

# **\$10 MULTIMETERS: RECLAIMING THE 'MAKER CULTURE' OF AMATEUR SCIENCE**



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PRESENT BY MICHAEL FENTON, M.Sc., Dip. Tchg., MRSNZ



## OUTLINE FOR THIS TASTER SESSION

- Introduction
- Reclaiming the Maker Space
- Aiming high – student outcomes
- Meeting a need
- Get Making!
- Bonus material

## WHO AM I?

- Programme Leader / Lecturer / Writer
- Science Teaching / Mathematics Teaching
- Registered teacher
- Research and industry experience
  - Game design/coding, robotics, biology, chemistry, physics, calculus
  - Ministry of Education eLearning Fellow
  - Microsoft Innovative Teacher
  - 2014 DEANZ eLearning Excellence Award
  - 2015 Prime Minister's Education Excellence award
  - Director/consultant, Focus Consultancy




[www.Focus-Consultancy.co.nz](http://www.Focus-Consultancy.co.nz)

[www.NexusResearchGroup.com](http://www.NexusResearchGroup.com)

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## PRIMARY SCIENCE / PRIMARY MATHEMATICS SCHOOL OF SCIENCE, TECHNOLOGY AND ENGINEERING



The image block contains two photographs. The left photograph shows the exterior of a modern building with a curved facade and large windows. The right photograph shows the interior of a large, multi-level atrium with a high ceiling, skylights, and a large wooden sculpture in the foreground. A URL is provided below the left image, and a footer with the presenter's name and navigation arrows is at the bottom.

<https://www.flickr.com/photos/cogdog/>

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Lower Hutt campus, North Island, New Zealand

100% of students learn by distance; not a student in sight!

Open Polytechnic is the only single mode open and distance learning provider in New Zealand. We provide flexible learning for over 34,000 mainly adult learners studying part-time, the majority combining work and study. All our courses are quality assured and accredited by NZQA.

## SCIENCE / MATHEMATICS TEACHING MY LABORATORY



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New Plymouth, Taranaki, North Island, New Zealand

Staff, as well as students, off campus.

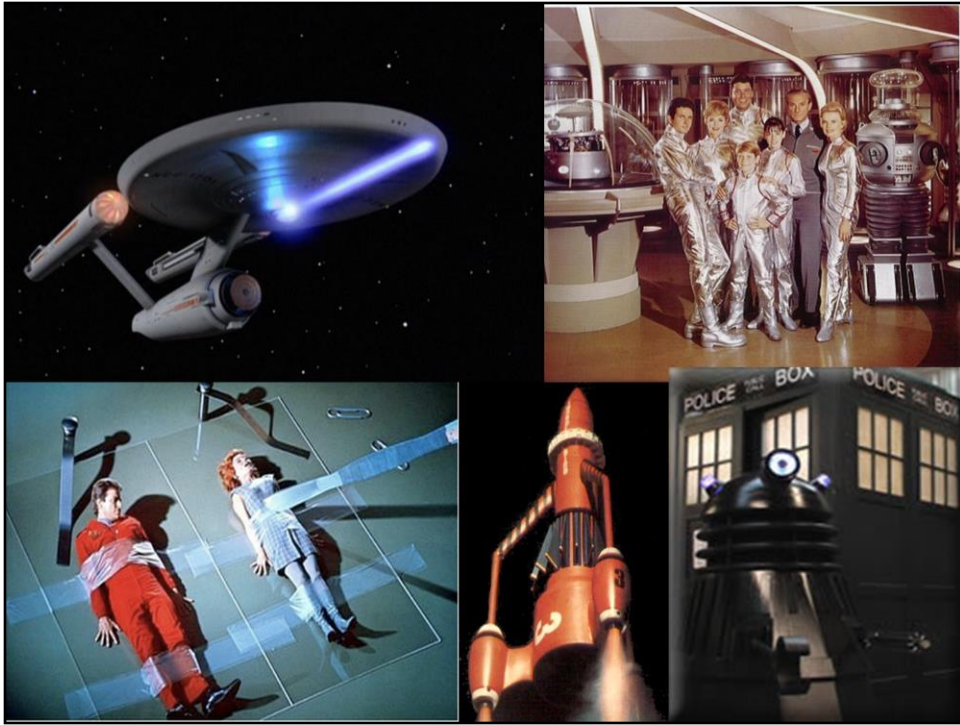
Taranaki region does not have a tertiary institute with science or teaching expertise / programmes



How did I get involved with the Open Polytechnic?

