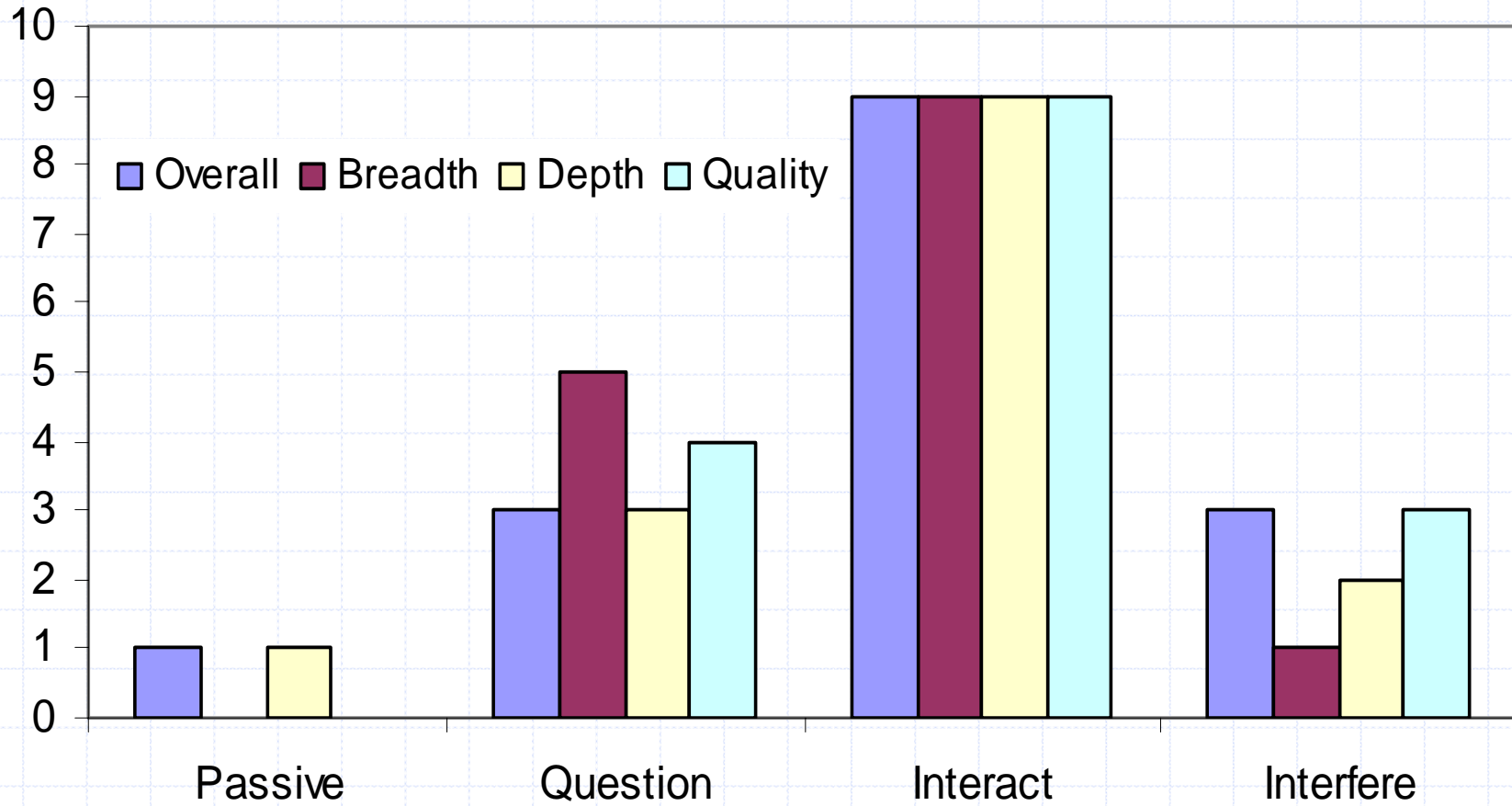
Pressure to attend sessions



Learning outcomes of PBL



Best facilitation technique for different goals



To Achieve Depth:

Either

Need to tighten the problem so students are more directed.

Or

Need to become an **active facilitator** – part of the group – helping them to explore the depth of ASPECTS of the subject as well as breadth.

Is this going against the principles of PBL?

Is it necessary for a discipline-based PBL approach?

What is problem-based learning?

“A learning method based on the principle of using problems as a starting point for the acquisition and integration of new knowledge.”

Howard Barrows (1982)

It is NOT problem solving – neither is our PBL approach:

Problem-solving - arriving at decisions based on prior knowledge and reasoning. We expect our students to research new areas in depth.

