He Pūtaiao, He Tangata

PŪHORO
He Waka Eke Noa

Measuring the Economic Impact of the Pūhoro STEMM Academy

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MATATIHI
Economic Research

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The Pūhoro STEMM kaupapa

The Pūhoro STEMM kaupapa is a hugely successful programme that helps support rangatahi Māori high school students to excel in science, technology, engineering, mathematics and mātauranga and is now guided within a by Māori, for Māori, and with Māori independent entity – The Pūhoro Charitable Trust. Pūhoro strives to become a global exemplar at the interface of science and Indigenous knowledge.

The Pūhoro STEMM Academy was set up in 2016 to work with local high schools to accelerate Māori student success in STEMM subjects, and prepare them for a smooth transition to tertiary study, internships and employment in the STEMM sector. Now in 2021, Pūhoro rangatahi are five times more likely than other Māori school leavers to transition from secondary to tertiary education at degree level.

Pūhoro in 2021 operates in five key regions; Manawatū, Hawke's Bay, Christchurch, Waikato and South Auckland. Pūhoro will continue to expand to a minimum of two additional regions annually. Pūhoro currently has 1074 rangatahi who are within the kaupapa across thirty-six (36) schools, and who affiliate to eighty-three (83) iwi from around Aotearoa.

Pūhoro was founded by Naomi Manu who is the Manahautū (CE) and a Trustee of Pūhoro and together with the Pūhoro Charitable Trust Board will guide the kaupapa into the next phase of STEMM participation in Aotearoa.

Executive Summary

The Pūhoro Academy partners with a selection of secondary schools to operate a STEM (science, technology, engineering and mathematics) Academy to increase Māori student engagement in STEM programmes. Pūhoro supports secondary schools to prepare their Māori science students for transfer to tertiary study and into employment. The Academy has had significant success in improving Māori educational performance rates.

This report builds on two previous reports produced by the lead author in 2018 and 2019. The current report provides a cost-benefit analysis (CBA) of the potential economic benefits of the Pūhoro Academy to individual students, a regional economic analysis of the impact of the Pūhoro Academy, and an exploration of some significant flow-on impacts of higher education for Māori. The Pūhoro Academy is improving Māori NCEA achievement rates. The CBA considers in the counterfactual that a cohort of Pūhoro students would not have been expected to pass NCEA in the absence of the Academy and would not have continued to tertiary study. It is this cohort, representing the difference between the average Māori NCEA pass rate and the Pūhoro Academy achievement rate, that represents the economic benefits of the Academy at a high school and tertiary level.

As the CBA is estimating potential future economic benefits, there is a degree of uncertainty in quantifying these economic benefits. Therefore, the CBA establishes a likely scenario based on past Pūhoro Academy performance data and three additional scenarios, all of which make more conservative predictions. We found that at the high school level, the Pūhoro Academy program covers its costs by a factor of 1.8 to 14.0 times and that the university program covers its costs by a factor of 4.9 to 16.5 times.

Based on the most likely scenario, we found that the Pūhoro Academy's high school and university programme's potential economic benefits outweigh the economic costs by a factor above 14 to 1 and 16 to 1, respectively. The total net present value of the potential economic benefit at July 2021 is calculated to be above $79,169 per high school student and above $121,035 per tertiary student. The net benefit for the high school program is above $60 million and $32 million for the tertiary program.

The results demonstrate that both the overall impact and the CBA ratio have improved since our last analysis in 2019, which found a CBA ratio of 10:1. The CBA utilises multiple conservative assumptions which potentially undervalue the benefits of the programme. Despite this, the Academy covers its costs under even the most conservative scenarios tested. The analysis illustrates the power of a successful intervention in a young person's life. The research also highlights the significant benefits that are possible through tertiary education. The Pūhoro Academy is delivering economic benefits above its costs. These benefits are being realised by students obtaining qualifications that they would not have been likely to receive in the absence of the Pūhoro Academy.

The economic impacts of the Pūhoro Academy ripple out through communities and regions. In addition to analysing the impact on individual students, we also estimated these ripple or 'multiplier' effects.

Pūhoro is having a significant economic and social impact on regional economies, stimulating over $1.9m value added to New Zealand's economy per annum and 6.3 FTE positions outside of Pūhoro's direct operations. These figures only account for easily quantifiable impacts and do not account for a wide range of other beneficial impacts Pūhoro is stimulating.