How does my industrial and research experience influence my decisions about what I teach and how I teach?

Ultimately, how does this impact on student learning?



For me, being a child of the late 60's and early 70's, scientists were heroes, not lab geeks or nerds!

They were fit, athletic, and knew how to save beautiful monsters from ravenous maidens!

Science was cool, immensely exciting and called upon the cunning and creativity of its heroes to save the situation!

As a research scientist with industrial experience who retrained as a teacher, it has been interesting to note the assumptions about science that many of my colleagues have. Even at Secondary level, hearing that "science is rather dry and boring" from other science teachers was not unusual.

How many of you have a vision of what a "typical" scientist looks?

How many of you would doubt that school children could ever contribute anything meaningful to the scientific community?

Don't you need a degree to do that? And a lab?

For me science topics are meant to be investigated as if we are trying to confirm these concepts, not just rote learn them...that is part of the nature of science.



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## AIMING HIGH – STUDENT OUTCOMES

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NEW ZEALAND

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Michael & Christine

Student Achievement

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Students/Parents

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Gifted Children

Microbiology

NCEA and Science

Nature of Science - what it looks like

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CST Experiments

# Nexus Research Group



Taranaki, New Zealand. **Original** articles, experiments & ideas for parents, teachers & students of all ages.




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**SEARCH / index**  
everything in one spot!

**April hot topics**

Taranaki Science Fair 2016; Entry forms & details here and winning [Science Fair projects](#)

**FEE FREE study for Primary teachers;** become a confident and effective maths teacher with course fees paid if you enrol in the [Graduate Certificate in Primary Mathematics Teaching](#)

DEANZ 2014; Michael Fenton wins [DEANZ Excellence Award](#) for his contribution to eLearning in New Zealand

Fun experiments / technology - [for teachers, parents and students](#)

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When I first entered teaching after leaving the University sector I decided to keep hold of my own authentic experiences in science...so the first school-based research group was founded in 1997. My wife Dr Christine Fenton and I encouraged students to "Question everything" .

This was not a science club...but a chance for students to work in an authentic setting with authentic roles and responsibilities to publish findings, attend conferences, and see what science is really all about!

www.NexusResearchGroup.com



Why do I believe our children at Primary and Secondary level have so much untapped potential?

Part of this comes from being a scientist, part comes from being a parent, but most comes from believing that science is as simple as “noticing something worth noticing” ...and then finding out more.

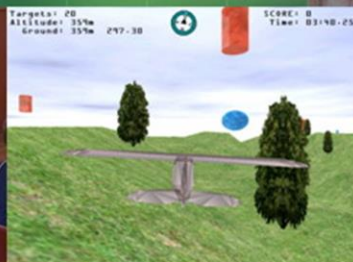
I build a lot of my own science equipment, largely by trial and error, and try to link it with ICT to make some interesting and very cool projects. Imagine making a heart beat sensor for 20 cents, and seeing your own heart beat on a computer screen!

What if you made this into a game using free game design software, and teach your class how to do this for themselves!

# MINISTRY OF EDUCATION E-LEARNING FELLOWSHIP SCIENCE AND MATHEMATICS



## Physical fitness



## MEETING A NEED

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## SEND IN 'EXPERTS' OR BUILDING EXPERTISE?





- Geographical isolation and travel time to professional development
- Lack of professional development opportunities for Primary/Secondary
- Class release time
- What is an 'expert'? Is there a 'right' way to teach?
- It takes time to embed meaningful changes to practice

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In 2012 the Open Polytechnic launched a unique NZQA approved Level 7 Primary Science Teaching programme to improve the science knowledge, competence and confidence of Primary teachers and lower Secondary teachers (Y9 and Y10) to teach science.

2 Certificates make up the Diploma

Certificate in Primary Science Teaching (Curriculum) focuses on improving classroom teaching and learning; most teachers will complete this

Similar courses for Primary/lower Secondary Mathematics Teaching.

2015 Prime Minister's Education Excellence Awards finalist



The course design for the first compulsory course in Science Teaching– very hands-on focus throughout.

The first module asks teachers to do an at home investigation, “Being a scientist”. The second module “Being a student of science” provides content knowledge, eg, what are cells?

BUT, there is a mix of read, view, do, activities. Encourages teachers to ‘get their hands dirty’ and try a number of practical activities.