Problem-based learning - the process of acquiring new knowledge based on recognition of a need to learn. Clearly a goal in our PBL.

Our conclusions

- Prescription does not detract from the problem-based learning philosophy.
- Depth requires some steering but does not demand problem-solving rather than PBL.
- As students progress in the subject they will need less steering since the problems will be more highly focussed (e.g. molecular) and defined.

What is the “product” we are hoping to achieve at the end of a degree course?

- Should we respond to the need for particular expertise at particular times for industry or ignore this as a natural consequence of our producing “excellent” graduates.
- Are we producing “excellent” graduates or sending them into steep learning curves which the “excellence” of their own persons allows them to cope with?

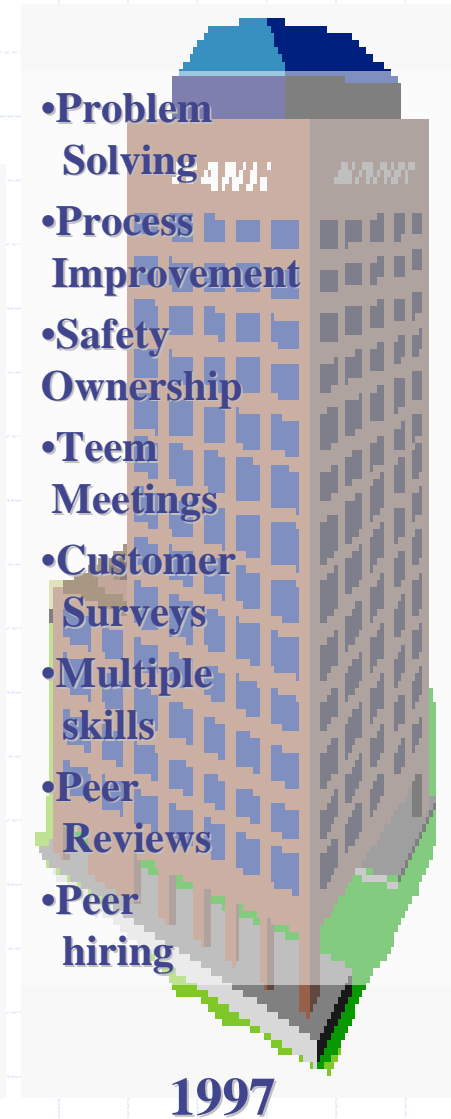
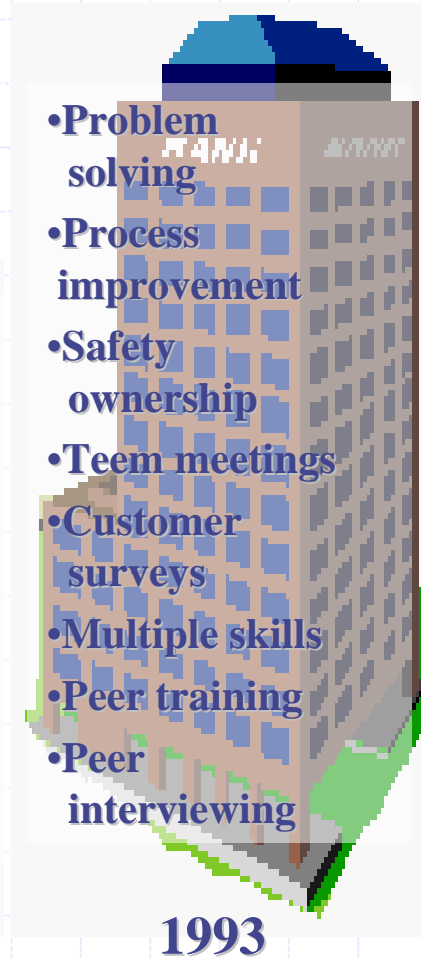
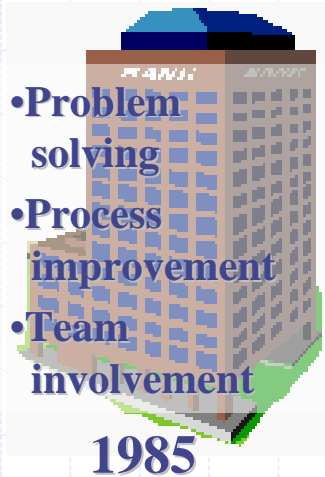
Feedback from one of our employers:

graduates have the intelligence and some knowledge base but lack “real-world” skills – e.g. group working, problem solving, time and project management.

They lack the benefits of being in a research environment!

Employee Expectations Are Increasing

In 1981, employees just expected skilled workers to “show up.” Today they expect employees to perform at many levels.



