

Engaging Engineering Students Using Problem Based Learning

Lessons learnt from implementing PBL as the primary teaching mechanism at the Manchester School of Engineering



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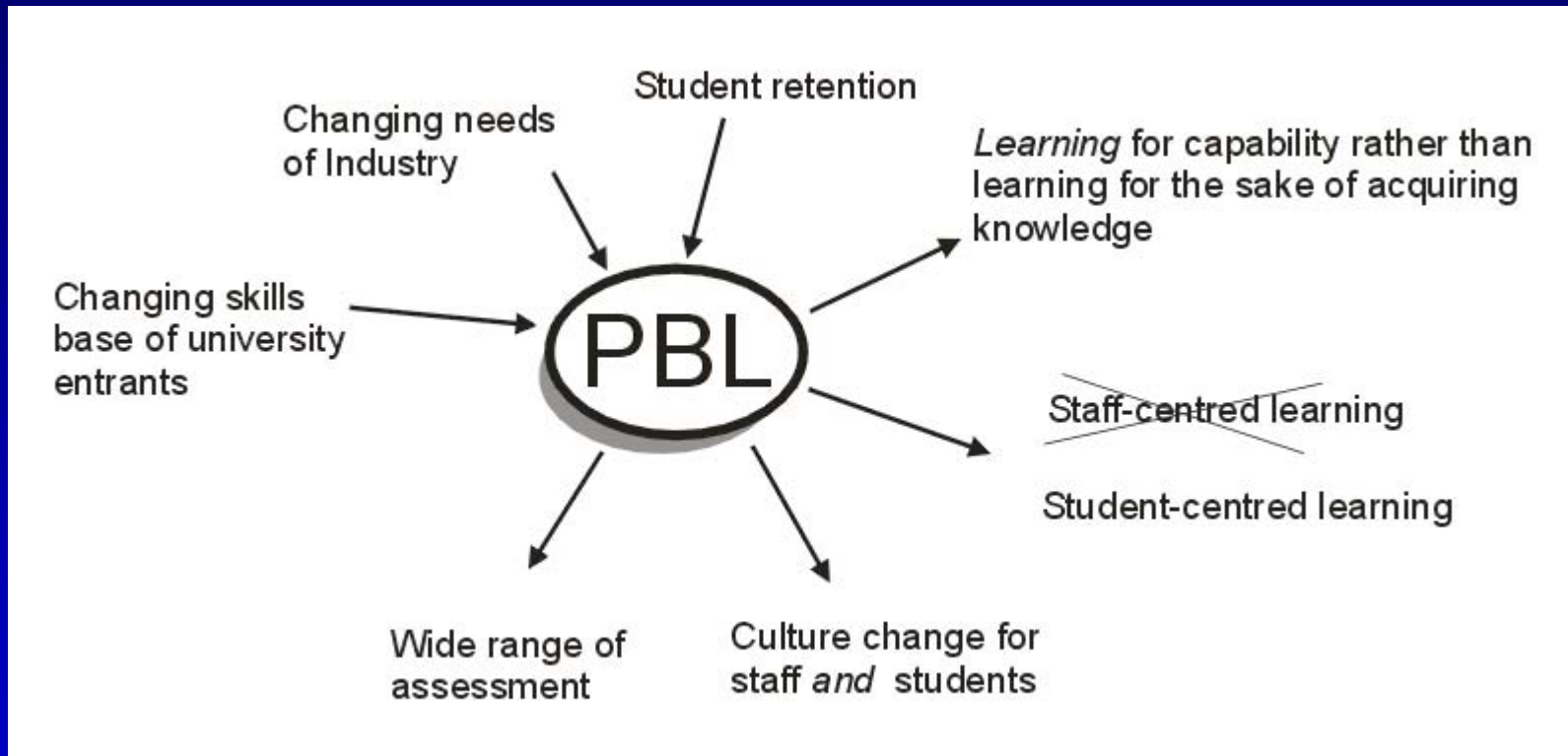
University of Manchester