Each course covers a different aspect of the Nature of Science; Living World looks at “Investigating in Science”

So in the second module, each chapter finishes with practical ideas suggesting how this knowledge, eg, about cells, could be rediscovered by children.

Topics are all framed in this way, not information to rote learn, but concepts to be rediscovered and reconfirmed through practical work and investigation!


# GET MAKING!



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**RICHARD FEYNMAN**  
**YOU CAN'T FOOL REALITY**

"It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong."



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Why is authentic science important?

Why is hands-on science important?

Going to the library or going online is not research...it is just passively accepting in an uncritical way second-hand information.

"I did some research in the library..."

Far too many low quality science sites online.

Teachers often share resources, perhaps unaware of factual inaccuracies, health and safety issues, etc

## SCIENCE AS “TO CONFIRM, NOT LEARN”



- World first...using a digital multimeter as an datalogger substitute
- Not just for Seniors
- More than occasional specialist experiments
- Reminds us maths is a science too

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Traditional silos of knowledge such as biology, chemistry and physics as taught in schools no longer match the way science is done now.

The Secondary / High School system is too tied to NCEA; so if you want to revamp science, it is at the Primary level where the greatest impact can be made.

Teachers guide students through 3 steps as they make their own sensor system kits;

- BUILD IT
- TEST IT
- USE IT

Testing may include calibrating sensors to give real-world values, eg, temperature in degrees Celsius

## A WIDE RANGE OF SENSORS – “MAKER SCIENCE”



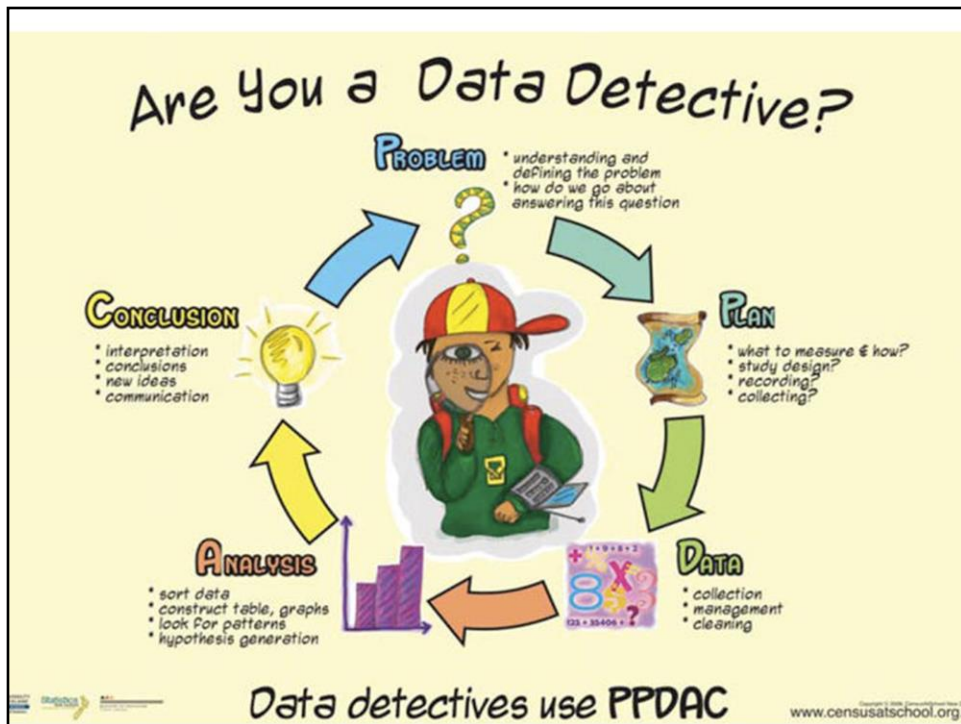
- sensor\_angle
- sensor\_carbon dioxide
- sensor\_colorimeter
- sensor\_conductivity
- sensor\_current
- sensor\_ecg
- sensor\_em field

Kits can be developed with the help of students and stored easily.

Many sensors cost \$1 or less (bought in bulk), so students could purchase their own multimeter, but the school supply consumables such as the sensors.

Time to go through the BUILD IT and TEST IT phases yourselves!

Handouts are for you to take away.



Mathematics and science, as a process in schools, follow a similar cycle; looks a lot like the traditional “scientific method”

Primary teachers often report they don’t have time for science; why not use science activities to develop authentic numeracy skills?

Using the multimeters permits students to pursue their own investigations after they have completed the introductory activities with the teacher.