Why should we consider it?

Skills Desired by Fortune 500 Companies:

The Number One skill is:

Teamwork!

From: *Creativity in Action*, Creativity Education Foundation, 1990

Can we possibly equip each student with all the knowledge/skills they will need to:

a) Get going in the field?

b) For their future careers?

Reflects the same problem as in medicine – but in science we see subject fragmentation and specialisation as a response to ever increasing knowledge base.

Teach knowledge or teach skills?

Or

Teach Both?

Is there core knowledge in your subject area that students should leave with?

Are there key skills essential in the successful graduate?

We must examine our courses with these questions in mind and look to future utility of what we teach students

How do we teach how to learn for “life-long learning”?

If we only teach core knowledge plus skills how will students cope with unseen/unfamiliar problems in their future careers?

Is this addressed by current lecturing and practical classes?

Probably not - as students rarely see connections until they bring everything together in project work.

Perhaps - in project work, honours projects and in “good” tutorials.

How can we impart the knowledge and teach the skills?

Are links clear to students where these two are separated?

Lectures

Practicals

Problem-based learning

Teach skills to answer the questions to acquire the knowledge.

Can be theory or practice.

Can revisit problems for more detailed analysis immediately or later.

These points are well reflected in:

Our own appreciation of good practice as teachers

Getting students involved in lessons is better?

The requirements of the QAA

Looking for student-centred learning

The appreciation of our students

Lecturers who engage students and impart enthusiasm are popular

How does PBL work?

Present a case to trigger learning process:

Easy for clinical studies/health professions

Identify knowledge and/or learning objects to understand and solve the problem.

Important to stimulate use of knowledge already acquired from other studies/previous courses etc.

Use knowledge gained to address problem and/or refine learning objects.

Praise information gathering and demonstrate **added value** of group work

Present solution.

Indicate successful learning outcomes

The 3-session system works the best

Session 1. You are presented with the problem. You should then discuss it in your group and set learning objectives.

Session 2. Bring the results of your research to the group and consider if the problem is resolved. Identify gaps in the information and set supplementary learning objectives.

Session 3. Present the final solution to your facilitator (problem 1) and another group (problems 2 & 3). A member of academic staff will attend the presentations and will provide feedback.

How to work with the problem?

- What do you already know about this problem? - Existing knowledge
- What do you need to find out? - Learning objectives
- Where and how do you get information? - Research
- Is the knowledge you have compiled sufficient explanation for what you see? - Refer back to the problem
- If the knowledge does not exist, or is incomplete, can you formulate a question for the research scientist? - Ph.D. project
(*If it is not testable it is not science*)

Important to provide appropriate and adequate resources for group work:

Each group will be given the following:

Small room timetabled for group work with:

White/black-board

Chalk or pens, paper

OHP pad and OHP pens

Photocopy card

Floppy disks (May be used to collate everyone's work)

Copies of problem statement

Group work is facilitated by an academic or trained facilitator

What does the facilitator do?

