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7 **Indigenisation of conservation education in New Zealand**

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Supplementary material

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20 **Fig. S1**

21 Punaha Akoako, Mātauranga Māori framework from Te Aho Tū Roa Kete

22 ‘Ko Au Ko Koe, Ko Koe Ko Au’

23

Kei hea tātou ināianeī?

He aha tēnā e mohioia ana i nāia tonu nei?

TAKAHIA TE ARA TŪHURA

He aha ngā āhuatanga ka kitea, ka rangona?

He aha ngā whakairo o tēnā, o tēnā tangata?

He aha ngā mea papai, ngā taero rānei?

RIKIU HŌHONU

He pēhea te āhua o te reo whakairo i tō tātou taiao?

He aha ngā mea hei wāitanaga?

He aha ngā taonga tūku iho hei arataki i a tātou?

RANGAHAUA

He aha ngā mea hei ako, hei rangahau?

Kei a wai, kei hea rānei ngā mātauranga?

He aha ngā pūkenga, ngā pūmanawa hoki
mō tēnei kaupapa?

Me ahu pēhea?

He aha ngā wawata, ngā moemoemā hoki?

He aha ngā tino whāinga?

Ko wai mā e tauroko ana, e hāpai ana i te kaupapa nei?

He aha ngā ara kei mua i a tātou?

He aha ngā ara kua parangia e ētahi atu?

He aha ngā mahi e taea ana e tātou?

He aha te huarahi hei whai atu?

Whakatinanatanga

He aha te mahi?

He aha ngā tikanga mō te mahi nei?

He aha ngā whakarangatanga?

Mā wai te kaupapa e tauroko, e whakamāna?

Mā wai e mahi?

Kei a tātou ngā pūkenga mō te mahi nei?

Mā wai e āwhina?

He aha ngā taputapu, ngā rawa, ngā rauemi rānei?

Nō hea tātou?

I ahu mai tātou i hea?

He aha ngā purākau, ngā kōrero o rene?

I pēhea i mua i te taenga mai o te tangata?

I pēhea i te wā o ngā mātua tūpuna?

He aha ngā āhuatanga o mua e pā tonu nei ki a tātou?

Pūmahara

He aha ngā mahi kua oti?

He aha ngā whāinga i tūruki?

He aha ngā hua i puta?

He aha ngā akoranga hou?

He aha ngā whanaketanga i roto i te mahi nei?

Mā pēhea ngā mahi e pāi ake ai?

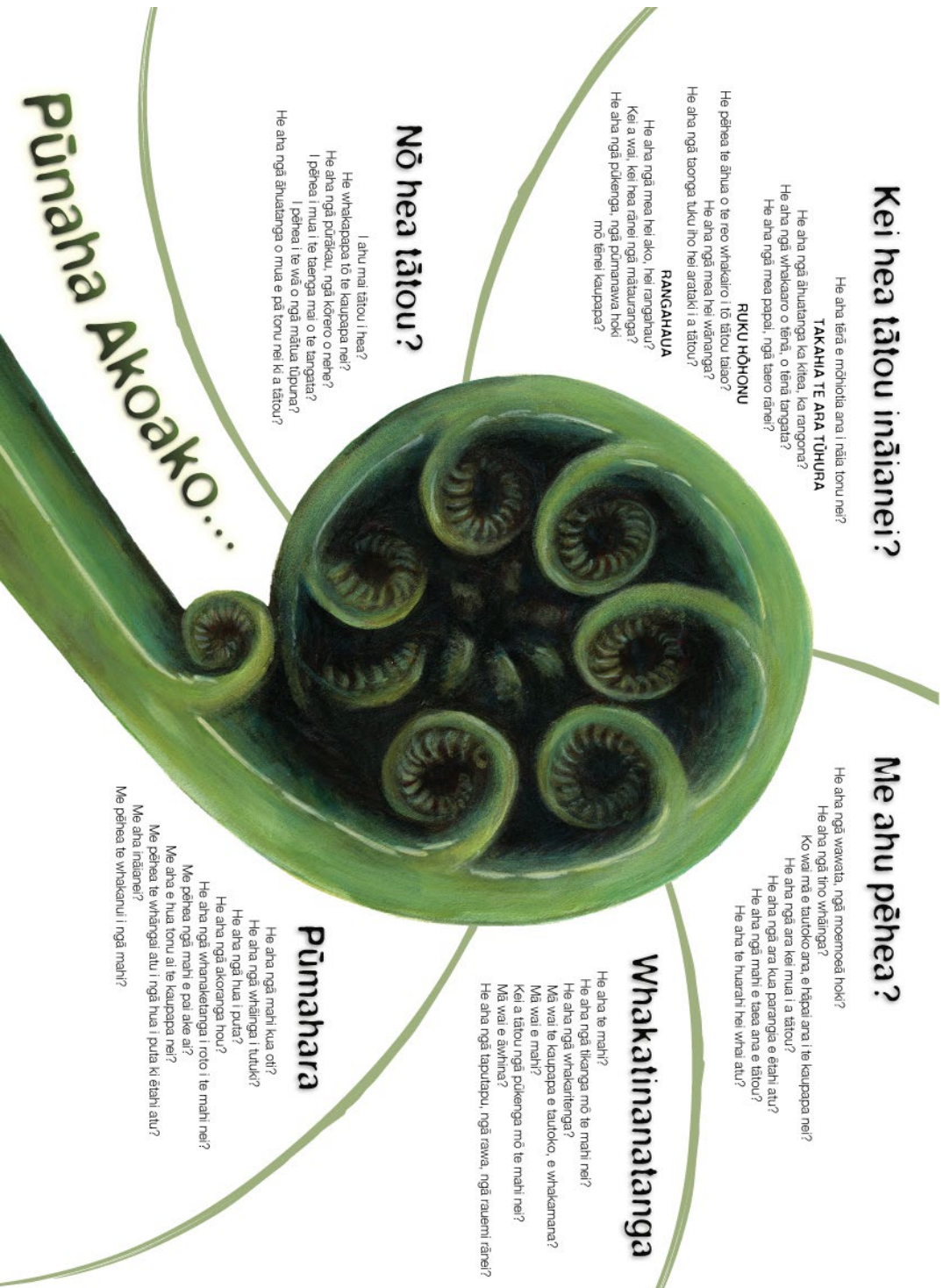
Me aha e hua tonu ai te kaupapa nei?

Me pēhea te whāngai atu i ngā hua i puta ki ētahi atu?

Me aha ināianeī?

Me pēhea te whakanui i ngā mahi?

Pūnaha Akoako...



31 **Supplementary Material: Noho taiao framework extension**

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33 A key feature of the Noho Taiao includes intergenerational learning (from the young to older youths,
34 as well as elders imparting to the youths and vice versa, a reciprocating teaching learning
35 experience) as well as mentorship formed from an elder youth supporting, teaching and learning
36 alongside a younger peer, known in Māori communities as the Tuakana - Teina model.

