Practical Skills in the Life Sciences: an Overview

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Why do practical work with students?

- Because science is a practical subject!?
- Desirable characteristics would include
  - Scientific method and experimental design
  - Open-endedness – leading to further work/ideas
  - Uncertainty, variability and error
  - Creativity and initiative
  - Challenge and problem solving
  - Training and practice e.g. observation skills, equipment operation protocols, etc.
- BUT are many practicals little more than processing students through a ritualistic procedure

Practical Work: Science in Action!

- Variety of situations/formats – pros and cons
- Usually the most expensive part of most courses
- Therefore, increasing managerial need to make practical work both **more efficient and effective**
- BUT educational need is to make them a **better learning experience - early years often mechanical and didactic**
- **Need to rethink role/s and content of practicals in both pragmatic terms and educational terms:**

Some Generic background issues

Aligning Objectives and Teaching Methods

- **Constructive Alignment** model of teaching (Biggs 1999): objectives, methods and assessments
- Learning takes place through the **active behaviour of the student**: it is what he does that he learns, not what the teacher does (Tyler, 1949: 63) – basis of practicals?
- BUT, not by simply working through practical protocols!

The ‘New’ Student Characteristics

Adapted from Smith, Brenda (2001). ILT plenary

- Longer tail of weak students
- Decrease in verbal skills and participation
- Motivation is ‘economical’ rather than intrinsic
- Increased time employed outside HEIs – financial load
- Decreased writing abilities and interest in reading
- Increase in learning disabilities and need for support/help
- Increase in non-English speakers
- Decrease in problem-solving skills

Where Do These Students Go and What Are Their Career Intentions [Motivations]?

- 80% of biological science graduates do NOT continue within the science
- In biochemistry, some 40% left the subject in 1999
- Thus significant numbers move out of subject – our goals are not their goals (non-alignment?)
- **Too much emphasis on content rather than process**

What Do We Want From Practicals?

- Desirable aims include
  - Learning / practice of manual and observational skills relevant to the subject
  - Familiarising with equipment, techniques and materials, including safety issues
  - Improving understanding of methods in scientific enquiry
  - Developing communication and other inter-personal skills

- Developing experimental, design, problem-solving and analysis skills
- Developing transferable skills e.g. data-recording, reporting, IT, statistical analysis, etc
- Linking theory and practise
- Nurturing professional attitudes (affective domain)

BUT are practicals as currently formulated the best way of achieving such aims?

In particular, are the assessments appropriate and aligned?

Why Are We Experiencing Difficulties?

- Curriculum time available for practical work is diminishing – especially for practising particular skills
- Class sizes are increasing
- Increasing student diversity (entrance qualifications, etc) > lowest common denominator approach OR should we pre-test for minimum standards

- Decrease in the practical skills developed during secondary education
- Unit of resource is falling, making the cost of running practicals a problem generally yet…
- Equipment/consumables becoming more complex and expensive to supply
- use of non-aligned course components, particularly assessments
- lack of recognition of the key features of learning processes and styles in the design of practical work

How Do We Learn?

- Most people learn (Glasser 1988)
  - 10% of what they hear
  - 20% of what they hear
  - 30% of what they see
  - 50% of what they see and hear
  - 70% of what they talk over with others
  - 80% of what they do in real life
  - 95% of what they teach someone else

