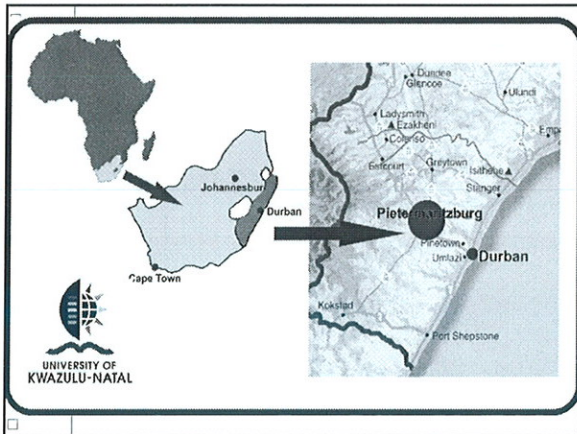


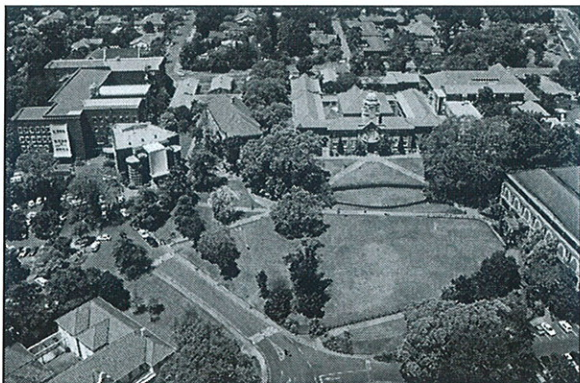


Some Thoughts on Assessment in Higher Education within a Climate of Curriculum Reform

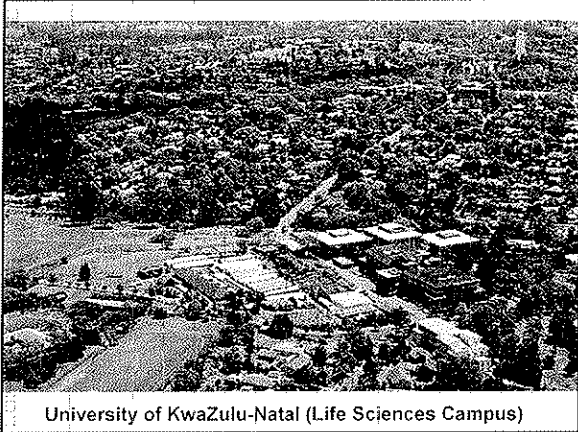
Trevor Anderson

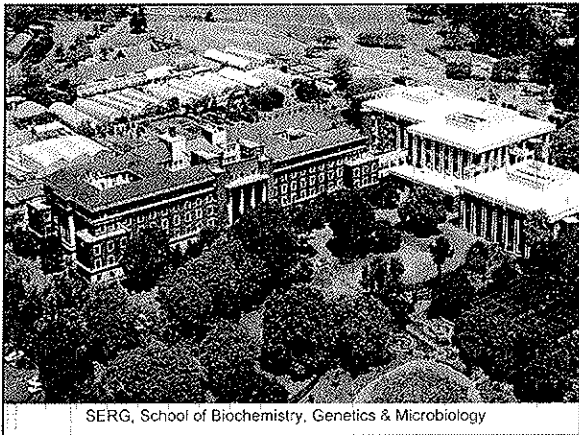
Science Education Research Group (SERG)
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Outline

1. The current educational climate
2. Innovation and scholarship in teaching
3. Assessment as a multi-purpose tool
 - a) Research probes for understanding and remediation
 - b) Assessment-driven academic development
 - c) Assessment-driven focusing of student learning
 - d) Continuous (formative) assessment (CFA)
 - e) Concept Inventory for MLS (Carrick)
4. Take-home message

1. The Current Educational Climate

The current educational climate

- Curriculum reform
- Pressure to be more innovative
- External Pressures:
 - ◆ Expectations of industry
 - ◆ Funding
 - ◆ Standards/accreditation
- Internal Pressures:
 - ◆ Discipline-specific Scholarship (SoTL)
 - ◆ Desire to do better (professionalism)

Why consider the process of reform?