37 Each noho includes a range of outdoor hands-on learning activities that provide genuine experiential
38 learning and engagement in, and for, local environments as a 'living laboratory' pūtaiao
39 (environmental) approach. Tutors highlight science concepts embedded in mātauranga Māori, te
40 reo me ōna tikanga (Māori language, customs and traditions) and, by making education culturally
41 meaningful, help Māori youth reclaim science in New Zealand. Students are able to explore the idea
42 that their tūpuna (ancestors) were scientists in their own right, intimately connected with their
43 environment, and able to read signs from the landscapes, ngā tohu o te rangi (from the
44 skies/celestial bodies), ngā tohu o te whenua (from the land), ngā tohu o te moana (from the sea), to
45 ensure their own survival in reciprocity with te taiao (the environment). Pumahara (reflections) are
46 carried out with rangatahi on various daily activities and at the end of the Noho provided vital insight
47 into the success of integrating the Tuakana-Teina approach.

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49 This Noho Taiao programme theme was 'Ki uta ki tai', from the 'Mountains to the sea'. The
50 programme was designed, led, and delivered by a collaboration of Māori researchers from Manaaki
51 Whenua and Te Aho Tū Roa - Toimata Foundation. Te Aho Tū Roa is a te ao Māori based education
52 programme of Toimata Foundation, that promotes 'connecting people to people' and 'people to
53 place', with a core focus on collaboration, empowerment and action-based outcomes for
54 environmental sustainability and a true understanding of kaitiakitanga.

55

56 Noho marae were planned and executed according to the maramataka Māori (tribal lunar moon
57 calendars), on days identified as high energy and productive learning days of Tangaroa mua,
58 Tangaroa a roto, Tangaroa kiokio and Otane (Taipari & Hoterene 2019). Students (TWKoM, TKToP)
59 experienced noho marae stays of three days and two nights, staying at a local marae, or shared
60 gathering space. During this time, students undertake activities including environmental monitoring
61 of different habitats (Mountains to the sea; forest, river and sea) with Māori and scientific experts in
62 each habitat, to expose them to the dual ecological perspectives.

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79 **Table S1**

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Programmes	School	Number of students who completed:		
		Pre-programme survey	Post-programme survey	Eko survey
Noho marae + Eko game	TWKoM	9	8	8
	TToP	15	9	26
Total		24	17	34
Eurocentric school curriculum + Eko game	TWKoR	17	8	13
Eko game only	TPHS	112	62	89
Total		129	70	101

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82 Table S1. The programmes and total participants who submitted surveys and which schools participated in the various
83 programmes. Numbers are from surveys submitted. Not all students who participated in the programme submitted
84 surveys.

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94 **Table S2**

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Summary statistics of available demographic data

Variables	Minimum	Mean	Median	Maximum	Standard Error	Observations
Maori (1=yes)	0	0.517	1	1	0.032	238
NZ European (1=yes)	0	0.513	1	1	0.033	238
Samoan (1=yes)	0	0.034	0	1	0.012	238
Cook Island (1=yes)	0	0.008	0	1	0.006	238
Tongan (1=yes)	0	0.029	0	1	0.011	238
Chinese (1=yes)	0	0.013	0	1	0.007	238
Indian (1=yes)	0	0.029	0	1	0.011	238
Other ethnicity (1=yes)	0	0.105	0	1	0.02	238
Age (years)	13	14.76	15	18	0.07	240
Gender	1	1.564	2	3	0.037	236
Male (=1)		48.3%				
Female (=2)		47.03%				
Gender diverse (=3)		4.66%				
Bests describe where you live:						
City (1=yes)	0	0.082	0	1	0.018	230
Rural (1=yes)	0	0.339	0	1	0.031	230
Town (1=yes)	0	0.626	1	1	0.032	230
Usually live in:						
Auckland (1=yes)	0	0.022	0	1	0.009	227

Waikato (1=yes)	0	0.189	0	1	0.026	227
Bay of Plenty (1=yes)	0	0.709	1	1	0.030	227
Northland (1=yes)	0	0.119	0	1	0.022	227
Hawke's Bay (1=yes)	0	0.004	0	1	0.004	227
West Coast (1=yes)	0	0.004	0	1	0.004	227
School	1	1.55	1	4	0.064	240
Te Puke High School (=1)		72.5%				
Te Wharekura o Rakaumangamanga (=2)		10.42%				
Te Wharekura o Maniapoto (=3)		7.08%				
Te Kura Taumata o Panguru (=4)		10%				

Notes: The variable `gender` takes on the values 1 if male, 2 if female or 3 if gender diverse. Respondents could choose more than one ethnicity. Respondents could describe where they usually live as a city, town and/or rural area. Respondents could choose more than one region where they live.

96 The average student is an almost 15 years old male Māori and NZ European who lives in a town in
97 the Bay of Plenty and attends Te Puke High School.
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Table S3. Means and comparison of means of demographics across programme groups

Variables	Noho taiao programme			Any environmental programme programme		
	Noho taiao (N = 41)	Eurocentric curriculum with or without an environmental programme or (N = 197)	P-value testing equality of means	Noho taiao or Eurocentric curriculum with an environmental programme (N = 64)	Eurocentric curriculum with no environmental programme (N = 172)	P-value testing equality of means
Age (years)	14.51	14.82	0.10	14.61	14.83	0.16
Male (=1)	0.56	0.46	0.23	0.68	0.40	0.00
Maori (1=yes)	0.95	0.43	0.00	0.97	0.34	0.00
NZ European (1=yes)	0.17	0.58	0.00	0.14	0.66	0.00
Samoan (1=yes)	0.07	0.03	0.12	0.08	0.02	0.03
Cook Island (1=yes)	0.02	0.01	0.22	0.03	0.00	0.02
Tongan (1=yes)	0.07	0.02	0.07	0.05	0.02	0.37
Chinese (1=yes)	0.00	0.02	0.43	0.00	0.02	0.28
Indian (1=yes)	0.00	0.04	0.22	0.00	0.04	0.10
Other ethnicity (1=yes)	0.00	0.13	0.02	0.00	0.15	0.00
City (1=yes)	0.10	0.08	0.62	0.11	0.07	0.36
Rural (1=yes)	0.62	0.28	0.00	0.39	0.32	0.31
Town (1=yes)	0.31	0.69	0.00	0.53	0.66	0.07

Auckland (1=yes)	0.00	0.03	0.31	0.05	0.01	0.11
Waikato (1=yes)	0.41	0.14	0.00	0.61	0.02	0.00
Bay of Plenty (1=yes)	0.00	0.86	0.00	0.00	0.99	0.00
Northland (1=yes)	0.59	0.02	0.00	0.38	0.02	0.00
Hawke's Bay (1=yes)	0.00	0.01	0.65	0.00	0.01	0.53
West Coast (1=yes)	0.03	0.00	0.03	0.02	0.00	0.11

107 Notes: Means and t-test for equality of means for variables are pooled from pre- and post-programme survey respondents
108 and observations are cross-sectional. The variable 'male' takes on the values 1 if male and 0 if female or gender diverse.
109 Respondents could choose more than one ethnicity. Respondents could describe where they usually live as a city, town
110 and/or rural area. Respondents could choose more than one region where they live.