STEPS 2002, Supporting Transition by Effective Progression Strategies

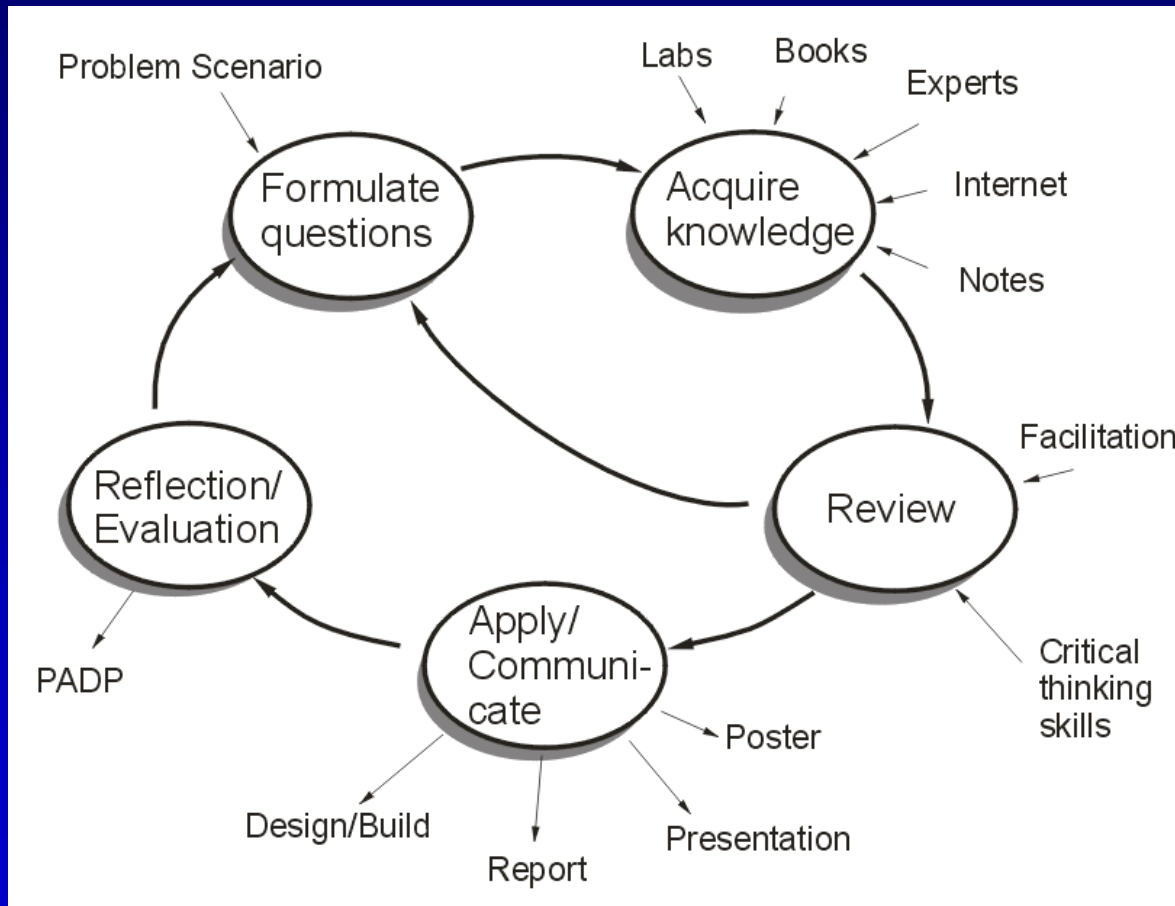
Presentation Overview

- PBL and the new Engineering Programme at Manchester
- PBL example (Hovercraft)
- Active learning: Engaging students
- Student opinions on the new Engineering Programme
 - The PBL learning method
 - Comprehension and knowledge acquisition in PBL
 - Competencies developed through PBL
 - Working in groups: pros and cons
 - Is PBL enjoyable?
 - How does PBL compare to the ‘taught courses’?
- Conclusions