- "Many great innovations from the educational literature have failed to take hold simply because the process of implementation was not properly managed" (Rogan, 2006)

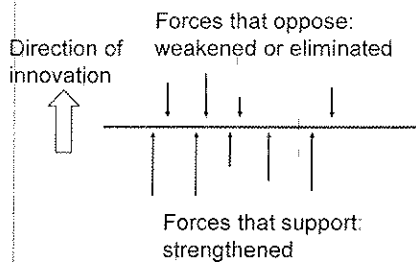
Management of curriculum reform

- Process managed by academics
- National Education Evaluation and Development Unit (Needu) Report: "Top heavy on evaluation, light on development"
- Well structured management strategy
- Academic freedom of individual
- Not change for sake of change
- Evolution (phased approach) not revolution
- Addition not replacement

Well structured management strategy- take cognisance of:

- The Zone of Feasible Innovation (ZFI)- new strategies beyond current practice, but realistic
- The Zone of Tolerance (ZoT)- those aspects of an innovation acceptable to the community
- Forces that support and oppose any innovation

Rogan (2006)

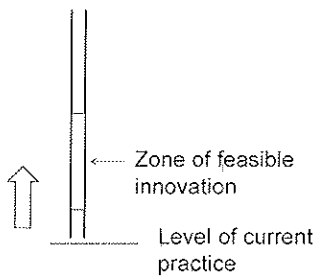


Rogan (2006)

Some Forces Opposing Innovation

- Innovation overload
- Complex change process with poor management strategies
- Historical and psychological barriers
- Staff competence, expertise, ideas
- Resources- staff, facilities, technical, financial, time, logistical
- Political, social, cultural, philosophical issues

Desired ideal practice



Rogan (2006)

A strategy for implementing an innovation

- Decide on an innovation
- List the forces that might hinder implementation of innovation
- Which could be eliminated or weakened? How could this be achieved?
- List the forces that support innovation? Which could be strengthened and how could this be achieved?
- Would this innovation fall within the Zone of Tolerance?

Rogan (2006)

2. Innovation and Scholarship in Teaching

... The most important obligation now confronting the nation's colleges and universities is to break out of the tired old teaching versus research debate and define, in more creative ways, what it means to be a scholar. It is time to recognize the full range of faculty talent and the great diversity of functions higher education must perform."

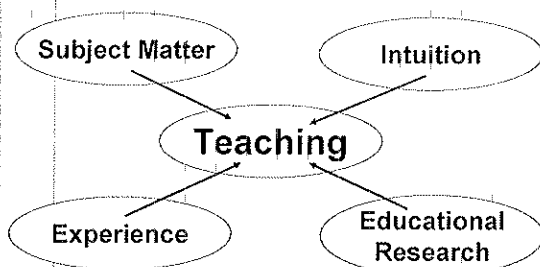
(E. L. Boyer, 1990)

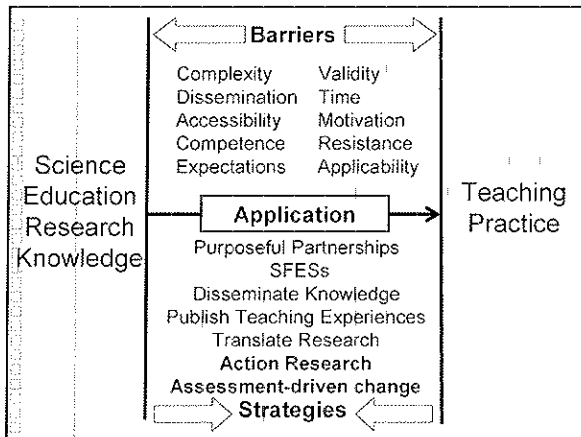
Importance of scholarship of teaching and learning (SoTL)

- "Scholarly inquiry into student learning and the public sharing of research outcomes for the advancement of teaching practice"
- Scholarship in scientific research and teaching practice (professionalism issue)
- Large body of science ed. knowledge
- Unique opportunity to improve practice

<http://www.issotl.org/index.html>

Important that teaching practice informed by research....





3. Assessment as a multi-purpose tool

a) Research probes for understanding and remediation of alternative conceptions

The majority of alternative conceptions:

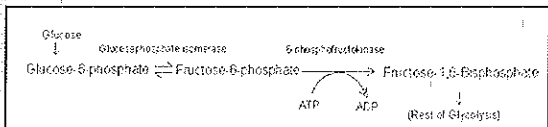
- Occur in high incidence;
- Logical to students;
- Resistant to change;
- Can interfere with learning;

(Also see CARD <http://www.card.unp.ac.za>)

Alternative Conceptions

- The inhibited reaction will proceed without enzyme, but at a slower rate (E_1)
- One of a pair of half reactions, coupled in parallel, can occur without the other (E_2)
- An inhibited enzyme-catalyzed reaction will proceed because other factors override the effect of inhibition, such as whether the inhibited reaction is spontaneous in nature (E_{3a}), or is displaced from equilibrium (E_{3b})

Consider the following part of glycolysis functioning in a cell.