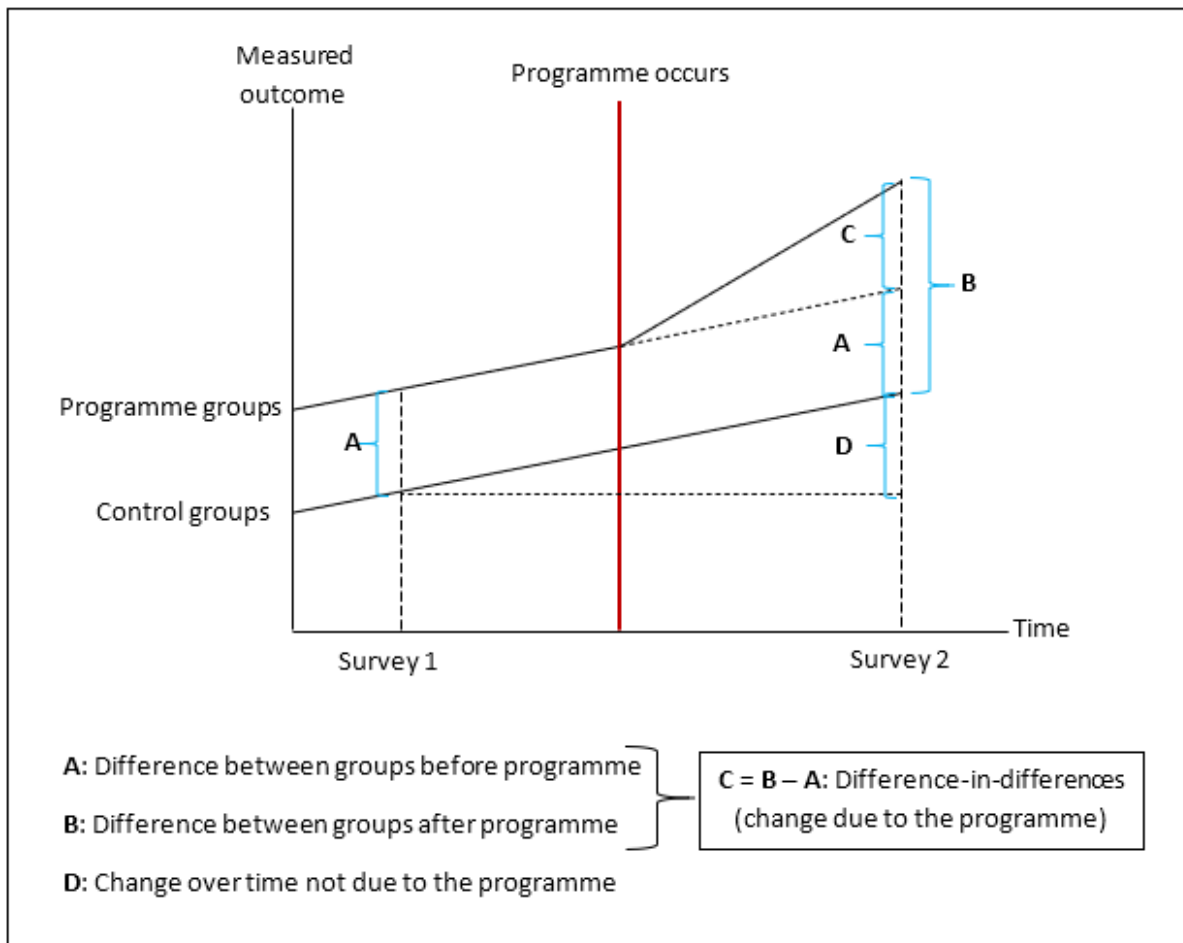
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112 There is a significant difference in the demographic make-up between students who were in the
113 programme groups versus students in the control groups. The students who attended schools that
114 participated in the noho taiao programme were on average almost 15 years old, male (53%), Māori
115 (93%) and live in a rural area (62%). In contrast, students in a school that held a Eurocentric
116 curriculum with or without an environmental programme were on average almost 15-years old,
117 female, NZ European (58%) and live in a town (69%).

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120 Fig. S2



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123 Figure S2. Visual representation of the difference-in-difference regression method. 'A' represents
124 the average difference in outcome that occurs between the intervention and control groups due to
125 observable and unobservable pre-programme differences such as ethnicity, values or age. 'B'
126 represents the difference in outcome between the programme and control groups after the
127 programme occurred. 'B' is composed of the pre-programme differences (A) and the post-
128 programme differences (C). 'D' represents the change in outcome that occurs normally in both
129 groups over time. 'C' is the value of interest and represents the effect that can be attributed directly
130 to the programme (e.g. noho taiao programme). 'C' is also referred to as the difference-in-
131 differences estimate as it is the difference between the pre-programme difference 'A' and the post-
132 programme difference 'B' that can be attributed to the programme.

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Table S4. Difference-in-differences regression table for schools that had the noho taiao programme

	Statements on the environment									
	1	2	3	4	5	6	7	8	9	10
School had noho taiao programme (=1)	-0.11 (0.09 9)	- 0.039 (0.11)	- 0.003 (0.11)	0.16 (0.11)	0.018 (0.11)	0.073 (0.11)	0.002 (0.11)	0.091 (0.10)	0.14 (0.11)	0.031 (0.11)
	-1.16	-0.37	- 0.035	1.53	0.17	0.65	0.024	0.88	1.32	0.29
Survey taken after noho taiao programme (=1)	0.003 3 (0.07 3)	0.12 (0.07 4)	0.018 (0.07 5)	0.019 (0.07 6)	0.026 (0.07 3)	0.12 (0.07 5)	0.019 (0.07 5)	- 0.023 (0.07 4)	- 0.017 (0.07 5)	- 0.043 (0.07 5)
	0.045	1.62	0.24	0.24	0.35	1.60	0.25	-0.31	-0.22	-0.58
Post-programme x school had noho taiao programme (=1)	0.45* ** (0.16)	-0.16 (0.17)	0.25 (0.16)	0.080 (0.16)	0.070 (0.17)	-0.25 (0.17)	0.21 (0.17)	0.14 (0.15)	- 0.079 (0.17)	0.065 (0.17)
	2.82	-0.97	1.50	0.49	0.40	-1.43	1.23	0.91	-0.45	0.38
Constant	0.36* ** (0.04 3)	0.37* ** (0.04 3)	0.50* ** (0.04 4)	0.50* ** (0.04 4)	0.36* ** (0.04 3)	0.47* ** (0.04 4)	0.41* ** (0.04 4)	0.62* ** (0.04 3)	0.48* ** (0.04 5)	0.59* ** (0.04 4)
	8.53	8.67	11.4	11.3	8.38	10.5	9.43	14.2	10.7	13.6
Observations	238	239	239	237	238	237	236	238	237	238
R-squared	0.040	0.017	0.018	0.024	0.004	0.014	0.014	0.016	0.009	0.003

F-statistic 3.62 1.37 1.85 2.33 0.27 1.10 1.18 1.75 0.72 0.26

141 Notes: The dependent variable in regression 1 to 10 is equal to 1 if response to the statement is
 142 'Strongly agree' or 'Moderately agree' and equal to 0 if response is 'Neutral', 'Moderately disagree'
 143 or 'Strongly disagree'. Regressions 1–10 correspond to statements 1–10 on the environment where
 144 the statements are: 1: "Science is often among the favourite subjects at school" 2: "Scientists are
 145 active in the community." 3: "Scientists are trying to solve problems that are important to me." 4: "I
 146 enjoy finding out about new ideas in science." 5: "Science and technology are too specialised for me
 147 to understand." 6: "It is important to be kept up-to date on science issues." 7: "Science is important
 148 in my daily life." 8: "Science is an important subject for people to study at school." 9: "Science is
 149 important for addressing key challenges affecting our society." 10: "Knowledge of science is useful
 150 for increasing career opportunities."