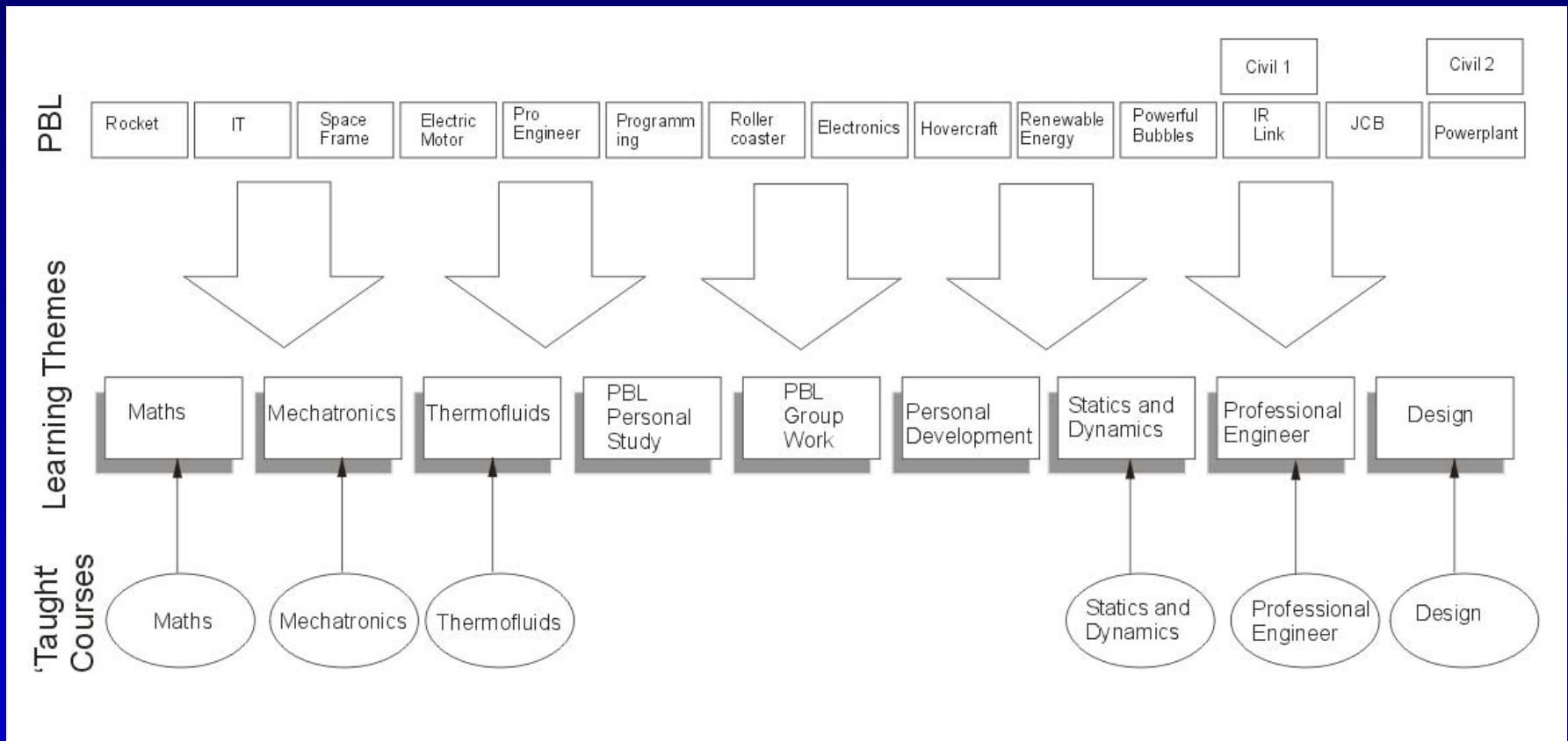
PBL within the New Engineering Programme at Manchester



The PBL Process



First Year Structure for Engineering



Hovercraft PBL Example

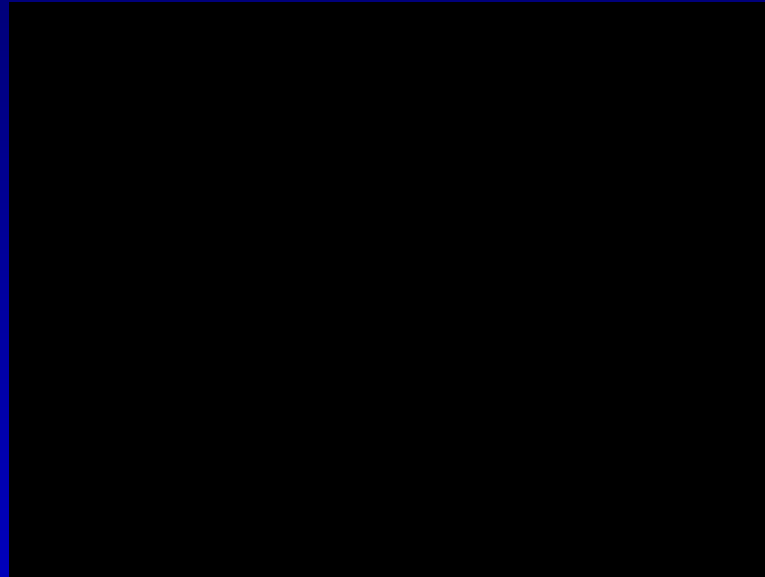
Problem scenario

A company that makes electrically powered ducted fans is considering developing a small, remotely controlled hovercraft for transporting payloads over uneven surfaces. The board of directors have requested technical information on how the hovercraft will work and its likely payload/duration performance. Following this, a demonstration of a prototype vehicle is required.