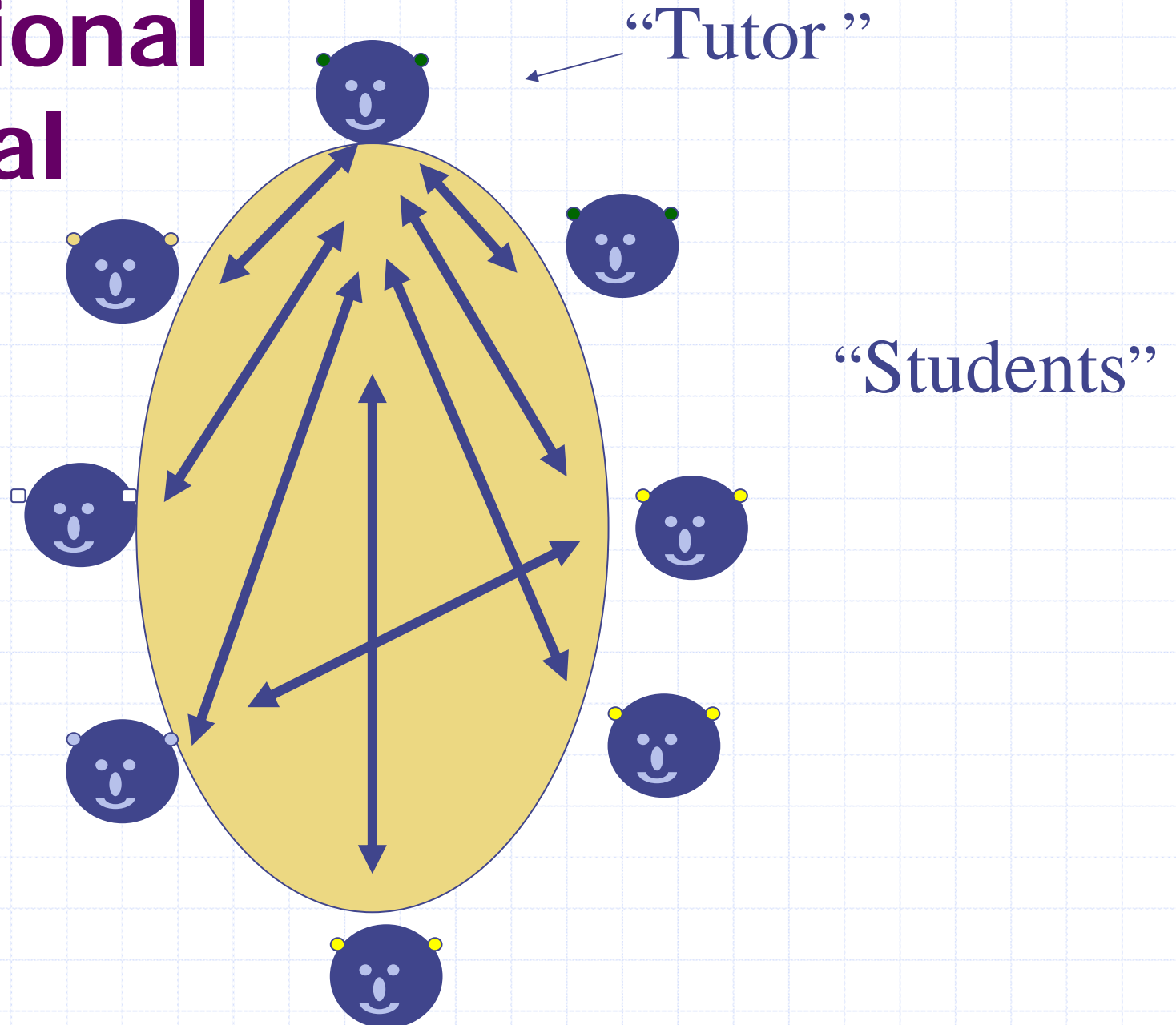
- Keep students focused on the problem without interference.
- Help students identify learning objects - how?
- By listening to discussion,