151 Robust standard errors are reported in parentheses. T-statistics are reported below standard errors.
 152 Stars on coefficients represent significant p-values of * $P < .10$, ** $P < .05$, and *** $P < .01$.

153 The 'programme' is equal to 1 if the school that the respondent attends participated in the noho
 154 taiao programme and equal to 0 if the school held a Eurocentric curriculum with or without an
 155 environmental programme. Te Wharekura o Maniapoto and Te Kura Taumata o Panguru
 156 participated in the noho taiao programme, Te Wharekura o Rakaumangamanga had a Eurocentric
 157 curriculum with an environmental programme and Te Puke High School had a Eurocentric curriculum
 158 without and environmental programme.

159

160 **Table S5. Difference-in-differences regression table for schools that had any environmental**
 161 **programme**

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	Statements on the environment									
	1	2	3	4	5	6	7	8	9	10
School had any environmental programme (=1)	-0.073 (0.085)	0.066 (0.090)	0.079 (0.092)	0.076 (0.091)	0.11 (0.090)	0.11 (0.092)	-0.067 (0.089)	0.10 (0.086)	0.18* (0.090)	0.049 (0.089)
	-0.86	0.74	0.86	0.84	1.21	1.21	-0.74	1.21	2.00	0.54
Survey taken after noho taiao programme (=1)	0.017	0.14*	0.009 7	0.016	0.053	0.100	-0.008 7	0.019	0.021	-0.045

	(0.078)	(0.079)	(0.080)	(0.081)	(0.078)	(0.080)	(0.080)	(0.078)	(0.080)	(0.080)
	0.22	1.82	0.12	0.20	0.68	1.24	-0.11	0.25	0.26	-0.56
Post-programme x school had any environmental programme (=1)	0.25*	-0.20	0.19	0.078	-0.052	-0.10	0.24	-0.047	-0.18	0.050
	(0.15)	(0.15)	(0.14)	(0.15)	(0.15)	(0.15)	(0.15)	(0.14)	(0.15)	(0.15)
	1.71	-1.35	1.34	0.53	-0.35	-0.67	1.64	-0.33	-1.17	0.34
Constant	0.37**	0.35**	0.48**	0.51**	0.33**	0.45**	0.43**	0.60**	0.45**	0.59**
	(0.046)	(0.045)	(0.048)	(0.048)	(0.045)	(0.048)	(0.047)	(0.047)	(0.048)	(0.047)
	7.97	7.67	10.1	10.7	7.37	9.46	9.12	12.9	9.49	12.4
Observations	238	239	239	237	238	237	236	238	237	238
R-squared	0.020	0.015	0.029	0.012	0.009	0.011	0.015	0.007	0.017	0.005
F-statistic	1.60	1.17	2.87	1	0.70	0.87	1.22	0.58	1.40	0.40

163 Notes: The dependent variable in regression 1 to 10 is equal to 1 if response to the statement is
164 'Strongly agree' or 'Moderately agree' and equal to 0 if response is 'Neutral', 'Moderately disagree'
165 or 'Strongly disagree'. Regressions 1–10 correspond to statements 1–10 on the environment where
166 the statements are: 1: "Science is often among the favourite subjects at school" 2: "Scientists are
167 active in the community." 3: "Scientists are trying to solve problems that are important to me." 4: "I
168 enjoy finding out about new ideas in science." 5: "Science and technology are too specialised for me
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170 in my daily life." 8: "Science is an important subject for people to study at school." 9: "Science is
171 important for addressing key challenges affecting our society." 10: "Knowledge of science is useful
172 for increasing career opportunities."

173 Robust standard errors are reported in parentheses. T-statistics are reported below standard errors.
174 Stars on coefficients represent significant p-values of * $P < .10$, ** $P < .05$, and *** $P < .01$.

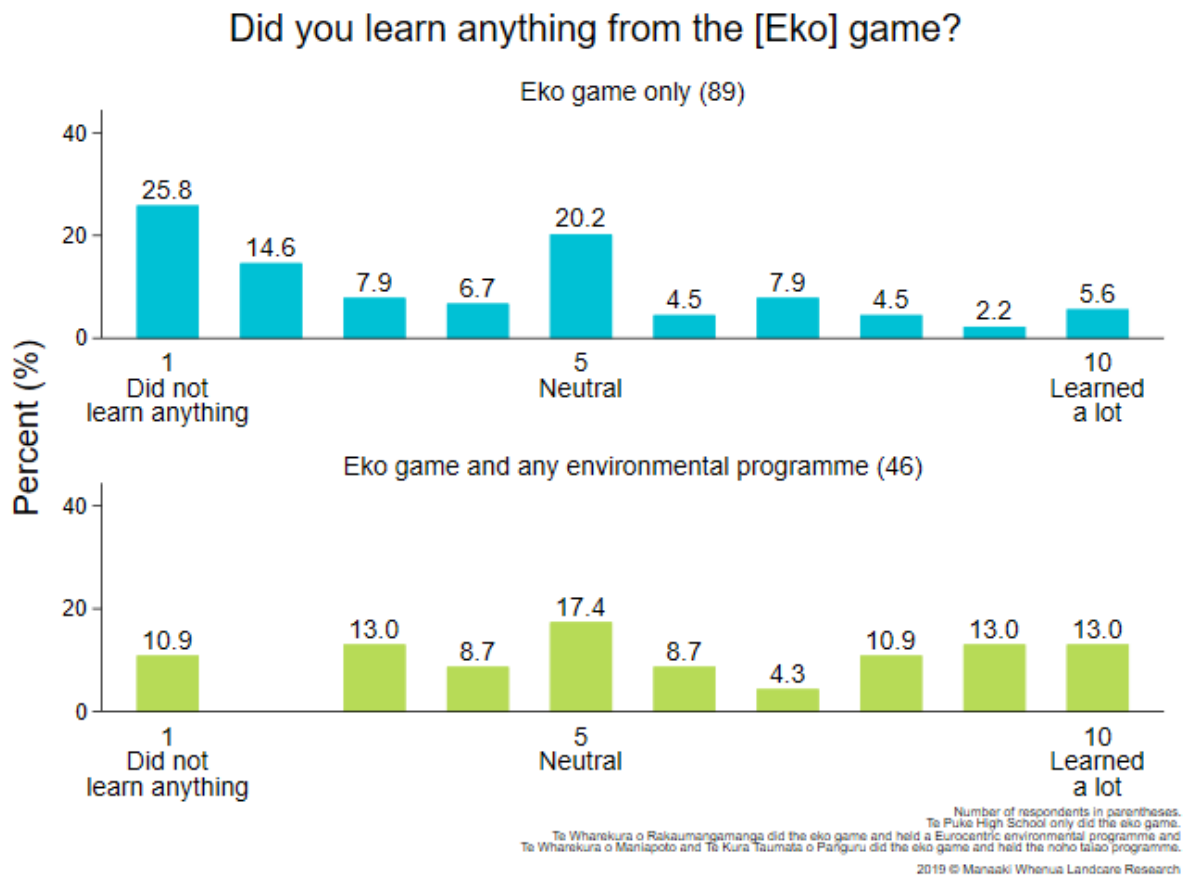
175 The 'programme' is equal to 1 if the school that the respondent attends participated in the noho
176 taiao programme and equal to 0 if the school held a Eurocentric curriculum with or without an
177 environmental programme. Te Wharekura o Maniapoto and Te Kura Taumata o Panguru
178 participated in the noho taiao programme, Te Wharekura o Rakaumangamanga had a Eurocentric