Additional benefits will ripple out through whānau, both in the present and in the future. Some of these benefits include:

- Increased job satisfaction and associated wellbeing.
- Increase likelihood to vote in elections.
- Less likely to smoke.
- Decreased obesity rates.
- Increased family involvement and associated wellbeing.

We also describe the impact of higher education on one of the most prominent issues facing present generations, homeownership. Homeownership may protect against unemployment, decrease crime rates, reduce welfare dependency and offer a greater chance for low-income families to create asset wealth. Our analysis suggests a significant positive association between the activities of the Pūhoro Academy and the potential for future homeownership. Overall, we find that the Pūhoro STEM Academy has a significant measurable impact on individual students, regional economies, and Aotearoa.

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1 Project Background

In September 2018, the first author was subcontracted by ESR to perform a cost-benefit analysis (CBA) of the Pūhoro STEM Academy. The initial analysis of Pūhoro's economic impacts was conducted, taking into account guidelines published by the New Zealand Treasury. The first report focused on the potential economic benefits the Pūhoro Academy was generating by assisting students through higher school qualifications. In February 2019, the lead author was contracted again by ESR to perform a second cost-benefit analysis (CBA) of the Pūhoro STEM Academy, this time considering the potential economic impact of extending the Pūhoro STEM Academy into tertiary education at a bachelor's degree level. This second analysis report built off and extends the first analysis, which demonstrated that through helping students achieve NCEA standards, the Pūhoro Academy was generating a positive economic impact. The second analysis found that large economic benefits could be realised by assisting this same cohort of students through higher education levels in STEM fields.

As of July 2021, the Pūhoro STEM Academy has now extended its operations into the tertiary sector. ESR contracted Matatihi to undertake a third analysis of the programme, accounting for new developments in the operations of the Pūhoro STEM Academy, including the first cohort of tertiary students, new locations, and other expansions of its operations. Additionally, the present analysis takes a broader perspective. The first two analyses concentrated on the financial beenfits to individuals from their particapation in the Academy. The present analysis also considers the regional economic benefits of the Academy, including jobs and flow-on financial impacts. The present analysis also complements the quantitative analyses with qualitative insights into the effects of the Pūhoro STEM Academy. Matatihi were asked to investigate three primary areas of interest:

1. An updated social cost-benefit analysis (CBA) that is extended to include tertiary student numbers and qualifications.
2. A regional economic analysis on job creation and financial impacts driven by Pūhoro's opperations.
3. A qualitative review of the social impacts that are driven by improving educational outcomes for Māori.

2 Introduction

Māori experience higher rates of unemployment, lower average wealth, lower business ownership rates and work in higher-risk occupations on average in comparison to the total population of New Zealand. As one of the most economically deprived sectors of society, it is critical that, where possible, economic activity is leveraged to benefit Māori communities.

Any economic activity can be configured so that disadvantaged communities can be assisted from the poverty cycle. This can be achieved through greater skills and salary increases and by acquiring enhanced professional abilities. In addition to increasing the number of jobs, Māori must be supported to attain more highly paid senior roles in the job market.

The Māori population will grow to close to 20 percent of New Zealand's total population and one-third of New Zealand's children by 2038[1]. As a young and growing population, the future of New Zealand lies in Māori, particularly rangatahi, and their ability to gain and retain quality employment and business opportunities. Educational achievement is one of the most powerful drivers of economic and social growth. As an entity focused on improving the education outcomes for young Māori, the Pūhoro Stem Academy has the potential to create a significant societal impact. In this report, we quantify this impact, both at an individual level and at a broad societal level.

This report presents three primary analyses. First, we provide a regional economic analysis of the multiplier effects of the Pūhoro STEM Academy. We investigate the value the Academy contributes to regional economies and the number of indirect and induced jobs created by the Academy's operations in the regions. Second, we provide a social cost-benefit analysis (CBA) using the Treasury's CBAx model. The CBA quantifies the lifetime earnings of an individual based on their potential educational achievement. Finally, we provide some qualitative insights on the indirect benefits of higher levels of education for Māori rangatahi that are being stimulated by the Academy's operations.

1 https://thehub.swa.govt.nz/resources/future-demographic-trends-for-maori-part-one-population-size-growth-and-age-structure/

3 Regional Economic Analysis

In this section, a multipliers analysis is conducted, which considers both the immediate financial and employment impacts of business activities and the beneficial ripples through the community that these activities can generate. We draw on various information sources, including existing surveys and studies, direct contact with experts, and data mining online resources to underpin our analysis.

