Enhancing Creativity in Scientific Thinking

2010 CASTL Institute

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A Practitioners Journey ...

Student Feedback

- Content heavy lectures/rote learning
- Lack of relevance of chemistry
- Bored/overwhelmed in labs

Our Goals

- Increase engagement
- Build interdisciplinary thinking
- Enhance learning – peer interactions
- Improved transitions
- Reduce attrition

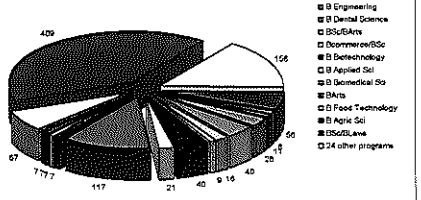
536 Female: 470 Male Students

Wide range of Academic Abilities (OP1-18)

60 Countries of Birth
(29 Permanent Countries including: Australia, Malaysia, Korea, Hong Kong, Singapore, China, Macao, Taiwan, USA, Japan, New Zealand, Vietnam, Saudi Arabia & Kuwait)

'Melting Pot'

Typical 1st Year Cohort (2008)



Up to 40 programs represented

Instructional Design informed by literature:

Addressing Diversity & Engagement

Learning communities; transitions and collaborative learning;

- **Kuh, GD** (2003) What we're learning about student engagement from NSSE. *Change* 35 24-32.
- Smith, K.A., Sheppard, S.D., **Johnson, D.W. and Johnson, R.T.** (2005). Pedagogies of engagement: Classroom-based practices. *Journal of Engineering Education* 94(1) 87-101.
- Van den Bossche, P., Gijselaers, W.H., Segers, M., and **Kirschner, P.A.** (2006) Social and cognitive factors driving team learning beliefs and behaviours. *Small Group Research* 37 490-521.

Constructivist Strategies

SOLO Taxonomy; authentic assessment;

Biggs, J.B (1999). Teaching for quality learning at university. Open University Press pp. 165-203.

Active Learning (for deep learning)

Learner centred (inquiry & discovery); engage in a learning cycle

Prince, M & Felder, R (2006) Inductive teaching and learning methods: definitions, comparisons and research bases. *J. Engr. Ed.* **95** 123-38.

Research Questions at this point:

Through the introduction of a collaborative research task, have we:

- Enhanced engagement?
- Increased relevance of chemistry?
- Initiated the sense of learning communities?

Research Methodology

Mixed Methods Approach:

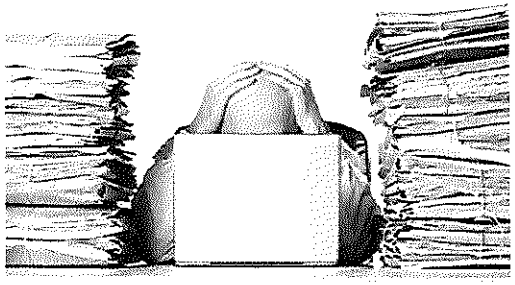
- Diagnostic & Course Evaluation questionnaires (N = 250 – 750) (Likert: Agree/Disagree and Student Assessment of Learning Gains (SALG) instrument)
- Open questions in surveys
- Focus group interviews (N = 6-8)
- Ethical Clearance (Institutional)

Analysis

- **Quantitative data:** Likert Scale Questions Statistical Analysis (SPSS).
- **Qualitative data:** Interviews and response to open questions. Independently transcribed and then coded inductively by 2 people to identify emerging themes. (Nvivo)

Academics perspectives:

Great idea but how do we manage 300+ groups & their assessment?



A: Online management & Peer Marking!

- Forum to facilitate group collaboration during task
- Online submission of group product
- Peer marking for group function
- Peer marking for other groups' products
- Instructor moderation

} Assessment focus on learning gains through collaborative interactions

Iteration 1: Semester 1 & 2 2008

Semester 1 2008:
Poster Task: (1034 students)
Topics included: hangovers, vaccinations & autism; concrete

Semester 2 2008:
Written Task: (1005 students)
Instrumental techniques: PET; TOF-SIMS; EXAFS

Iteration 2: Semester 2 2009

Pay more attention to grounded theory .....

- Students clustered by programs (eg pharmacy; Biomedical Science etc)
- Groups formed by distributing academic ability, gender & nationality

Research topic & a stimulus article assigned → program:

Pharmacists: Herbal Antioxidants
Arts: NanoViolin String
Biomedical Science: Snow Flea Antifreeze
Dentists: Cavity Fighting Candy

Task: Identify & communicate the chemistry concepts and link these to the application

Locus of Control

The dependence on the academic abilities and working with people they don't 'know' were the biggest factors for students who prefer to work alone.

The noise of group dynamics and negative interdependence obscured evidence of:

- Enhanced engagement
- Increased relevance
- Interdisciplinarity

We needed to enhance 'positive interdependence, accountability, cognitive development and social development' (Slavin 1991)

Evolution of collaborative inquiry activities:

2008	2009	2010
Poster Group Task:	Report Group Task:	MetaQ ResearchTask:
• Random topic assignment	• Strategic topic assignment	• Choice of topic
• Random group formation	• Strategic group formation	• Self-selection of groups
• Peer evaluation	• Peer evaluation	• Interdependence
• Peer marking	• Peer marking	• Peer evaluation
		• Peer marking

Task Facilitation:

Web-based group domain where students:

- Are guided through sign up & group formation
- Opt for an Individual Quest and have drop box for information
- Collaborate through a discussion forum (with threads)
- Upload a final report (1 per group)
- Are stepped through internal & external assessment
- Receive mark and feedback

Each report is viewed and marked by at least 12 students to encourage reflection and comparison to their response.

Our Challenges .... Diverging research Qs!

- How do we measure shifts in engagement, relevance, interdisciplinarity, integrative thinking?
- How do we access the group process to explore the role of peer interactions in developing higher order thinking and creativity (divergent thinking)?

Our worry - Are going to over-evaluate the students?

Scales/questionnaires for:
Interdisciplinary thinking
Engagement
Group process
Cognitive expectations

Theoretical frameworks and models .... 'Top down' issues!

Instructional design based on multiple grounded theories & models opens a can of worms .... Which way do we go?

•Collaborative group work/learning communities (social dependence)
•Active learning (inquiry/scenario based learning)
•Authentic assessment (graduate attributes)
•Cognitive (creative thinking)

And then ...

The experts don't agree on the effectiveness of minimally guided teaching: techniques : Sweller, Kirschner & Clark (2007) Educational Psychologist 42, 115- 21.