Waka physics

NZASE resource

Te waka hourua Te Matau a Māui, of Ātea a Rangi Educational Trust, in Te Whanga a Ruawharo/Hawke's Bay in 2014. Photo from the trust's Facebook page, used with permission.

Waka is a poignant and special subject that kaiako can explore to unpack aspects of physics with ākonga. Mike Stone, Pākehā, and Mere Manning, Ngāti Kahungunu ki te Wairoa, explain ways in which the western science of physics can be braided within Te Ao Māori knowledge of the waka.

When considering any Māori kaupapa, a good approach for kaiako is to explore the whakapapa and tikanga of the topic first and understand why it is so important to Māori, before looking at the western science ideas, as the teachers below have done.

Tikanga and waka

It is important that ākonga and kaiako alike understand the importance of waka as a taonga. As ancestral waka have deep-seated tikanga, any knowledge passed on about this must be checked with mana whenua before exploring deeply. It is important to ensure that any teaching kaiako do in this area has been checked as tika, correct, and that the kaupapa is treated respectfully.

Some schools report local iwi not wanting students to use waka hourua as a context. Waka ama are much less likely to involve tapu, but still related to the same science concepts.

This Archives NZ film, the only one of its kind, traces the construction of a waka taua from the finding and felling of the forest trees, to the launch. It shows students the rituals surrounding this most sacred process, interweaving, through the seasons, the tikanga and way of life on the marae as this build took place.

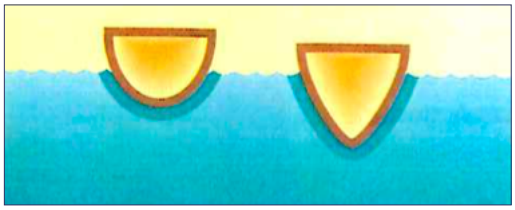
This waka was made at Tūrangawaewae Marae by command of the Māori Queen, Te Arikinui Dame Te Atairangikaahu. Elder and master carver Piri Poutapu, MBE, designed and supervised the build over 18 months.

This *NZ Geographic* article describes the huge and passionate effort to build or refurbish 20 waka taua to meet at Waitangi on February 6, 1990. Buddy Mikaere explains many aspects of tikanga and describes how the waka became a symbol of Māori unity and pride in that year of remembrance.

Waka as a rich context

Stephen Williams is a PLD facilitator with the University of Otago (UoO). Focussing on waka hourua, he helps teachers develop resources for the classroom involving waka, which he sees as a rich application for physics:

- The pock-marked hull produced by adzes make the hull move faster (similar to dimples on a golf ball).
- A wide beam with no keel makes it easier to counterbalance forces against the sail.
- Hulls create interference patterns.
- The maximum distance between two hulls is limited by constraints on the timber but needs to be as great as possible to reduce the effect of interference waves.
- Māori boat builders use a formula used to calculate the widest point of the hull (two thirds from the bow).
- Hull shape affects waka motion – a V shape keeps it



A U-shaped hull for a coastal, paddled waka, and a V-shaped hull for a waka hourua sailing the Pacific from Hawaiki. From Applications booklet.

on track more easily; a round shape is fastest.

- The paddle at the back of a waka hourua has similarities to a centreboard. Lowering it into the water puts the waka into the wind, and lifting it out moves the waka away from the wind.
- Ropes were used to join the different wood sections, passed through drilled holes, tightened with levers and pegged to secure the rope in the hull.
- Making tūwiri to drill the holes requires an understanding of momentum, mass and speed.
- The large taurapa (at the stern) and the tauihu (bow) increase the moment of inertia, making the waka rock less as the waves go beneath it. [From Tristan O'Hanlon, UoA]

Stephen has focussed on making and testing model waka with students, using a sheet of plastic, straws and sellotape. To test the model he puts each hull in a 1.5m length of guttering, adds heavy nails for mass, and attaches a pulley at the end of the gutter. A fishing line is tied to the waka at one end and at the other end is attached to a falling mass.