179 curriculum with an environmental programme and Te Puke High School had a Eurocentric curriculum
 180 without and environmental programme

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183 **Figure S3**



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185 Fig. S3. Comparison of responses to the question, “ Did you learn anything from the [Eko] game?”
 186 across students who attend a school that did not participate in any environmental programme
 187 versus either participated in the noho taiao programme or an environmental programme in an
 188 Eurocentric curriculum.

189 Students who attended schools that participated in any environmental programme said that, on
 190 average, they learnt more from the Eko game than students who attended a school that did not
 191 participate in any environmental programme (5.89 vs 4.01 out of 10, $t(133) = -3.72, P < .01$).

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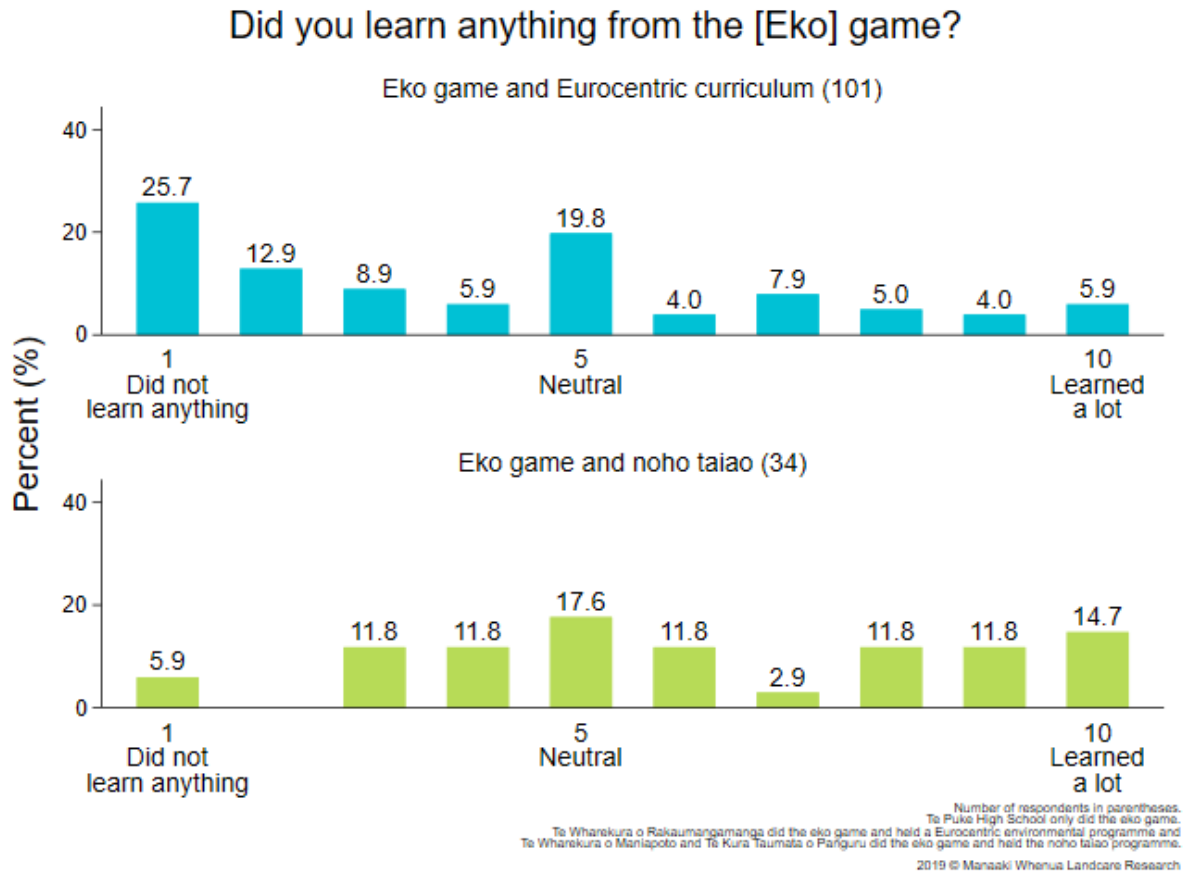
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Fig. S4



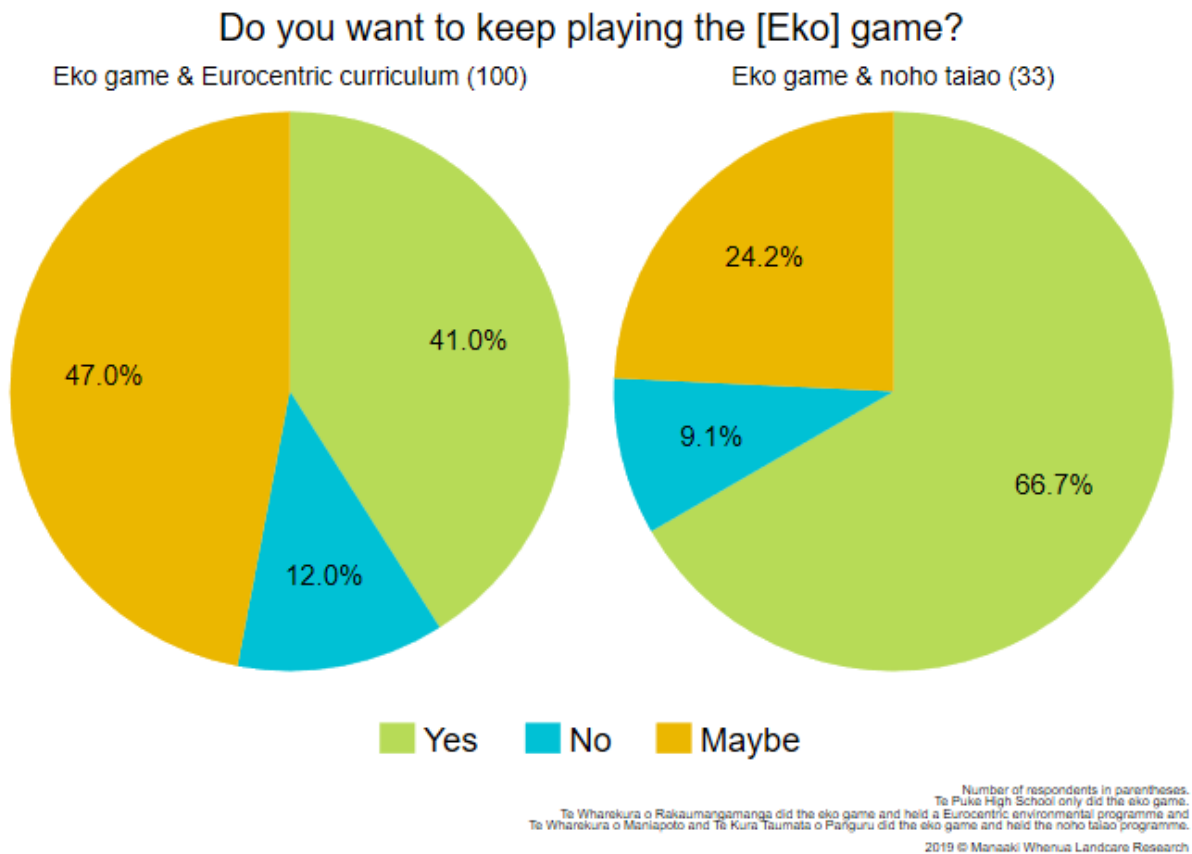
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Fig. S4. Comparison of responses to the question, “Did you learn anything from the [Eko] game?” across students who attend a school that held the noho taiao programme versus students who attend a school with a Eurocentric curriculum with and without an environmental programme.

