

# **Birth and affiliations**

Born Rotorua, 1968. Ko Turi o Murimotu te maunga, ko Tokiahuru te awa, ko Ngāti Rangi te iwi; ko Ngā Mokai te marae.

## Schools

Lynmore School, Rotorua, and St Paul's Collegiate, Hamilton; "I was one of two Māori at the college". Chemistry, Physics, Maths – "te reo Māori wasn't offered".

## How he got into science

"I wanted to understand the workings of the world. I come from a farming background, and science had good explanations."

# **Training and jobs**

**BSc** (Maths/Physics) with honours, 1990. **PhD** (Physics), Massey University, 1997 **Lecturer** in physics, electronics and science, Massey University Albany during PhD.

**Postdoctoral researcher** in medical physics, University of California, USA

**Software/network engineer**, Silicon Valley. **Teaching Diploma**, Wellington Training College, 2004.

**Physics/Science teacher**, Onslow College; **Senior Teacher** in Māori Achievement, Correspondence School.

**Lecturer** in education, Mātauranga Māori, Victoria University of Wellington, 2013-2020. **Principal Investigator**, MacDiarmid Institute, University of Auckland, 2018-2020.

Senior advisor, Oranga Tamariki, Wellington. "MRI is very high-tech with a lot of

programming, so I was able to cross over into

IT. It was a very interesting time in Silicon Valley but the work was a bit soul-destroying, so we came home and had a family. I was overqualified for the IT industry here."

maintains

strong friendships

with

former

teaching

colleagues.

"I'd always loved teaching, so I retrained with a one-year diploma, and taught at secondary school. I quickly got into Māori achievement; our principal encouraged us to do innovative and interesting things."

For the Correspondence School, "I worked online, supporting Māori organisations around Wellington that used the school for science, because they didn't have science teachers."

"The education system openly and tacitly encourages you to leave your Māoriness at the gate. It was only after a long time that I realised how much I was missing. Students need to expand their mātauranga Māori the same as their science."

"My work was always about trying to make change for tamariki, whether in education, research or social care. Seventy-six percent of children in care are Māori, but there are no specific questions for them about how to improve their cultural connections – we're trying to get tamaraki voices influencing policy."

# **Fields of science**

Physics, mātauranga Māori, Māori educational achievement. "These days I'm happier in Māori Studies than science."

## **Research topics and examples**

#### Materials science - complex fluids

"My PhD measured shearing, slipping and spurting in complex non-Newtonian fluids." Non-Newtonian fluids are not fully liquid or solid, and sudden force or pressure changes



their viscosity, or thickness. Examples of these fluids include "different polymers added to oils to help reduce friction," says Craig, "and Xanthan gum added to toothpaste to help it squeeze out of the tube. A swimming pool of corn starch thickens so quickly, you can run across the top of it" (see link video).

"We measured fluid movement with nuclear magnetic resonance (NMR) microscopy, the same technology as MRI. Large magnetic fields enable us to look at very small spaces, using radio frequencies rather than light."

Working with physicist Paul Calaghan, Craig and others "built apparatus to measure the elasticity of fluids, and created a machine inside an NMR microscope, the first time it was done. It produced fields with steep magnetic gradients, able to measure diffusion, the tiny movements of molecules".

Craig's USA research built the same steep magnetic field gradients to measure fluids moving in the carotid (neck) arteries of war veterans with atherosclerosis. In this slow, progressive disease. deposits of fatty substances form plaque on the walls of arteries, making them thick and stiff. "We built a tiny NMR apparatus to fit around the neck."

#### SPRINGER BRIEFS IN EDUCATION

Craig Rofe

Learning through School Science Investigation in an Indigenous School Research into Practice

2 Springer

# Student learning through science investigation

Craig worked on this project with researcher Azra Moeed and kaiako at a Wellington wharekura, to understand teachers' beliefs about science inquiry and their development as science teachers. He also studied the cultural capabilities of staff in early childhood education and kohanga reo; and teachers' use of science investigations in English language

schools. He worked with kaiako to make practical investigations into stronger learning tools for students.