Students find that when the mass pulling the waka is changed, it produces a linear relationship between maximum speed and mass. However, when the length of the waka is changed, this relationship becomes nonlinear. His resources are available here.

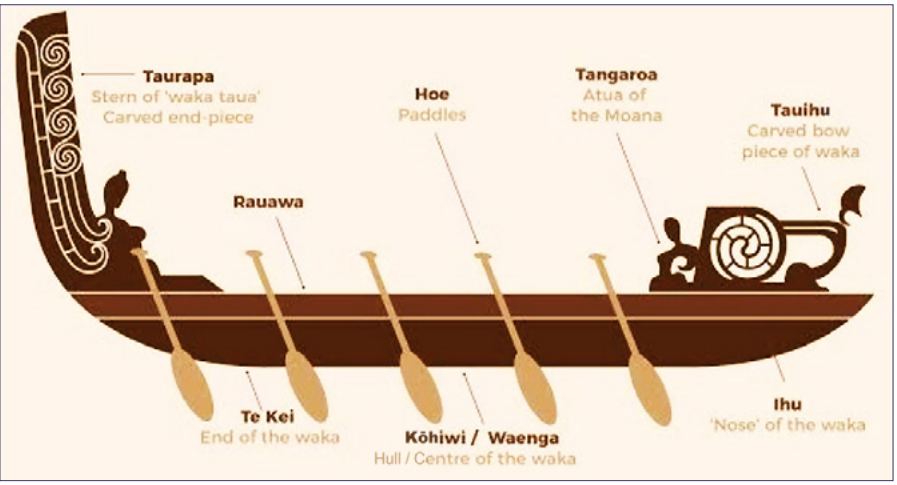
Types of waka

Māori arrived in Aotearoa in large, wind-powered Polynesian voyaging waka, carrying many people and food supplies. Smaller waka are also found in the islands – made from narrow trees, usually with an outrigger (ama).

As the source trees in Aotearoa are larger, Māori waka are wider and more stable in the water. The wealth of large trees, such as tōtara, means that Māori could build a greater variety of waka in Aotearoa than was possible in the islands. Māori developed several different types of waka: -

- Waka hourua – double-hulled canoes, some with a sail woven with raupō or harakeke. Use died out in early 1800s, until a renaissance began when Hekenukumai Busby built his first in 1990. Cook recorded their travel at 5-12 knots (9-22km/h).
- Waka taua – have a carved bow and stern posts, were usually used to carry warriors, and are tapu. Cook noted that these were faster than his sailing ship.
- Waka tētē – smaller, simpler, used for fishing and to carry goods and people. Today's waka tangata are similar.
- Waka tīwai – light and swift, carried one or two people, used for racing and fun.
- Waka ama – waka fitted with a smaller outrigger were common in Cook's time.

Larger hulls consisted of three sections – the kōhiwi (hull) and two rauawa (gunwales), held together by a haumi (a mortise and tenon joint) and lashed in place. Hongi Heke is known to have used waka that could be broken down for portage across land.



Most waka have the same basic parts. NZI Architects.

Year 8: Waka design

Jade Argent teaches at Putāruru College and has developed a unit on waka for her Year 8 students. Jade was greatly helped by the local iwi, Ngāti Raukawa, which shared local stories, and the school's cultural leader, Tiniwata Hill, who ran after-school PLD.

The unit begins by exploring Māori as scientists. Students research traditional Polynesian canoes, watching the video on *Te Ara* and then exploring navigation with this animated TEDEd lesson.

The main part of the unit focuses on waka design. Students learn about hull shape and sail position. They test the buoyancy of a range of materials, and investigate the effect of mass, sail size and shape on waka speed.

Then students design, test and evaluate their own waka made of ice-block sticks, straws and tin foil. The waka are judged on their ability to float with a specified mass, travel a set distance as fast as possible, and handle waves.

