Should we be more creative when teaching science?

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Overview

How we learn
Traditional way science is taught
Drivers for change
Ways of embedding creativity within the curriculum
Challenges
Should we redesign the curriculum to provide students with more time and space to be creative?

“The great engine of academic creativity is intellectual curiosity - the desire to find out, understand, explain, prove or disprove something or simply to imagine something different”

Jackson et al, 2006
“I have no special talents. I am only passionately curious.”

Albert Einstein, 1952

Tom Woodward @ bionic teaching

http://www.mountainhome.af.mil/

Sugata Mitra, 2016
“Schools teach how to answer, not to question”

Csikszentmihali, 2006

https://www.scienceabc.com/
In the early stage of science education we unconsciously discourage students from questioning by indoctrinate them with facts and certainty

Jenny Waller, 2016

“For students of particular disciplines, the invisible, taken-for-granted nature of paradigms has obvious functional advantages since it means they can work within their chosen field without wasting time attempting to redefine or defect the 'hypothetical rules of the game'.”

Kuhn, 1974
“Until the very last stages in the education of a scientist, textbooks are systematically substituted for the creative scientific literature that made them possible”

Kuhn, 1974
“Creativity is inhibited by predictive outcome-based course designs, which sets out what students will be expected to have learned with no room for unanticipated or student-determined outcomes”

Jackson, 2006

“There is a general disengagement from science through tedium”

Brooks, 2011
We have been teaching science this way for centuries so why should we change this approach now?

https://jamesaltucher.com/
“social and creative skills; decision-making under pressure and the development of novel ideas”

Klaus Schwab
World Economic Forum
Judgement and Decision Making
Fluency of ideas
Active learning
Systems evaluation
Originality
Learning Strategies
Deductive reasoning
Complex problem solving
Systems analysis
Monitoring

“Interdisciplinary view - original thinkers and problem solvers”

‘Soft Skills’

- Initiative
- Resourcefulness
- Communication
- Mathematical Skills
- IT Skills
- Teamwork
- Organisation Skills
- Enterprise
- Creativity
- Lifelong Learning

Can we learn from the way design based art disciplines are taught?
Principles of practice based arts teaching

Teach method, not content

Principles of practice based arts teaching

Encourages exploration and experimentation
Principles of practice based arts teaching

Provides a safe space to fail

Principles of practice based arts teaching

Assessments focused on process not outcome
Principles of practice based arts teaching

Educators are tutors; role is as a facilitator rather than teacher

Can we adopt similar approaches within the sciences?
Traditional Practical Session

Barnett, 2014

Traditional Lab Skills Development
Each group provided with:
10 ml 3% Hydrogen Peroxide Solution
10 ml 1% Potassium Iodide Solution
5 ml 50 mM Ascorbic Acid
5 ml Starch Water
Distilled Water

20 Test Tubes
A Stopwatch
A P1000 Micropipette and blue tips
A P200 Micropipette and yellow tips
Graph Paper

S. Thompson, J. Vernon & J. Murray (University of Westminster)

Recall, Adapt & Apply

“Provide all equipment and reagents - but limited instruction so they need to recall prior knowledge & experience”

Alison Sinclair
http://tinyurl.com/hikp3wt
What happens if you allow students become teachers?
“It’s really valuable to have the opportunity to try and teach others what you have been taught, helps to condense and revise”

Student Quote
School Outreach Activities

STEM Festival
Students as teachers

- Initiative
- Communication
- IT Skills
- Organisation Skills
- Creativity
- Resourcefulness
- Mathematical Skills
- Teamwork
- Enterprise
- Lifelong Learning

Can we rethink the way we assess skills?
Objective Structured Practical Examination (OSPE)

Based on approach commonly used in medical and pharmacy education

- ECG Measurement
- Serial Dilutions
- Respiratory Testing (calculations)
- Solution making
- Urine analysis
- Phlebotomy

Student Observable Behaviors

**Learning Design**
- Practical problem-led holistic workshops
- Challenges, mini-projects and case studies

**Self-paced**
- Students dictate pace and order of which learning outcomes are demonstrated
- SOB Online tool

**Assessment**
- Competency based (Pass/Fail)
- Stretch and Challenge (Threshold, Typical or Excellent)
- Assessed Labs, group sessions, presentations or one-to-one tutorials
What happens if you give students the choice to learn through creativity?

Research Methods Module

Students can chose traditional lectures or a 'creative' alternative

THINK MAKE LEARN SHARE
Research Methods Module

Students can chose traditional lectures or a 'creative' alternative

THINK MAKE LEARN SHARE

Ambitious when given their freedom
Take ownership of the learning process
Willing to take risks and try things out
Learning through the doing - learning from their mistakes
Motivated by being able to share what they had created

Mark Feltham on Who-topia

What happens you allow students to collaborate across disciplines?
Interdisciplinary Art/Science Module

Broad Vision
Art/Science Research & Learning at the University of Westminster


Broad Vision
Art/Science Research & Learning at the University of Westminster

Mell Fisher, Kitti Edwards & Freddie Bell
Judd Welland, Malgorzata Stasiewicz & JJ Hastings

Idea Translation Lab

2015 - Future Farm
2014 - Strange Weather
2013 - Synthetic Biology
2012 - Hack the City
2011 - The Future of Water

1 theme
12 weeks
1 lecture + 1 ‘lab’ per week
A final pitch
Public output - cultural/social/scientific value
Emergent Team Projects

- Initiative
- Communication
- IT Skills
- Organisation Skills
- Creativity
- Resourcefulness
- Mathematical Skills
- Teamwork
- Enterprise
- Lifelong Learning

Extracurricular team competitions

iGEM
INTERNATIONAL GENETICALLY ENGINEERED MACHINE
LEARN.BUILD.SHARE.
WITH THE OFFICIAL STUDENT HACKATHON LEAGUE

Global Game Jam® January 25 – 28, 2018
Search
International competition

8 weeks

Open community for synthetic biology collaboration

Fundraising and Sponsorship

Public engagement


Extracurricular Team Projects

Initiative
Communication
IT Skills
Organisation Skills
Creativity

Resourcefulness
Mathematical Skills
Teamwork
Enterprise
Lifelong Learning
Should we redesign the science curriculum to provide students with more time and space to be creative?
“You need time and space in your mind to be creative and if your mind is full of studying this that and the other then there's no space for it”

Student quote in Jackson, 2006
Getting the balance right

Content  Learning by doing

Challenges
Setting Expectations

Teamwork & Project Management
Creating a safe space to fail

“Let’s try it without the parachute.”

http://nelsonscolumn.co/

Assessment

Research Journal  Critical Evaluation

Focus on process not output
Summary

Traditional teaching approaches often provide limited opportunities for creativity
Redesign of the curriculum can reawaken curiosity and tap into intrinsic motivation to learn
Expand opportunities for original thinking and problem-solving
Requires time and space in the curriculum as well as a safe environment to fail

Mellissa Fisher, 2015