highlighting points raised

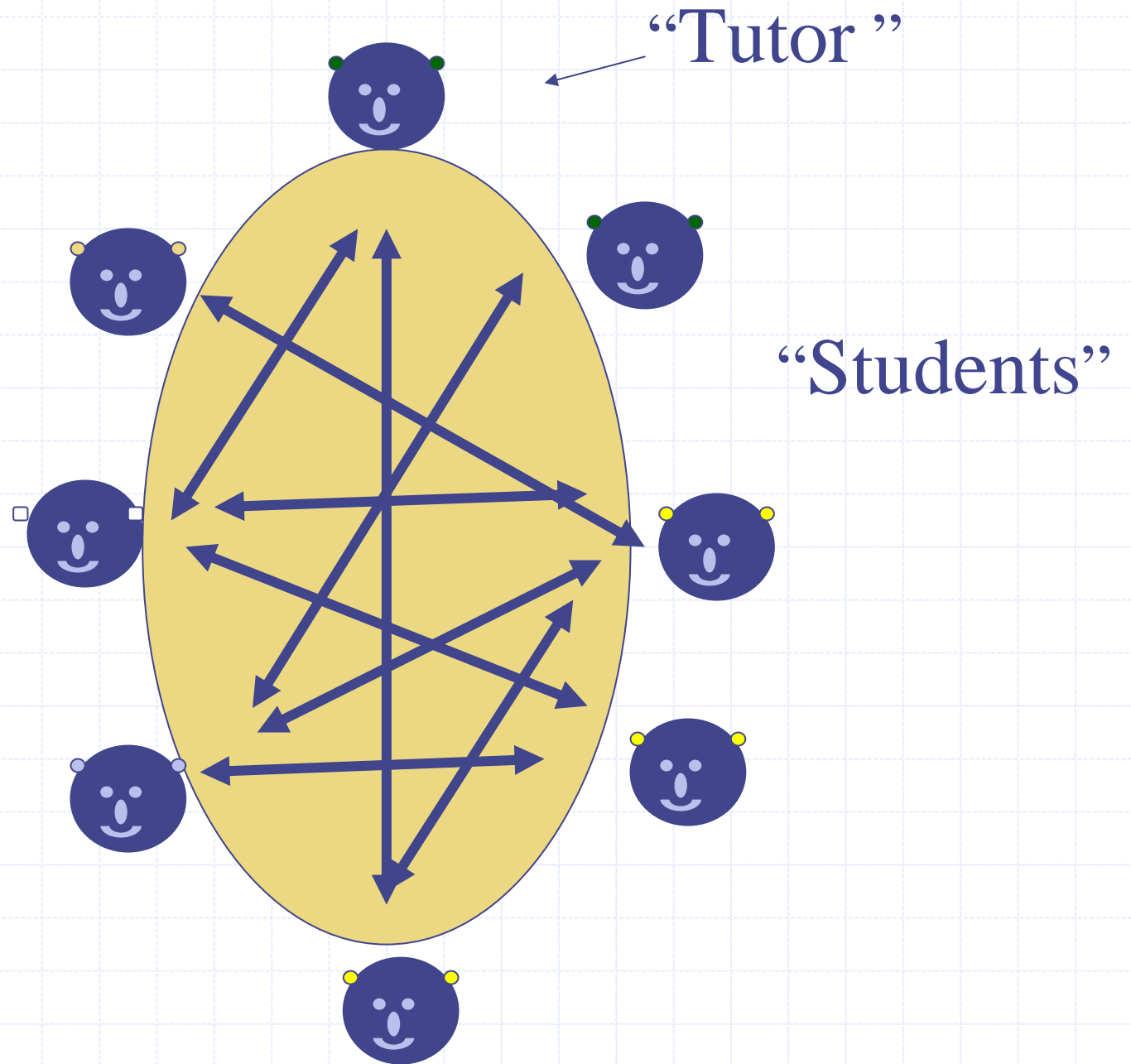
and/or questioning knowledge

(e.g. is this fact or theory? Does this need research? Is this a learning objective?)

Traditional Tutorial



PBL Tutorial



What makes a good teacher?

(From my children)

Someone who knows what they are trying to teach?

(obvious when they don't)

Someone who earns the respect of the students – how?

By treating them as equals – learning partners?

Someone who can explain something in more than one way.

(different students need different explanations to understand)

Still true of facilitators?

My view (for what its worth):

- PBL is an exciting and innovative teaching tool that is a powerful motivator of students.
- PBL does not have to be open-ended as in the medical model. I see no reason not to be more prescriptive and to define clear learning objectives (as we do for lectures) for each problem.
- PBL can thus fulfil exactly the same learning objectives as a lecture course with well designed problems.
- I see no harm in students being told what the learning objectives are and facilitators keeping students on track by indicating if they stray too far from the objectives. In fact our students greatly appreciated this approach.

Welcome to the real world!

“I remember much more and it makes sense”

“I appreciate the subject better since I don't think about exams”

“I don't need to revise as much as for lectures”

- PBL gets students reading/working since you are not spoon feeding.
- PBL gets away from exam-passing mind sets.
- PBL enhances learning since it is context-based and acquired on a need-to-know basis.
- PBL stimulates learning and brings back the interest and enthusiasm apparently missing.
- PBL is independent of good or bad lecturing skills but still requires good subject knowledge.

“Why wasn't I taught like this?”

“These students are confident and able to take part in all aspects of work.”

Evaluation is a major concern in PBL

Evidence for achieving knowledge:

Formal presentations to peer groups, written reports of group work, exams?

Evidence for achieving skills:

Observation of group work, presentations, written reports,
Anecdotal evidence of better communication by students
in other parts of course?

IS IT GOOD?

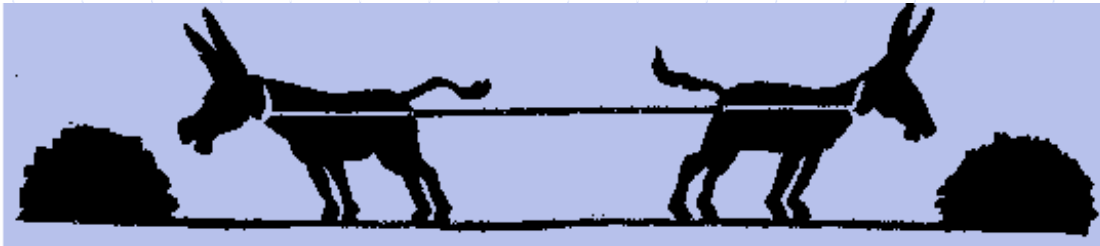
Students enjoyed it

Good/improved academic achievement

Ancient Chinese Proverb

Tell me, and I forget
Show me, and I remember
Involve me, and I
understand

PBL = Learning + added value



Competition



Problem based learning



Cooperation to solution