This is a form of authentic learning that permits students to develop and improve their key competencies, explore concepts in science topics first-hand, and develop their mathematical skills.




Assembling a sensor and using mathematics to describe how it functions.

Here a maths class goes through the BUILD IT, TEST IT phases.

This activity reminds students that mathematics is based in the real world and has real world consequences if calculations are incorrect...

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## TAKE SCIENCE HOME



- Key competencies
- Higher level thinking
- Practical skills assessment
- Research!
- Real investigations!
- Cheap – about \$10
- Robust
- Simple to use; Yr1 –Yr13

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<http://nexusresearchgroup.com/technical-data/multimeter-sensors.htm>

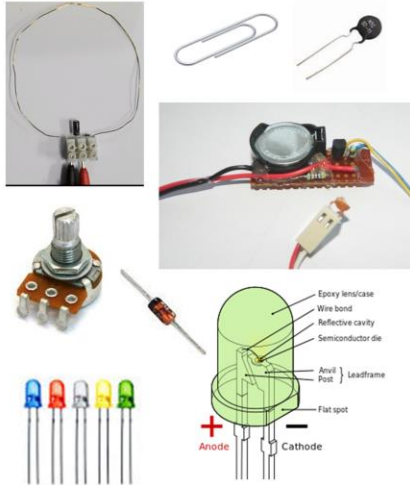
For more about authentic science, using inexpensive equipment students can take home, to embed numeracy skills.

Here a student enters the third phase, USE IT.

She has decided to investigate the air temperature at various locations and distances above the floor.

She could then investigate temperature at home, perhaps exploring convection currents, the effect of curtains on windows, etc.

## MAKER SCIENCE - TIPS



- Any device, any material
- Responds to environment
- Change in
  - resistance
  - voltage
  - current
- Passive - simplest
- Active - powered

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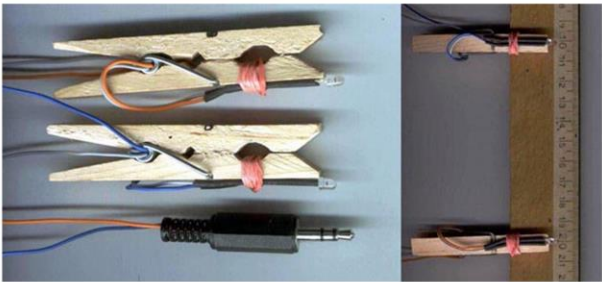
## BONUS – MIC INPUT SENSORS


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## BONUS





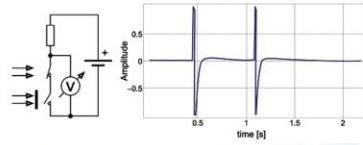
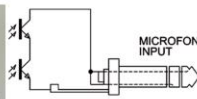
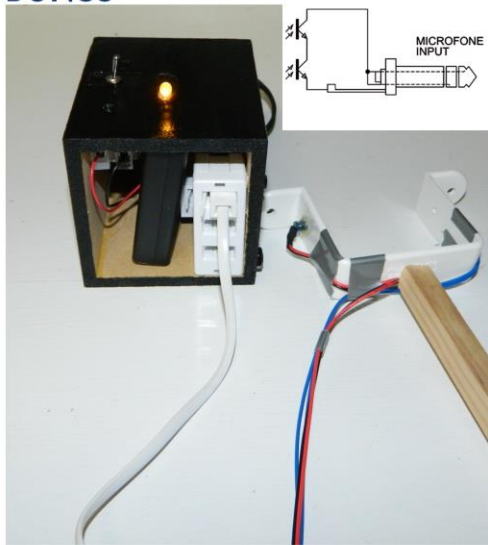
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An alternative low cost system to capture data is to cut the plug from an old pair of headphones (or purchase a 3.5mm stereo plug as in the photo) and connect a light dependant resistor or photodiode.

If plugged into the mic socket, changes in light levels can be seen using sound recording software.

This system can be used for time of flight investigations, acceleration due to gravity, motion of a pendulum, and impact sensing.

**BONUS**

## BONUS



## MEETING A NATIONAL NEED SUPPORTING COMMUNITIES OF PRACTICE

- Study while you work
- Study anywhere
- Study any time
- Creating leaders in education



Fascinating stuff so far. I really like the way this material is presented ..."

# THANK YOU

[www.openpolytechnic.ac.nz](http://www.openpolytechnic.ac.nz)



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