Students who attended schools that held the noho taiao programme said that, on average, they learned more from the Eko game than students who attended a school with a Eurocentric curriculum with and without an environmental programme (6.15 versus 4.15 out of 10, $t(133) = -3.61, P < .01$).

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Fig. S5



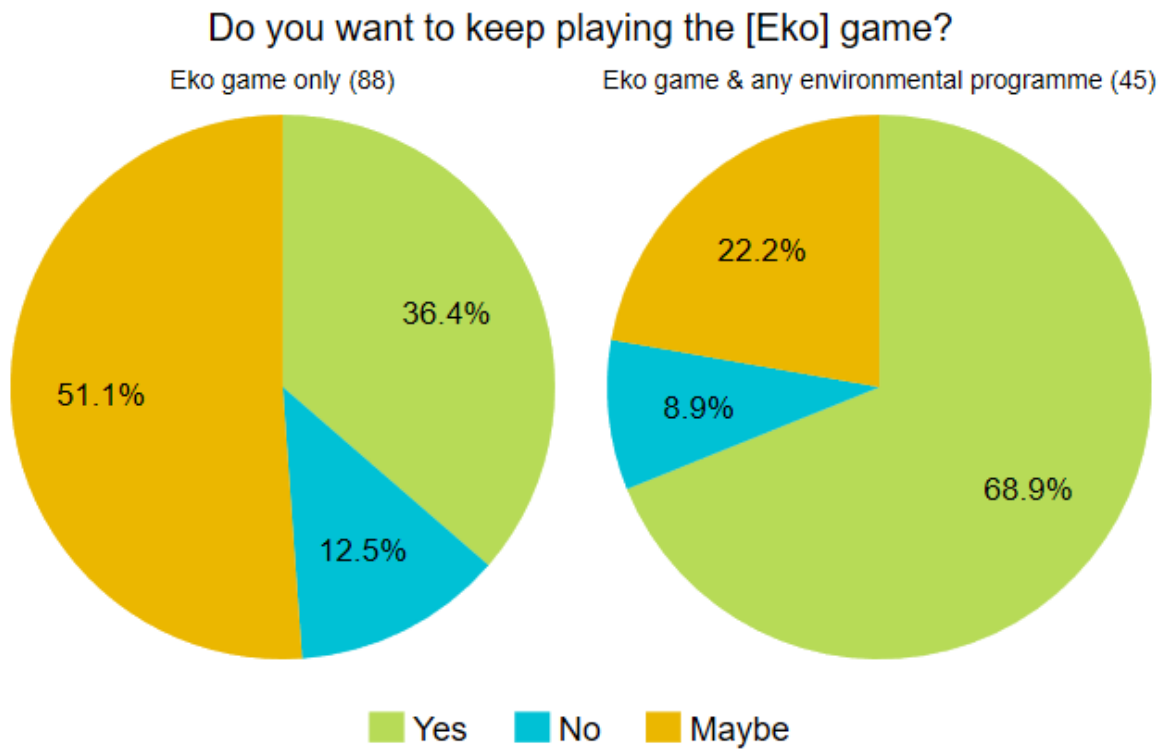
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Fig. S5. Comparison of responses to the question, “Do you want to keep playing the [Eko] game?” across students who attend a school that held the noho taiao programme versus students who attend a school that held the Eurocentric curriculum with or without an environmental programme.

Students who attended schools that held the noho taiao programme were more likely to say they would like to keep playing the Eko game than students who attended a school that held a Eurocentric curriculum with or without an environmental programme (66.7% said ‘yes’ versus 41% who said ‘yes’, $t(131) = 2.61, P < .0102$).

