PHEE Annual Conference
January 2003

Problem Based Learning

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Overview

- PBL - What is it, and how does it work?
- Engineering Education – a suitable case for treatment
- IEE – HEFCE PBL project
  - Background
  - Aims and objectives
- Evaluation
- Conclusions

What is PBL?

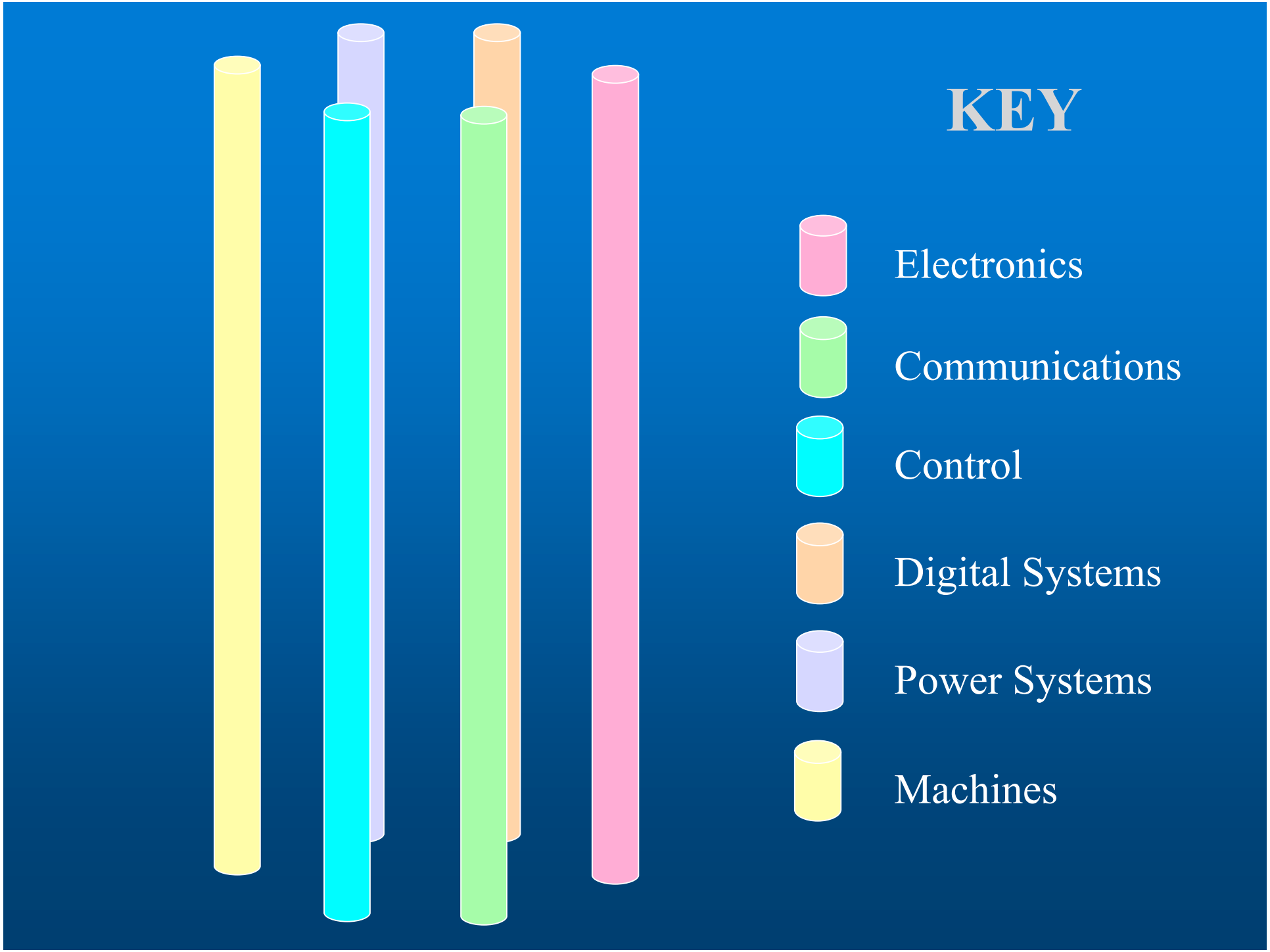
- Problems are used as the stimulus and focus for student activity
- PBL courses start with the problems rather than with exposition of disciplinary knowledge
- Students acquire knowledge, skills and understanding through a staged sequence of problems presented in context