#### Professional development for teachers

Craig worked with a trainer on what they called teacher restorative professional development. "It was a non-threatening way to observe teachers, discuss their pedagogy



Craig, left, with Sir Paul Callaghan in the early 1990s. Photo: Radio NZ.

and skills, and how to improve them." The training aimed to engage students more by changing teachers' classroom talk and role. Their research found that teachers who spent more time facilitating their student's work, rather than instructing, engaged more of the students, even when students thought that their tasks were more difficult.

#### Best hangi stones

"Which iwi has the best hangi stones is always a yarn around the hangi pits. Some are volcanic, some river stones, and others glassy. So I thought, okay, whose *are* the best? We connected with schools and students built equipment to measure hangi stones. We had to work out safe ways for them to do that - as long as the heating temperature of the rocks is low, sufficient heat exchange occurs to establish differences in rocks, without the risk of rocks fracturing. Slow and steady heating also adds to safety. Students heat them in school ovens and put them in a calorimeter (an insulated container), then in water and measure how much it heats the water. We got useful data, and I was sorry I had to leave in the middle for a new job."

# How he finds things out

**Physics**: Nuclear magnetic resonance microscopy.

**Education**: Surveys, observing as a classroom participant, individual and group interviews, and action research – "teachers changing how they teach, with us observing what the results were during teaching".

# Most valuable results

"Seeing the impact on my students in the classroom as a science teacher, impacting on each other's lives to become better people – teaching is the most rewarding job. It's much harder to measure impacts from research, but with teaching you can see impacts every day."



# Science and Mātauranga Māori

"There's a stark difference between the categorisation and dissection of Western science and the inclusive environment and connection through whakapapa of mātauranga Māori. Scientists compete with each other for funding and publishing – it's not a collective effort across the discipline. I struggle to find connections between Western Science and mātauranga Māori."

"Hangi stones have mauri – each stone is a living entity with its own mauri. Food can whakanoa something – remove tapu and make it common. Karakia can open up those concepts. The science of hangi stones is about elements and heat capacity, not the totality of Tāne-mahuta. Mātauranga Māori is spiritual, not just physical."

#### Zombification of Mātauranga Maori

Craig uses Pākehā mathematician Brian Tweed's analysis: "A zombie is a partial replica of someone, missing vital components. The zombification of Mātauranga Maori creates misinformation and repeats it with students, producing a poor replica of the original version."

Craig's "perfect example" is the tuakanateina relationship. "For us it's only a same sex relationship – it doesn't exist across genders. In education it's used for a senior-junior buddy system, regardless of gender."

# What he likes about science

"I'm excited by the new frontiers and technologies of science – electric cars, space

# Ngā Kupu

Honokarihi – Fusion
Ingo – Diffusion
Kaihanga papatono – Computer programmer
Kūtorotoro – Elasticity, elastic
Mauri – Life force
Māngaro – Food starch
Tāne-mahuta – Atua of trees and birds
Waerau – Polymer
Whaitua autō – Magnetic field.



travel, new research about industrial fusion. This is hot rather than cold fusion – controlling reactions in tiny spaces at extremely high temperatures, enabling water to be used to create huge amounts of energy. I love that I can understand the science behind those technologies. Fewer people are taking science in schools, so we're getting fewer science literate people – they don't understand their everyday devices."

Another budding scientist? Craig with his daughter Māia, making an erupting volcano from baking soda and vinegar in 2021.

# Links

Maori Dictionary & Paekupu

- Beyond play: Learning through science investigation research project, 2014-6.
- Catherine Smallbone, Craig Rofe, Azra Moeed, 2017, <u>Learning Pūtaiao in wharekura and teaching Pūtaiao</u> values in mainstream schools.
- Dr Brian Tweed, Massey Uni, <u>Zombification and</u> <u>disappearance – a challenge for educational</u> <u>research in 21st century Aotearoa.</u>
- Tech Insider, 2018, <u>These people are walking on water</u>, 3m video.

Craig with his children: from left, Hēmi, Māia and Anahera, in Maupuia, Wellington, 2021.





Representing the needs of science teachers