Year 11: Ngā Pūtaiao Waka o Te Arawa

Jamie Carroll is a pre-service teacher from Ako Mātātupu Teach First, currently based at Raukura Rotorua Boys' High School (RBHS). For his leadership project, he is developing a unit for teaching NCEA L1 mechanics in the context of waka, and blogging about the experience.

RBHS aims to make learning meaningful for their students, around 70 percent of whom are Māori. The school has an ongoing relationship with Ngāti Whakaue. The iwi has developed a series of Te Arawa resources and has experts who local schools can call on as they weave Mātauranga Māori into their classrooms.

The Deputy Principal responsible for cultural capacity has found Jamie a local expert who will work with the students on their planned field trip. On the lake, the boys will hear about the significance of Te Arawa waka, some details about how they were built, and some of the iwi pūrākau. They will also learn paddling skills, race strategy and waka calls.

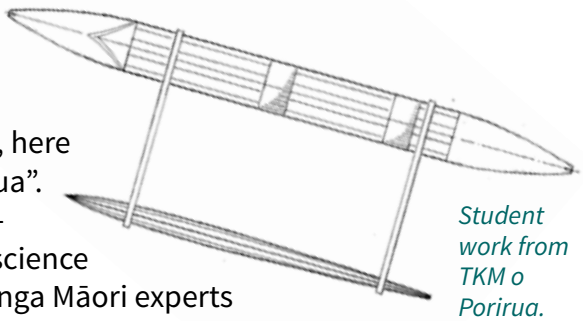
"The boys will jump into school-owned waka ama and feel the forces and pressure as they explore motion and work and conduct speed trials, providing data that will be used later in the classroom," explains Jamie.

Jamie says waka have "huge historical significance to Te Arawa, and are a central element in many local pūrākau." He hopes to light his students' fire and sense of place by using this context.

Year 12 or 13: Physics application

Jinesh Joseph teaches physics, maths and robotics at Te Kura Māori o Porirua, a total immersion area school. He has been involved in the Science Academy PLD with the University of Otago (UoO) with other low-decile schools struggling to connect with students. Here teachers can explore new contexts.

Jinesh says "Most of our students compete in waka ama, here and in Rotorua". With the support of UoO science and Mātauranga Māori experts he developed a research task exploring physics applications in the context of waka. This could be set at L2 or L3 of NCEA, depending on the physics focus.



Student work from TKM o Porirua.

Jinesh says: "Our students come from kōhanga reo to kura to wharekura, well versed in te reo Māori. They say they understand NCEA exam questions better if they have a copy in te reo, so I order these for them. For this reason I also translated their task and assessment schedule into te reo." In the unit Jinesh also included some lessons on the history of the waka and Polynesian navigation.

This article was improved by critique from Dave Thrasher and Doug Walker.

Resources

Te Papa's Pacific Explorers programme compares Māori and Pacific canoes and voyages; an online version was developed in 2020.

Ātea a Rangi Trust in Hawke's Bay take students out on their voyaging waka.

Te Toki Voyaging Trust take groups out on their voyaging waka in Tāmaki Makaurau/Auckland, and teach tamariki concepts of traditional navigation.

Tairāwhiti Waka in Gisborne take ākonga on board Tairāwhiti waka hourua for day sails, multi-day sails and in-port activities.

Applications booklet, Waka, 94/204.

Applications booklet, Hawaiki.

School Journal, Nov 2020, L2, The kōrero of the waka (Year 4).

School Journal, June 2018, L2, Painted hoe.

Raranga Matahiko, Waka inquiry units.

Te Ara, Waka - canoes.

Ngā Kupu

Hoe – Paddle
Kaupapa – Project, policy, programme
Pūrākau – Ancient story
Raupō – Large wetland reed
Taonga – Treasure, anything valued
Tapu – Sacred, restricted
Tikanga – Correct procedure, customary practices
Tūwiri – Drill.

From Te Aka Maori Dictionary