How does PBL Work? - I

- Small groups of students (~ 8) work with a PBL Tutor or Facilitator
- Groups meet twice a week, each time for around 2 - 3 hours
- At the 1st meeting, students are presented with an unfamiliar situation or problem
- Students identify the main issues and formulate questions to work on

How does PBL Work? - II

- Following a period of individual study (2 - 3 days), the group reconvenes
- They will discuss what they have learned, and apply the new learning back to the original problem
- Supporting activities (labs, lectures) are timetabled as ‘Fixed Resource Sessions’ during the periods of individual study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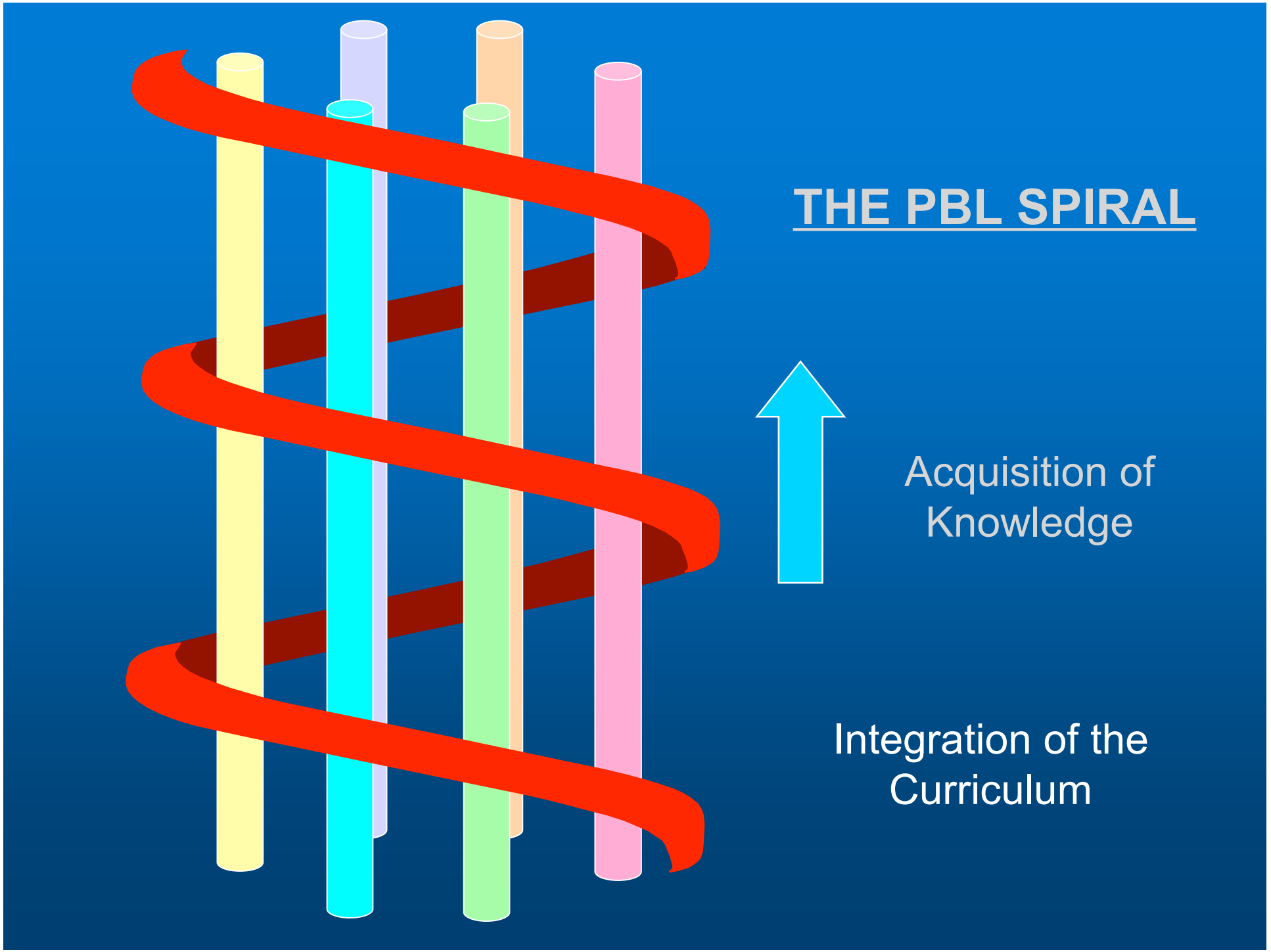
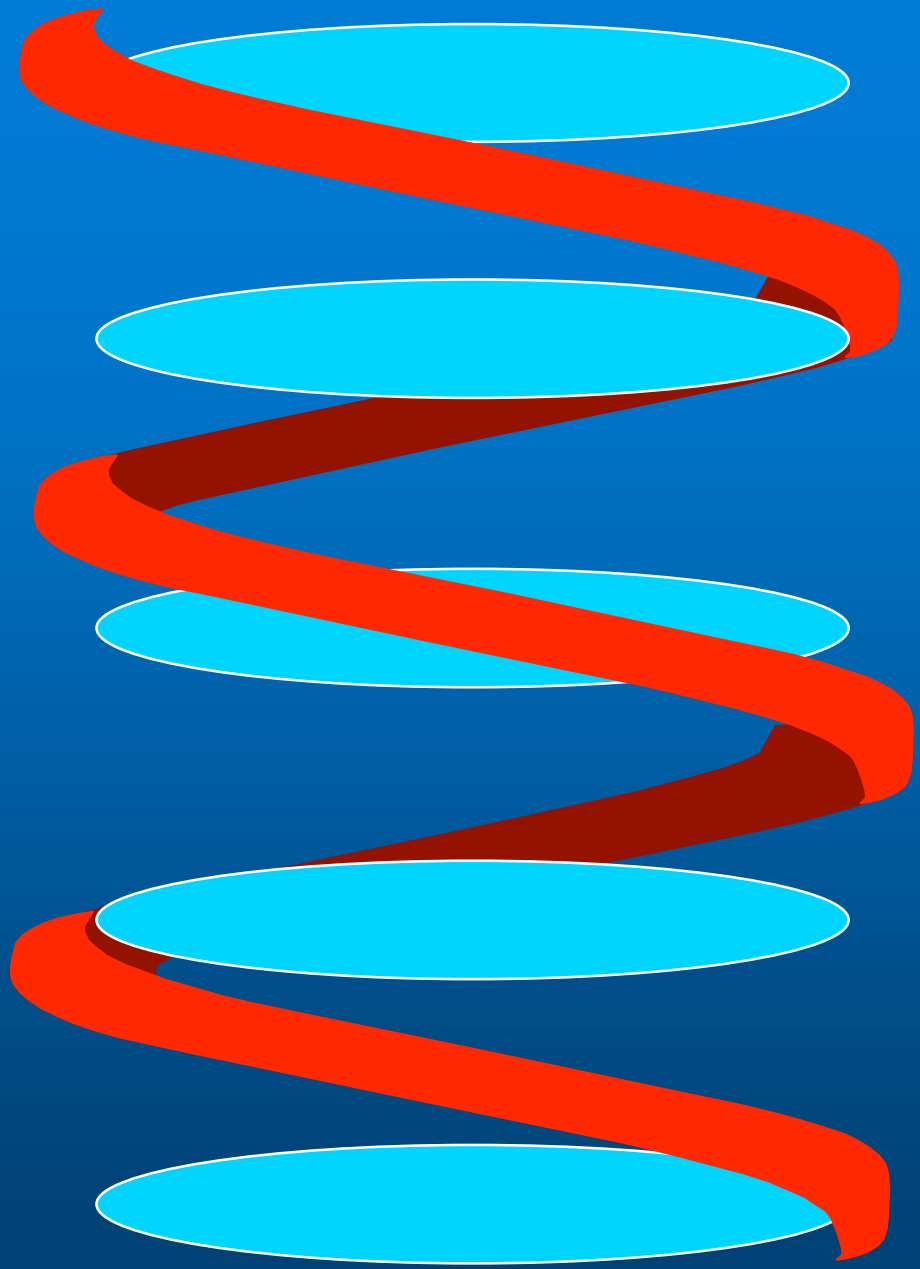