  } Good practicals

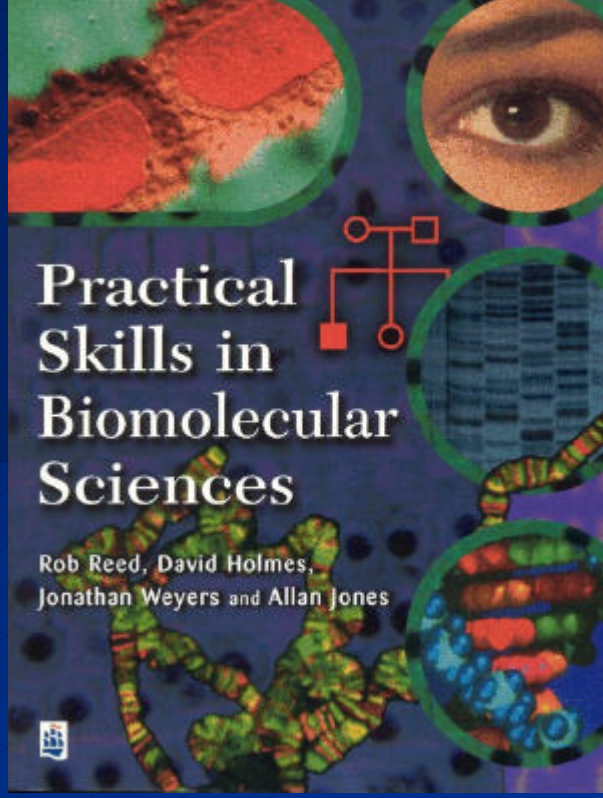
- Models of Learning – **preparation** and **reflection** are key components largely neglected within practical work
- ***Surface and Deep learning*** – properties of curriculum design NOT of the students

The Changing Paradigm in Life Sciences Teaching

The sage on the stage > the guide on the side

- This should include:
  - a move away from prescriptive, teacher-led practical activities towards student-centred approaches
  - Increased use of Open Learning opportunities provided by C & IT e.g. VLEs
  - More alignment between our outcomes, teaching methods and assessments

The Practical Skills Series of Textbooks



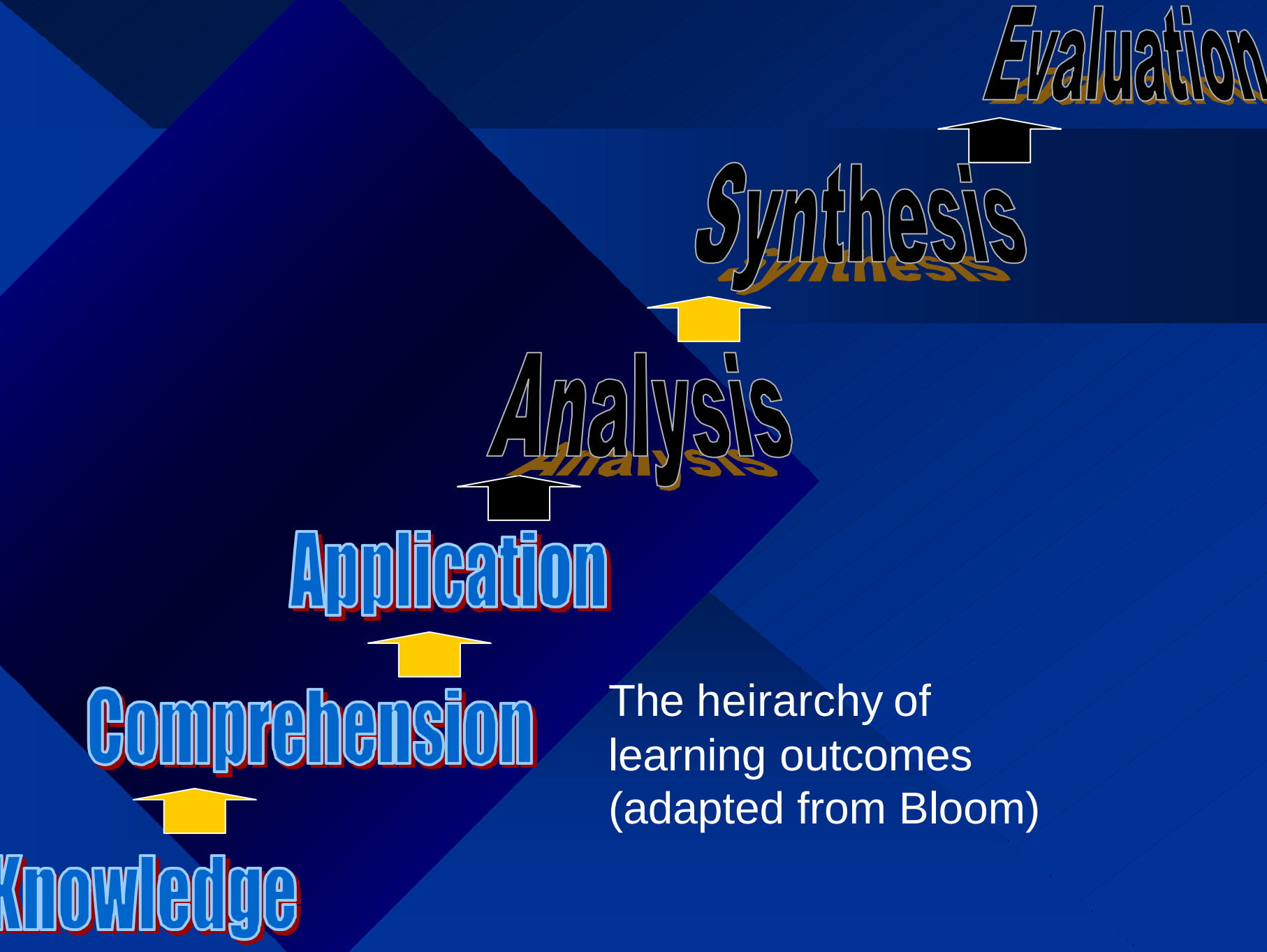
- Practical Skills in
  - Biology
  - Biomolecular Sciences
  - Environmental Science
  - Analytical Chemistry (in press)
- Developed in response to these problems
- Intended to provide basis for practical sessions by facilitating pre-reading and laboratory reference