If 6-phosphofruktokinase is totally and irreversibly inhibited by a toxic substance:

1) The conversion of fructose-6-phosphate to fructose-1,6-bisphosphate will: Speed up / continue at the same rate / slow down / stop

because (Probing for E_1)

2) The concentration of fructose-6-phosphate will increase and force the formation of fructose-1,6-bisphosphate.

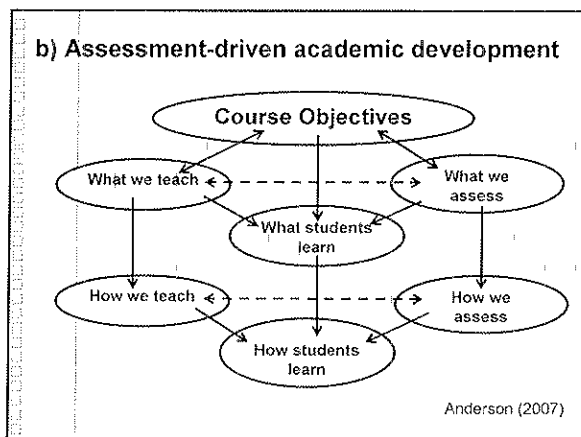
Correct/ Incorrect Explanation.... (Probing for E_{3b})

Basic Remediation Strategy

Tutorial questions that assessed:

- Critical concepts e.g. spontaneity, chemical energy, chemical equilibrium
 - Integration of key concepts composing explanatory framework
 - Essential nature of enzymes
 - Mechanisms of enzyme catalysis
- Conditions favouring conceptual change

Results					
Difficulty	No Remediation		Before Remed.	After Remed.	Prevention
	1999	2000	2001		2002
E₁	51% 44/86	48% 52/108	31% 29/95	2% 2/98	5% 4/89
E₂	27% 23/86	53% 55/103	44% 43/97	1% 1/98	0% 0/89
E_{3a}	30% 26/86	20% 23/118	34% 32/94	4% 4/98	1% 1/89
E_{3b}	44% 38/86	16% 19/118	11% 10/94	1% 1/98	2% 2/89



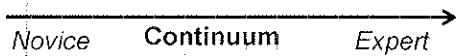
- What and how faculty assess influences what and how they teach**
- Assessment-driven curriculum change (teaching to the test)
 - The 'how':
 - ◆ Promotes specific teaching approaches
 - ◆ Develops teachers' pedagogical content knowledge (PCK)
 - The 'what':
 - ◆ Skills-based
 - ◆ Case studies
 - ◆ Theme-based
 - ◆ Problem-solving
 - Banks of questions: textbooks, concept inventories

c) Assessment-driven focusing of student learning: Use what and how you assess to promote what and how students learn

- The 'what':
 - ◆ Assessment-driven learning: learning to the test (students are strategists)
 - ◆ Assessment of cognitive including visual skills- stimulates students to develop cognitive and visual skill competence (visual literacy)
- The 'how':
 - ◆ Deep rather than surface approach to learning

(Anderson and Schönborn, 2008; Schönborn and Anderson, 2008. In preparation)

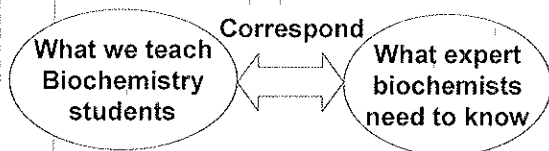
Argument for explicitly teaching cognitive and visual skills in the curriculum



- Essential components of experts' (tacit) knowledge
- Students show extensive difficulties
- Difficulties need to be addressed

Type of Graduate?

- What knowledge and skills do expert biomedical scientists require in the workplace?
- What knowledge and skills do we currently teach our students?



Understanding a concept means the ability to:

- Memorize knowledge of the concept in a mindful manner
- Integrate knowledge of the concept with that of other related concepts so as to develop sound explanatory frameworks
- Transfer and apply knowledge of the concept to understand and solve (novel) problems
- Reason analogically about the concept
- Reason locally and globally about the concept (system thinking)

(Anderson and Schönborn, 2008; Schönborn and Anderson, 2008, In preparation)

Example of task promoting transfer and application of knowledge

- Transfer- "ability to apply knowledge to solve problems, answer questions, facilitate learning new subject matter" (Mayer & Wittrock, 2002)
- "Imagine that you are a molecule of ADP inside a cell. Describe how you manage to "find" an ATP synthase, so that you can become an ATP.
 - a) I follow the hydrogen ion flow
 - b) ATP synthase grabs me
 - c) My electronegativity attracts me to the ATP Synthase
 - d) I would be actively pumped into the right area
 - e) By random motion or diffusion"
- Provide a reason for your selection above....