Currently the quality assurance department measures the thrust of the ducted fans using an electronic balance. However, a need has been identified for a simple way of determining thrust using pressure measurements alone.

A hovercraft simulation programme is also currently being developed in-house to investigate manoeuvre dynamics, however the code is not yet complete.

Hovercraft PBL



Active Learning

- Active learning *engages* the student in the learning process
- Engaged students
 - Learn more
 - Enjoy themselves whilst learning
- PBL is an example of active learning
- Its success can be measured against
 - What and how much the students are learning
 - The student progression from year 1 to year 2

Review of the first year of implementation

- Students' views were established by means of a questionnaire and individual interviews.
- The questionnaire was piloted with ten students, altered slightly and then, in weeks 10 and 11 of semester two it was completed by a further 69 students.
- The total sample of 79 represents 56% of the first year student cohort.

PBL as a teaching method

When presented with the following statement
'I have learnt a lot from participating in PBL exercises'.
12% of students strongly agreed and 63% agreed

Student quotes:

'I tend to remember a lot more from PBL than from lectures because it puts learning into practice'

'PBL has been good for enjoyment and for learning'

Student comprehension through PBL

- Students showed a degree of nervousness about how comprehensive and thorough their technical learning from PBL had been since:
 - Groups had freedom to address problems in different ways
 - facilitation was by non-specialists, and
 - There was strong reliance on performance of other group members

Knowledge Acquisition through PBL

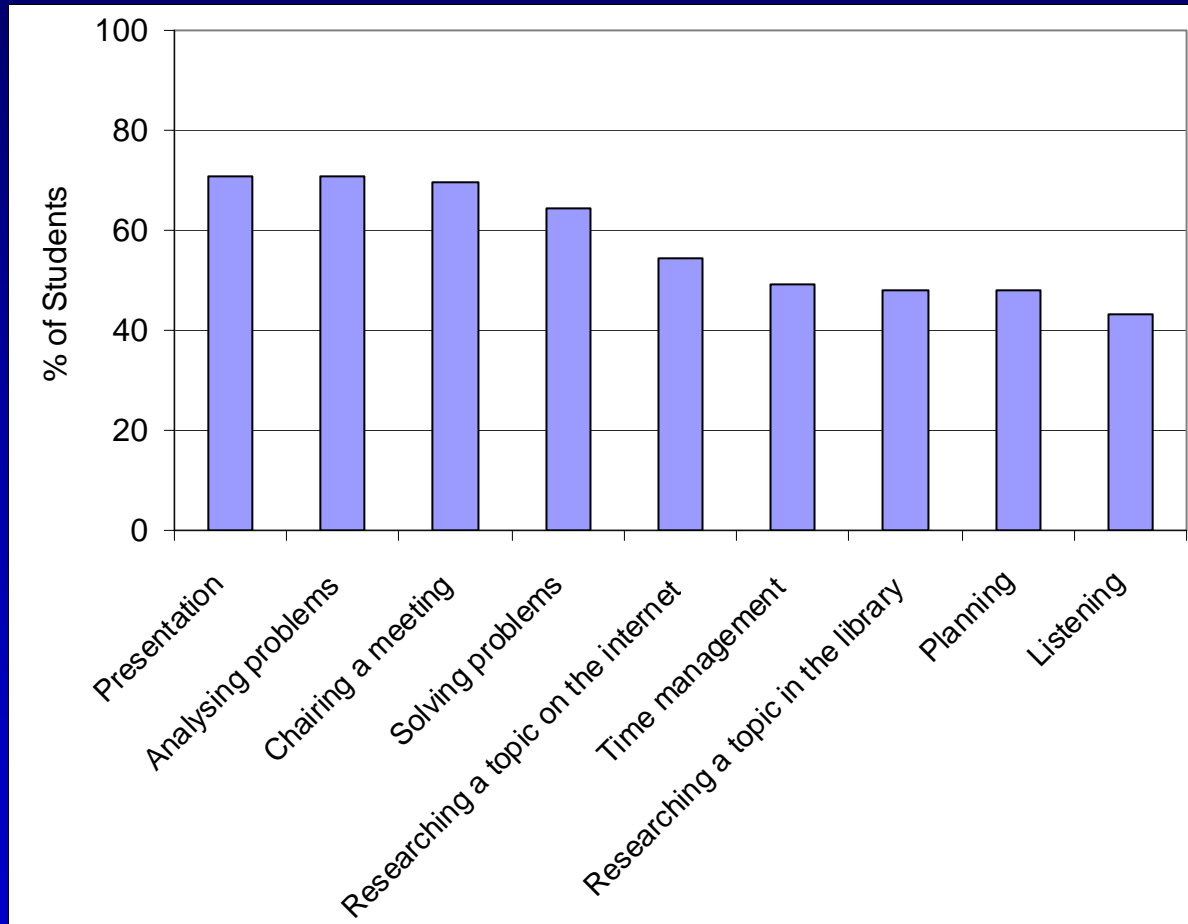
'It seems fantastic, but I could be missing major points'