THE PBL SPIRAL
Acquisition of Knowledge
Integration of the Curriculum



SCENARIO #5

SCENARIO #4

SCENARIO #3

SCENARIO #2

SCENARIO #1

Problem Design

- The following must be considered:
  - What do you wish the students to learn?
  - Which questions would lead to that taking place?
  - What in the learning problem will lead students to pose the right questions?
  - Is the problem sufficiently interesting, and does it stimulate the right number of questions?
  - What materials/resources will need to be made available?
  - What additional learning experiences will be required?

The Seven Step Strategy

1. Clarify concepts
2. Define the problem
3. Analyse the problem – brainstorm
4. Problem analysis/systemic classification
5. Formulate learning objectives
6. Self-study
7. Discussion report

Advantages of PBL

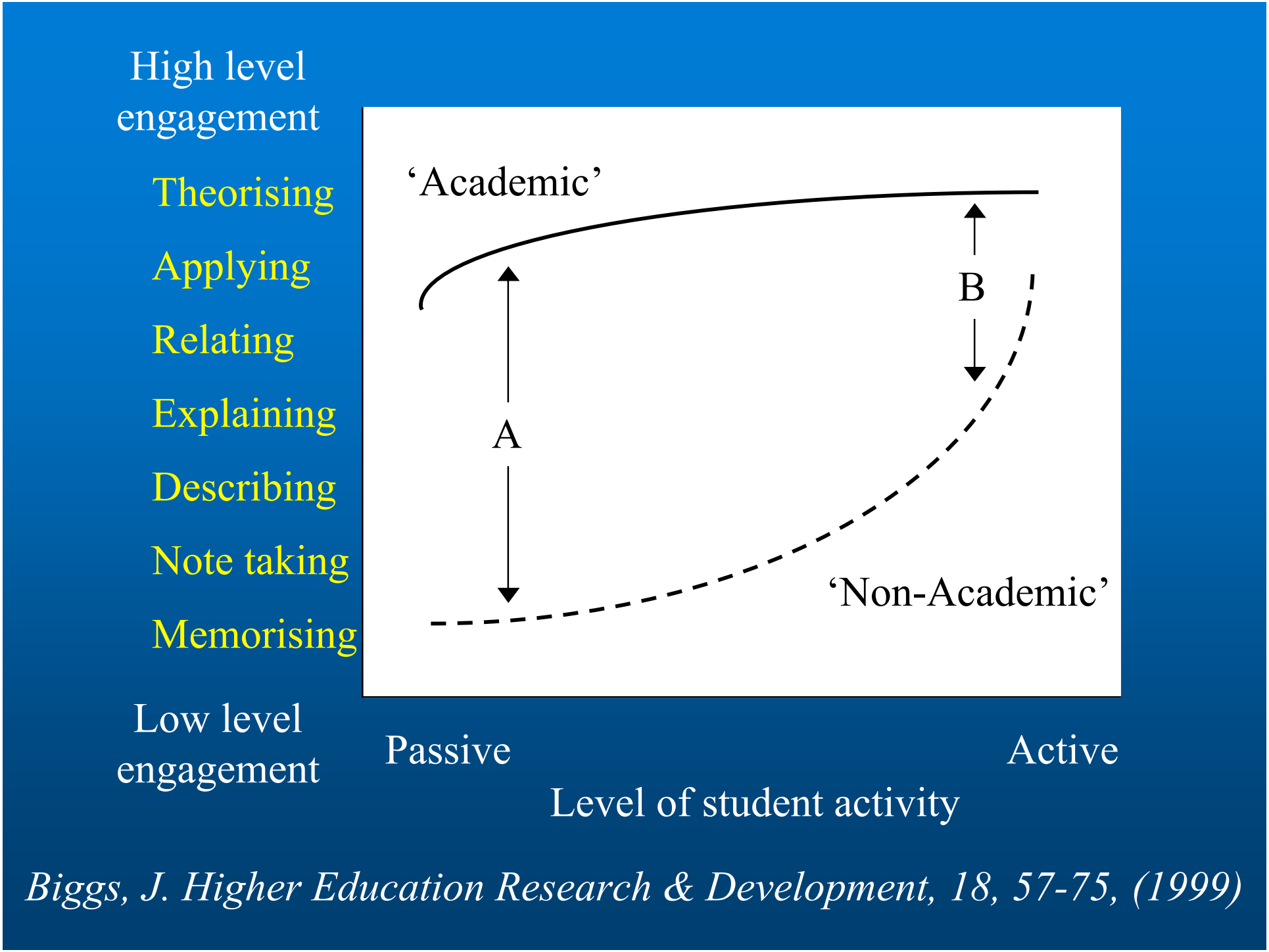
- Active learning - occurs in context
- Integrated, holistic approach
- Leads to deep learning; long-term recall
- Promotes development of key skills
- Fosters the learning ethic
  - Solid foundation for Lifelong Learning

Engineering Education

- Diversification of student intake
- Expansion of the curriculum – rate of change accelerating
- Teaching, learning and assessment – is it as effective as we think it is?
- Industry critical of engineering graduates for their lack of skills
  - Mode 1 versus Mode 2