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Fig. S6



Number of respondents in parentheses.
Te Wharekura o Rakaumangamanga did the eko game and held a Eurocentric environmental programme and
Te Puke High School only did the eko game.
Te Wharekura o Maniapoto and Te Kura Taumata o Pariguru did the eko game and held the noho taiao programme.
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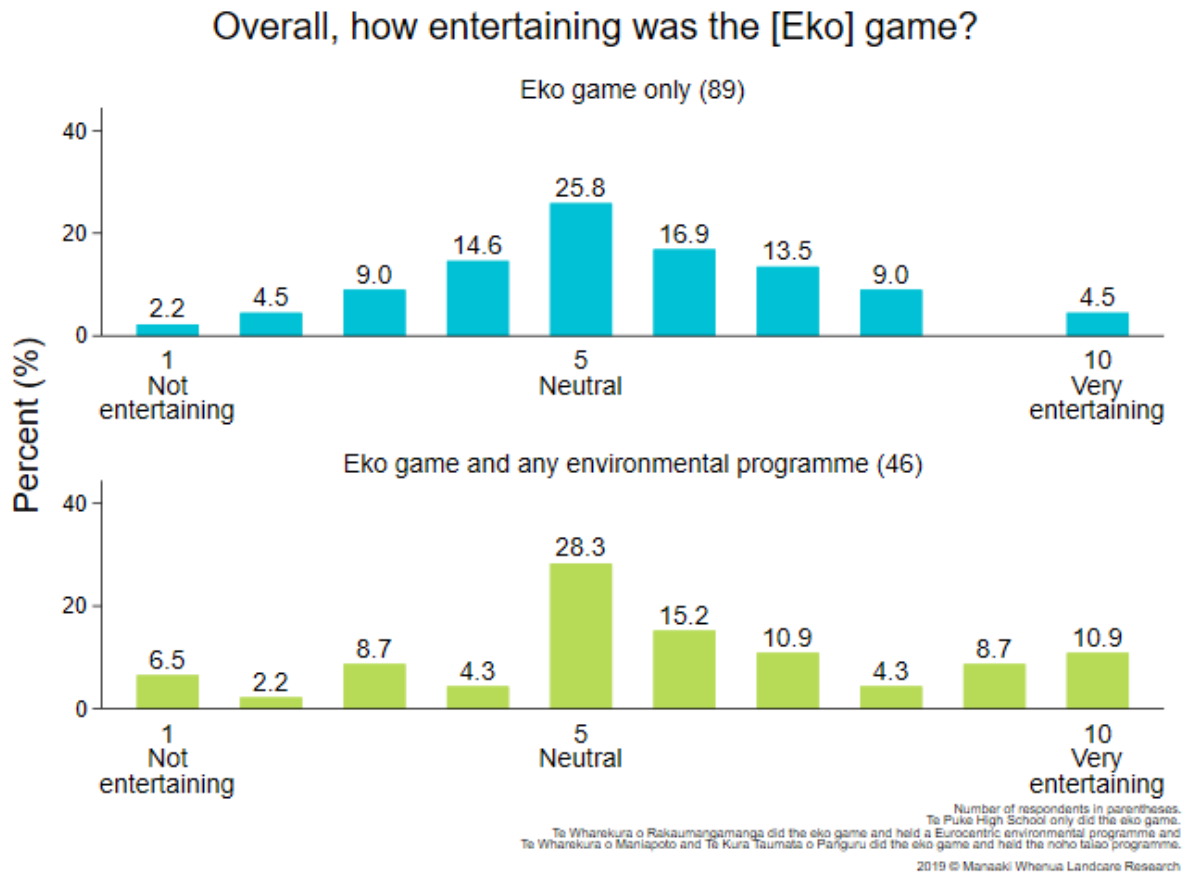
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Fig. S6. Comparison of responses to the question, “Do you want to keep playing the [Eko] game?” across students who attend a school that did not participate in any environmental programme versus either participated in the noho taiao programme or an environmental programme in a Eurocentric curriculum

Students who attended schools that participated in any environmental programme were more likely to say they would like to keep playing the Eko game than students who attended a school that did not participate in any environmental programme (68.9% said ‘yes’ versus 36.4% who said ‘yes’, $t(131) = -3.71, P < .01$).

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Fig. S7



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Fig. S7. Comparison of responses to the question, “Overall, how entertaining was the [Eko] game?” across students who attend a school that did not participate in any environmental programme versus either participated in the noho taiao programme or an environmental programme in a Eurocentric curriculum

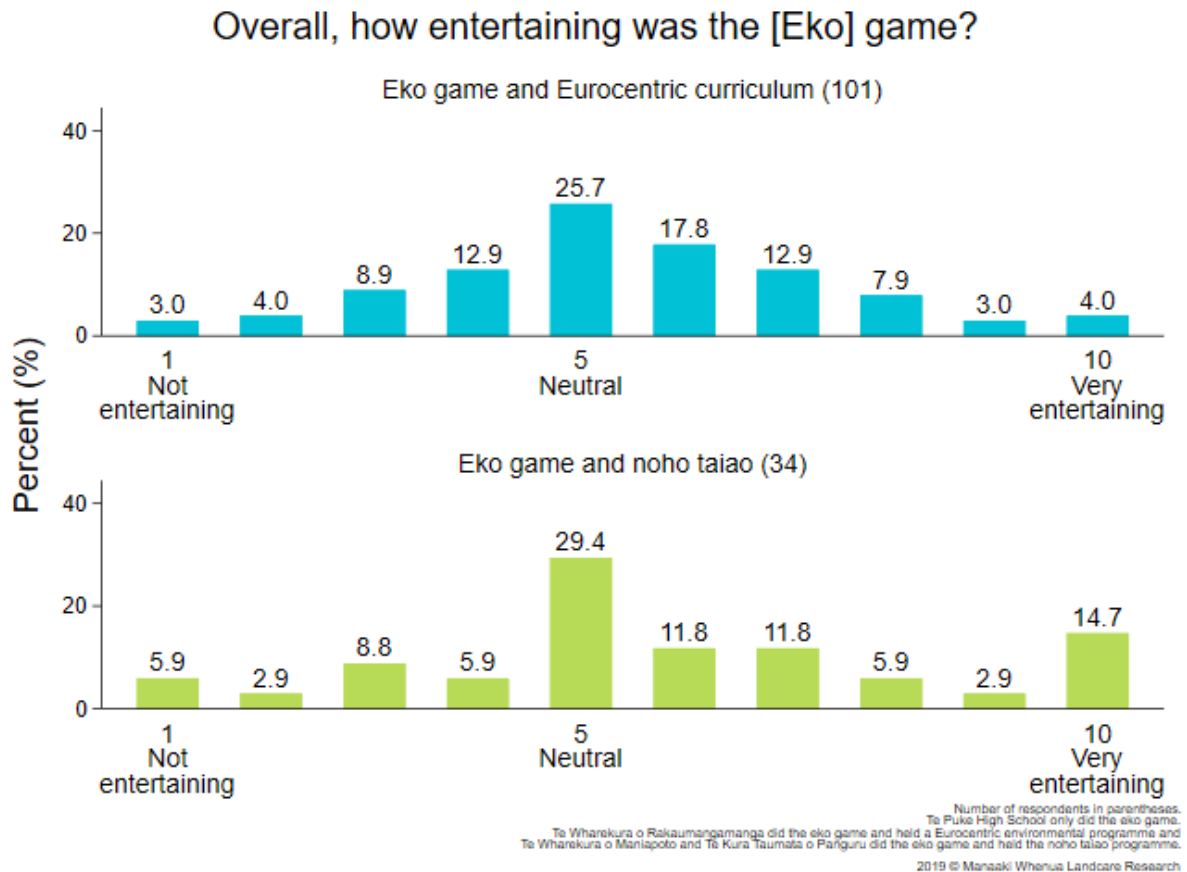
Students who attended schools that participated in any environmental programme said the Eko game was, on average, more entertaining than students who attended a school that did not participate in the environmental programme (7.9 versus 6.7 out of 10, $t(133) = -2.59, P < .011$).

274

275

276 Fig. S8

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278

279 Fig. S8. Comparison of responses to the question, “Overall, how entertaining was the [Eko] game?”
280 across students who attend a school that held the noho taiao programme versus students who
281 attend a school that held a Eurocentric curriculum with or without an environmental programme.

282

283 Students who attended schools that held the noho taiao programme said the Eko game was, on
284 average, more entertaining than students who attended a school that held an Eurocentric
285 curriculum with or without an environmental programme (8.1 versus 6.8 out of 10, $t(133) = -2.63$, P
286 $< .01$).