'Some aspects I feel I have learnt, others feel sketchy'

'in PBL you can't guarantee that you've learnt everything you are supposed to have learnt. ..If your group has missed...if they just haven't quite clocked on to a major part of it, then you haven't done a major section of the work.'

'It would be a benefit to be told what you have got right and what you haven't got right....there is often no explanation as to why you got that bit wrong.'

Student opinion of competencies developed through PBL

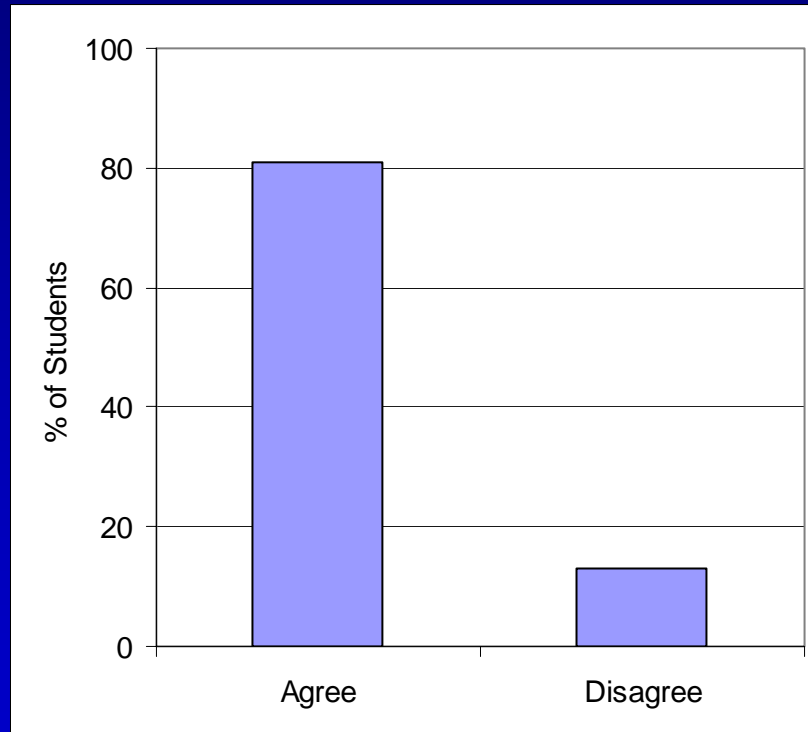


Other competencies identified by students

- *team work*
- *patience*
- *communication*
- *writing minutes*
- *judging character*
- *co-operation*
- *understanding other's points of view*
- *controlling others*
- *dealing with conflict.*

Group Working

Student response to 'I have learnt a lot about myself from working in a group environment' :



Challenges of group work

‘Some people are a bit too pushy whilst others are submissive. Both are dealt with differently’

‘You learn the group dynamics, how each member operates, their strengths and weaknesses, how best to utilise the group to get the best result, etc’

‘I have learnt that people work in different ways and convey ideas differently, so you have to get to understand them.’

‘I have become aware of how difficult it can be to work with other people with conflicting ideas.’