Diversification of Student Intake

- Transition from an elite to a mass higher education system
- Changes at secondary level (Curriculum 2000 etc.)
- Widening participation
- Despite the diverse backgrounds of students, all are treated the same way



Biggs, J. Higher Education Research & Development, 18, 57-75, (1999)

Expansion of the Curriculum

- Explosion of the knowledge base
- Tendency for the curriculum to become overloaded
  - Teachers feel they have to cover everything the student may need
  - Results in a surface approach to learning
- Need to move to a ‘Just-in-Time’ rather than a ‘Just-in-Case’ approach

Teaching, Learning & Assessment

- 'Teaching' – creation of environments in which students can learn effectively
- A good deal of research has been done into how students learn
- Traditional methods based on the didactic lecture are ineffective
  - Superficial learning
  - Poor retention of knowledge
  - Poor for learning skills and understanding

Teaching, Learning & Assessment

- **Student learning is assessment-driven**
  - **Assessments must be matched to desired learning outcomes**
  - **Not just about testing the recall of factual knowledge**

Impetus for Change

- **Employers are seeking graduates:**
  - **Who know how to learn**
  - **Who know how to tackle (and solve) problems in the real-world**
  - **Who possess key/transferable skills**
    - **Communication**
    - **Group working & Interpersonal**
    - **Presentation**
    - **IT**

Comments from Industry

- “ … Graduates do not know how to apply knowledge.”
- “ … Ability to relate to engineering principles is important – not learning by rote.”
- “ … More basic practical skills … not just academic theory.”
- “ … Want to see deeper understanding; practical application of academic science and technology …”

IEE PBL Project

Three universities are working with the IEE on a project aimed at introducing Problem Based Learning into Electronic Engineering Degree courses

IEE PBL Working Party

- Established in late 1998 in response to the recommendations of the IEE Industry Course Working Party
  - Noted that a number of medical schools had moved to PBL following the General Medical Council's 1993 report, "Tomorrow's Doctors"
- Aim was to assess what PBL had to offer electronic engineering degree courses and determine the costs involved

Recommendations - I

- As a method of learning PBL offers many advantages and it should be considered for use alongside other teaching and learning methods.
- Three universities (Bristol, UCL and UMIST) should embark on a pilot project to demonstrate the effectiveness of PBL in electronic engineering degree courses.

Recommendations - II

- **The involvement of the IEE is important for the following reasons:**
  - **As the professional body responsible for Degree Accreditation, the IEE must keep abreast of innovative developments in teaching and learning**
  - **To determine whether the introduction of PBL fulfils the key skills requirements identified by the IEE Industry Course Working Party**

HEFCE Proposal

- In March 2001 a joint proposal was submitted to HEFCE for funds to support the introduction of PBL.
- This bid was successful and £252K has been awarded by HEFCE under its ‘Restructuring and Collaboration Fund’
- The HEFCE project runs for three years commencing September 2001

Additional Financial Support

- The IEE is committing £100K to the project from its own resources
- The three universities are contributing staff time and overheads estimated to be worth £218K
- The IEE is planning to hold a major fund raising event to attract subscriptions from key industrial organisations

Project Management Committee

- Chaired by Professor David Howard, Department of Electronics, University of York
- Administrative support provided by the IEE
- Reports to HEFCE and to the IEE's Degree Accreditation Committee and Qualifications Board

Evaluation

- A major task that will be undertaken as part of the PBL project is an evaluation of the effectiveness of this mode of learning
- The evaluation work will be carried out by the ELICT team led by Dr Gordon Doughty. This is based in the Robert Clark Centre for Technological Education at the University of Glasgow

Other costs

- Rooms
  - Large number of small rooms required
- Library
  - Substantial increase in use expected
- IT
  - Additional hardware and software
  - Good IT support

PBL in Engineering

PBL is being used to support engineering courses in the following universities:

- **Manchester**
- **Bradford**
- **Oxford Brookes**
- **Aalborg (Denmark)**
- **Monterrey Tec (Mexico)**
- **McMaster (Canada)**
- **Newcastle, New South Wales (Australia)**

PBLE Project

- **Promoting Project Based Learning in Engineering**
- **Funded under Phase 3 of HEFCE's FDTL programme (Fund for the Development of Teaching and Learning)**
- **Led by the Department of Civil Engineering, University of Nottingham**

http://www.pble.ac.uk

Conclusions

- PBL has a number of distinct advantages as a learning method - it can deliver graduates that will be highly prized by industry
- The time, effort and money required to implement a PBL-based programme is substantial - but so are the potential rewards