Practical Skills and Their Development

- 4 types of intended learning outcomes
  - Knowledge (declarative) and understanding (functional)
  - Key Skills (PTS): communication, numeracy, IT, learning to learn
  - Cognitive skills (e.g. critical analysis, synthesis)
  - Discipline skills (e.g.manual laboratory skills)
- Need to encourage 'deep' approach to learning rather than just the 'surface' approach
- Need to be aware of strategic learning approach increasingly adopted

Assessment for Learning in Practical Work

- Need more emphasis on formative assessment
- Do we need to formally assess laboratory skills at some point? When? What? How?
- BUT assessment without appropriate training or practice (=repeated exposure)?
- Skills development should increasingly focussed into open project activities with appropriate support
- Peer- and self-assessments should be used more widely
- Need to develop higher-order skills rather than low-level ones



The heirarchy of learning outcomes (adapted from Bloom)

How Do We Do It in Practise?

- ‘Follow the recipe’ practicals: the most common approach to so-called experiments!
- Demonstrations – illustrations
- Individual rather than small group approaches
- Structured / guided enquiry
- Fieldwork – small group investigation and observation
- Open-ended and self-paced enquiry (mini-projects)
- Extended projects
- CAL e.g. Simulations and data analysis

Some Conclusions

- Need to re-examine practicals at several levels
  - Individual practical outcomes
  - Module outcomes and opportunity to practice skills (matrix approach)
  - Course outcomes (matrix approach to course aims and objectives)
- Need to make assessments appropriate and better aligned with outcomes/objectives
- Need to recognise the limitations on our expectations of practice skills development.

- Need to recognise that students have different preferred Learning Styles, requiring diversity of teaching methods
- Need more training of demonstrators and teaching staff in facilitation and formative assessment
- Need to critically examine both
  - the content of practicals
  - the timing and frequency of exposure
- Aims and objectives need to be explicit not implicit
- More emphasis needed on preparation and reflection in practical work by the students.
- Re-consider assessments – what, how, when and why! Emphasise assessment for learning rather than for grading

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