PBL Passengers

- **The ghost**
 - Rarely turns up
 - Not well known by the group
 - Hardly ever delegated work
- **The floater**
 - Attends regularly but participates little in the group interaction.
 - If allocated work rarely completes it
 - Not trusted by his group members, although he might be 'a good laugh' and so quite liked
 - Quite happy to do the absolute minimum and be carried along by the efforts of his more conscientious peers.
- **The willing-but-not-very-able**
 - Regular attendee and a very reliable group member
 - Regularly accepts delegated work and always completes it on time
 - However, only allocated the 'easy' bits by the group
 - May be seen by his peers as a valuable and likeable team member – but won't know this

Which were the most enjoyable PBLs?

‘PBLs with practical aspects, e.g. rocket, were most enjoyable’

‘Hovercraft PBL was great. Any PBL where you have to race is fantastic’

‘We spent a lot more time on the problems we enjoyed. In the hovercraft one some of the guys spent all hours researching different ways of building hovercrafts.’

Student comments on 'taught courses'

'More taught courses would help with PBLs and make the course more understandable'

'More taught courses so there are more notes and we can learn more'

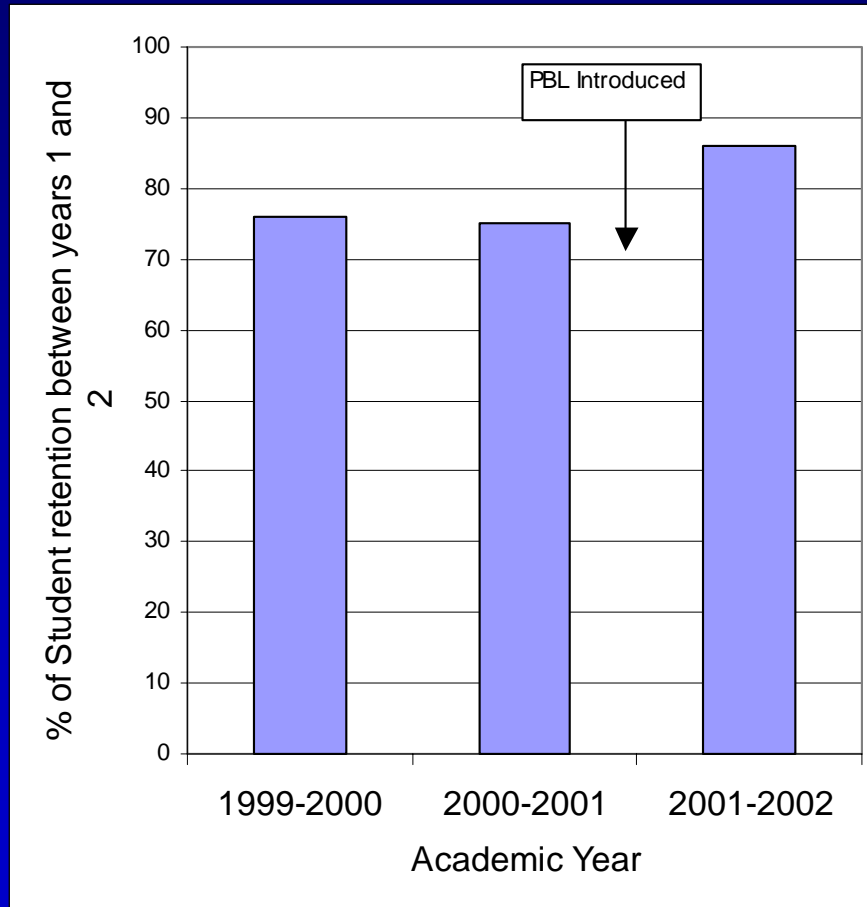
'There should be introductory lectures for a PBL so that we have a background knowledge before we start'

'Have longer lectures. Adopt the style of maths in other subjects. Make more lecture notes'

'Despite the fact that PBLs are enjoyable I feel I could have learnt more'

'The core engineering material should be taught through traditional lectures to establish a sound foundation of knowledge'

Effect of PBL on student retention



Conclusions

- PBL is now the primary delivery mechanism for the early years of the Engineering programme at Manchester
- This has resulted in a major change in attitude towards learning for both students and staff
- Student surveys show that
 - students greatly enjoy learning through PBL and achieve a wide range of learning outcomes,
 - however they still like the support of formal lectures
- Since the change to PBL, student progression from year 1 to year 2 has improved from 75% to 86%.