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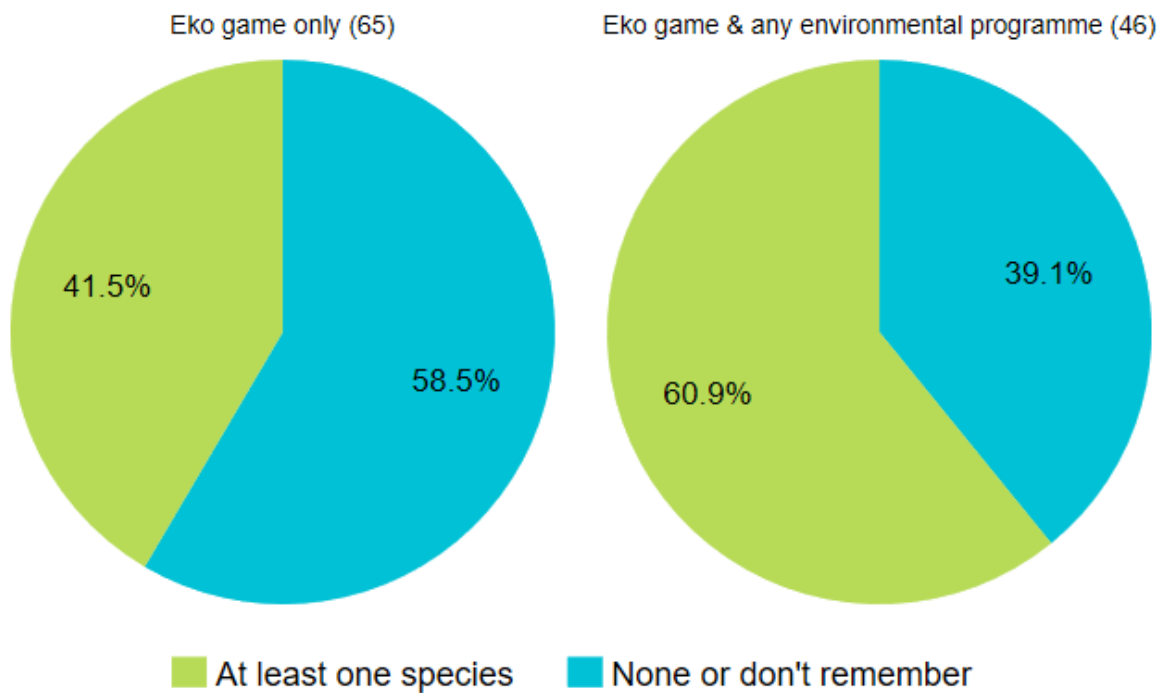
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296 **Fig. S9**

How many species can you name from the [Eko] game trial?



Number of respondents in parentheses.
 Te Wharekura o Rakaumangamanga did the eko game and held a Eurocentric environmental programme and
 Te Puke High School only did the eko game.
 Te Wharekura o Maniapoto and Te Kura Taumata o Pariguru did the eko game and held the noho taiao programme.
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297

298 Fig. S9. Comparison of responses to the question, “How many species can you name from the [Eko]
 299 game trial?” across students who attend a school that did not participate in any environmental
 300 programme versus either participated in the noho taiao programme or an environmental
 301 programme in a Eurocentric curriculum

302

303 Students who attended schools that participated in any environmental programme were more likely
 304 to say they would like to keep playing the Eko game than students who attended a school that did
 305 not participate in any environmental programme (61% versus 42%, $t(109) = -2.02, P < .045$).

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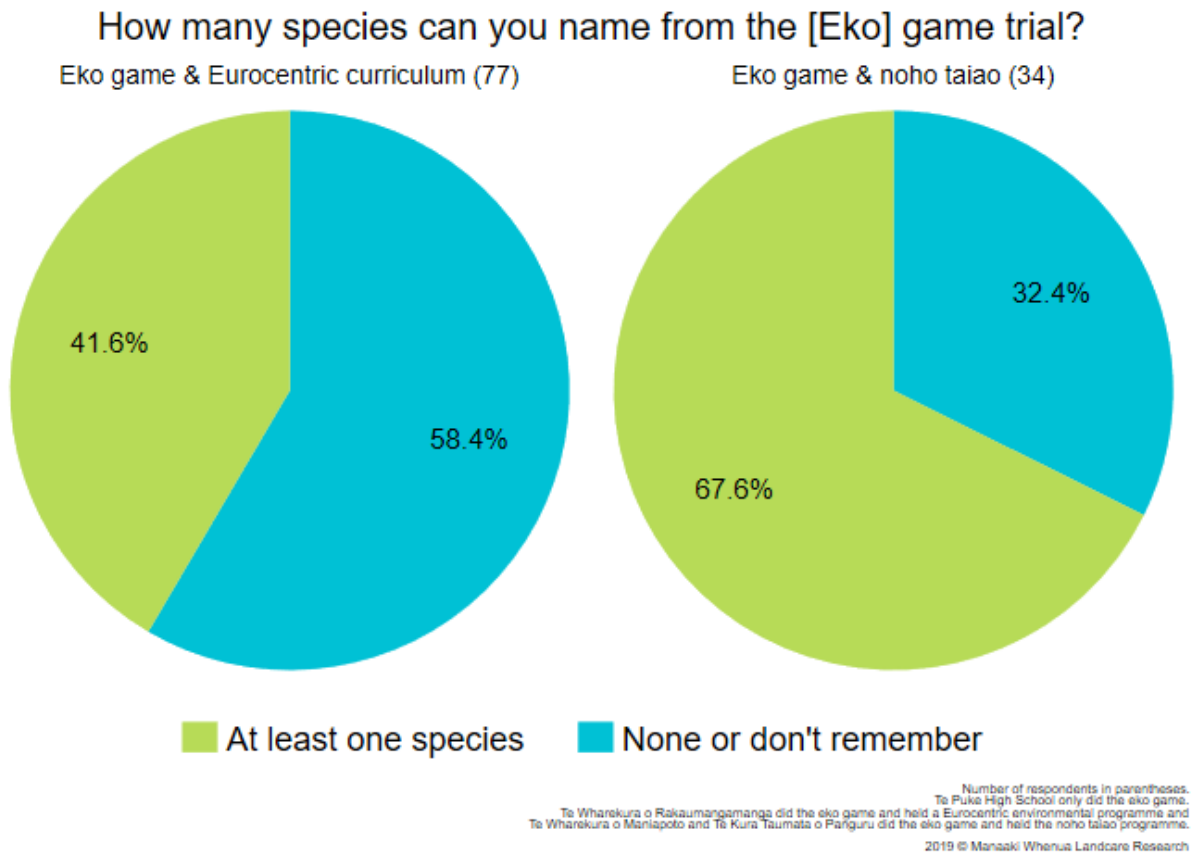
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314 **Fig. S10**



315

316 Fig. S10. Comparison of responses to the question, “many species can you name from the [Eko]
 317 game trial?” across students who attend a school that held the noho taiao programme versus
 318 students who attend a school that held a Eurocentric curriculum with or without an environmental
 319 programme.

320

321 Students who attended schools that held the noho taiao programme were more likely to say they
 322 remembered at least one species after playing the Eko game than students who attended a school
 323 that held a Eurocentric curriculum with or without an environmental programme (68% versus 42%,
 324 $t(109) = -2.59, P < .011$).

325