Enhancing creativity in science and engineering students:

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The process of generating unique products by transformation of existing products. These products, tangible and intangible, must be unique only to the creator, and must meet the criteria of purpose and value established by the creator. (Welsch in Isaksen et al., 1993)

In a creative act of perception one first becomes aware (generally non verbally) of a new set of relevant differences and one begins to feel out or note a new set of similarities which do not come merely from past knowledge. (Bohm, 1998)

Creativity is a process needed for problem solving. Secondly creativity is not a special gift enjoyed by a few but a common ability possessed by most people which can be developed or suppressed as a result of their individual experiences. (Jones in Isaksen et al., 1993)

The making of the new and the rearranging of the old (Bentley, 1997)

Improbabilist creativity – new and valued creativity within constraints
Impossibilist – transformation of conceptual space – new ideas arise that were impossible before (Boden, 1996)

Conceptual combination – merging of two or more concepts resulting in a novel entity (Ward et al., 1997)

The ability to perceive reality accurately and compare cultures objectively, having a genuine degree of spontaneity and being able to look at things in a fresh, simple, naive way. (Davis in Clemen, 1996)

A creative person can regularly solve problems or can fashion products ranging from a theory to a new technique in a domain in a way that is ultimately judged acceptable (although initially it may seem bizarre) by the field; in this case the field is a cultural setting of people and institutions that make judgements about new products in a domain. (Gardner in Russell, 1998)

The process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficult; searching for solutions, making guesses or formulating hypotheses about the deficiencies, testing and retesting them and finally communicating the results (Torrance, in Isaksen et al., 1993)

The development of creative alternatives in decision problems (Clemen, 1996)

An unease emerging out of a struggle between two opposing forces (Robinson / Rundell, 1994)
Creativity is ...  
SHARED IMAGINATION
...is INNOVATIVE when a commercial application becomes apparent

If this is not 'domain-specific' it becomes an INVENTION
Preparation
Incubation
Unconscious incubation
Illumination
Verification

(CLEMEN, 1996)

Preparation
Generation
Incubation phase
Evaluation
Implementation

(GELB, 1996)

Problem description
Briefing: 'The problem as given'
Formulation and reformulation
'The problem as understood'

Idea development
Purge
Creative move

Critical step
Clustering
Selection
Criteria check

Final report and action planning
(COCD, 1999)

Innovation
Clarification
Distillation
Perspiration
Evaluation
Incubation

(PETTY, 1997)

Imaginative insight
Find ratios
Rational insight
Imaginative fancy
Rational fancy

(BOHM, 1998)

Generative – memory retrieval, association, mental synthesis, mental transformation, analogical transfer, categorical reduction

Exploratory – attribute finding, conceptual interpretation, functional inference, contextual shifting, hypothesis testing, searching for limitations

(GENOPLORE MODEL; FINKE ET AL, 1992)
Preparation

‘Is this the right question?’ Gelb, 1996

Generation

“If you want to get a good idea, get a lot of ideas.” Linus Paulling

Incubation

“I call intuition cosmic fishing, you feel a nibble then you’ve got to hook the fish, after bathing the hook through preparation and generation, and trolling deep waters with incubation it’s time to reel in the catch” Buckminster Fuller.

Verification
Preparation
Prior knowledge
Problem setting
Freedom
Immersing into a way of thinking

Generation
Convergent/divergent thinking
Knowledge building
Personal development
Creativity techniques
Group/personal

Incubation

Verification
Valid Student evaluation
And Assessment

Unblockers

Stimulators

Communicators
Revisit the course content and the way concepts are organised. Can they be logically ordered in a different way? Ask the students to create a mind map of how these concepts link together and to other parts of the course.
Ask students to write a reflective analysis of their work – why they did it the way they did, and mark it as part of the assessment.
Visual research - ask students to collect together all manner of items which they can see, hear, feel etc which allow them to explore different perspectives and different ways of looking at their problem - a three dimensional brainstorming
Engineering students teaching design students about composites and design students teaching engineers about visual thinking

Travelling zone - international, interdisciplinary workshops to design and make with composites
Composites workshops

- ‘I learnt how to use composites – seems like we can use a low tech process to create high tech materials’
- ‘Engineers know how strong they are and whether or not a process is likely to work. We play and come up with ideas that use the whole notion of what composites are... Then we work out what’s possible and get on with it…’
- ‘I can see the potential of composite materials in a new way now’
- ‘Composites are like nature – you can show dynamic properties unlike any other material’
- ‘Learning the concepts through cartoons was great – I understood them for the first time!’
Creating a Creative Learning space
“I call intuition cosmic fishing, you feel a nibble then you’ve got to hook the fish, after bathing the hook through preparation and generation, and trolling deep waters with incubation it’s time to reel in the catch”
Buckminster Fuller.