Klymkowsky et al., 2007

Visual literacy encompasses ability to:

- Decode the symbolic language composing an ER
- Evaluate the power, limitations and quality of the ER
- Interpret and use an ER to solve a problem
- Draw or modify an ER to explain a concept or solve a problem.
- Spatially manipulate an ER to interpret and explain a concept
- Translate across multiple (abstract, stylized and realistic) representations of the same (and different) concept(s)
- Visualize concepts at, and translate between, various levels of organization and complexity (macro, micro, sub-micro).
- Visualize orders of magnitude, relating to the concept, with respect to quantity, relative size and scale

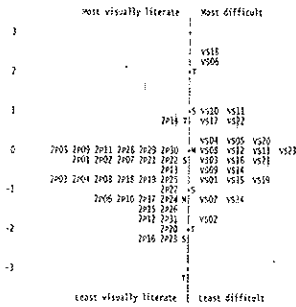
(Anderson and Schönborn, 2008; Schönborn and Anderson, 2008, In preparation)

Describe and discuss all the different types of protein structure that are/are not represented in the slide (Promotes teaching of models and symbolic language)



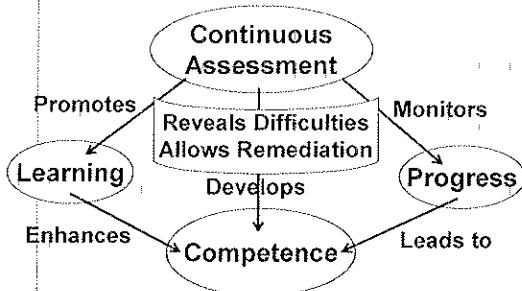
Rasch Analysis: Person-item map of students' visual literacy levels vs order of difficulty of various visualization skills

- Converts non-linear raw scores to linear logit values
- 2PC5, etc at 0 logits, have a 50% probability of answering probes VS 08, VS 12 etc
- 25% chance of answering VS 10 & 11
- Instrument sensitive to differences in skill difficulty and student competence
- Mean of person abilities lower than mean for item measures- the test instrument too difficult for most students



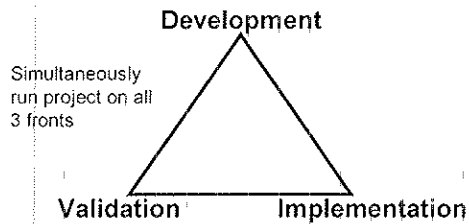
d) Continuous Formative Assessment (CFA)

Scaffolding of knowledge and skills- exams not necessary!



e) Concept Inventory for MLS: Essential Phases

- Carrick project: Hamilton, Wright (UQ, Susan Howitt (AUC), Manuel Costa (Minho), Anderson (UKZN)



Howitt et al. 2008 Aust. Biochemist

Development Phase: Expert Perspective

- Aim:
 - ◆ Identify core knowledge
 - ◆ Design assessment tasks

Design of Assessment Tasks

- 1) What key criteria characterize quality MCQs?
- 2) What approaches can we use to identify authentic alternative conceptions (distractors)? – Major problem!

Validation Phase: Student Perspective

- Aim:
 - ◆ Use CI on students at selected test sites- in progress
 - ◆ Use quantitative and qualitative educational research to check validity of CI tasks and identified core knowledge

Some Questions

1. Is the knowledge identified as core really core to understanding our discipline?
2. Do the CI tasks:
 - Correctly assess conceptual understanding and cognitive skill competence?
 - Detect students' alternative conceptions?
 - Detect students' visualization difficulties?
 - Detect changes in student knowledge?
 - Pass item analysis tests?

Schönborn, K.J. & Anderson, T.R. (2009) *Int. J. Sci Educ.*, 31 (2), 193-232
Anderson, T.R. & Schönborn, K.J. (2008) *BAMBE* 36 (4), 309 / 36 (5), 372

Implementation Phase: Does it contribute to improving education in our discipline?

Some Questions

- How would it be best to disseminate knowledge of the CI to the community?
- What strategies could be used to promote its use?
- Does it yield useful data for improving teaching practice and curriculum design?
- Does it inform remediation and prevention strategies (Literature)? – a key step!
- What future educational research projects could emanate from use of the CI?

Take-home message

- Curriculum reform can be a fruitful and rewarding process if properly managed
- Innovation and scholarship are a part of professional practice
- Promote SoTL through research-based education in our discipline
- Assessment is an extremely powerful tool for improving the quality of education

Acknowledgements

- Lynn Rodgers for the kind invitation
- SERG students for all their contributions
- NRF, UKZN, Carrick for research sponsorship