Our analysis is based on isolating the impact of Pūhoro's contribution to the education industry and the subsequent flow-on effect to regional economies from this contribution.

Economic activity has direct and indirect effects in that the demand for a product or service draws in inputs from other sectors. For example, Pūhoro requires inputs from other industries outside education such as Postal Services, Publishing Businesses, Telecommunications, Rental Services, and many more. By purchasing inputs from suppliers, Pūhoro generates income for people who supply Pūhoro (e.g., cleaners, caterers, suppliers etc.). These people will then spend some of their income on inputs for other businesses. Evaluating the regional economic impacts of Pūhoro requires assessing these flow-on multiplier effects. Multipliers make it possible to identify the direct, indirect, and induced effects in terms of expenditure, overall economic impact, and full-time equivalent (FTE) employment.

Input-output tables are a powerful analytical tool for describing multiplier effects. Input-output analysis looks at the product of each enterprise as a commodity demanded for final consumption and as a factor in the production of itself and other goods. The process consists of constructing an input-output table where the rows describe how one enterprise's total product is divided among various production processes and final consumption, and the columns denote the combination of productive resources used within an industry.

- *Direct impact* – this is a result of direct spending injected into the local and national economy by Pūhoro's economic activity.
- *Indirect impact* – this is a result of downstream revenue created by other firms selling goods and services in a related sector.
- *Induced impacts* – these are the effects of the above two contributions on further household spending which generates revenue as a result of increased purchases of household goods and services.

For this report, input-output tables produced by Statistics New Zealand were used by Matatihi to generate multipliers. These tables allow for the study of individual enterprises and their inter-relationships as reflected in sectoral multipliers. In analysing these inter-relationships, it is necessary to think in terms of an equilibrium model, where the effects on an exogenous change in anyone enterprise can be traced through the entire economy.

The multipliers analysis is based on the National Accounts produced by Statistics New Zealand in 2013. We have updated these tables to 2017 values. Multipliers remain relatively consistent over time, as the inputs needed to create a good or service remain similar over time. However, the figures produced by a multipliers assessment are an approximation and are intended to provide insights into the scale of impacts rather than provide highly accurate figures. The data requirements for enhancing the accuracy of multiplier assessments are extensive and reflected in the infrequent updating of the National Accounts by Statistics New Zealand. We are confident that the numbers produced here provide a close approximation of Pūhoro's impact and are more likely to underestimate the impact rather than inflate it.

3.1 Regional Economic Analysis Results

We based our assessment of Pūhoro's wider economic and social impact on financial and student enrolment information provided by Pūhoro. Pūhoro students are based at multiple schools spread across several regions. We conducted the analysis at a regional scale based on the five primary regions Pūhoro operates within at present. We did not have access to financial information at a regional or school scale. Therefore, we assigned Pūhoro's operating and capital expenses (investment) across the five regions, based on the relative proportion of students in each region (Table 1). The number of students ranged from 15 to 32 students per school, with an average of 22 students per school.

Table 1. Assignment of investment across five regions

Region	Ratio	2020 Investment	2023 Investment
Manawatū	0.28	$ 479,080	$ 574,896
Auckland	0.3	$ 513,300	$ 615,960
Christchurch	0.17	$ 290,870	$ 349,044
Hawke's Bay	0.19	$ 325,090	$ 390,108
Wellington	0.06	$ 102,660	$ 123,192
Total	1	$ 1,711,000	$ 2,053,200

Pūhoro expects expenses to increase by 20 percent by 2023. We, therefore, model what this increase would look like to provide insights into the future impact of Pūhoro. All organisations rely on a range of inputs from supporting industries. By purchasing inputs from these supporting industries, Pūhoro stimulates additional regional economic development. We analysed the input requirements for Pūhoro across 106 different industries. In Table 2, we report the ten industries in which Pūhoro stimulates the largest relative economic output. These results and all following multiplier results are based on classifying Pūhoro as operating within the 'School Education' industry. They are intended to be an approximation as any detailed accounting would require extensive surveying. These results are presented as the total impact rather than at a regional scale.

Table 2. Top 10 industries supporting the 'School Education' industry nationally.

	2020	2023
Heritage and artistic activities	$36,874	$44,249
Publishing (except internet and music publishing)	$21,647	$25,977
Library and other information services	$19,678	$23,613
Tertiary education	$19,260	$23,112
Central government administration services	$15,600	$18,720
Adult, community, and other education	$12,058	$14,469
Motion picture and sound recording activities	$11,362	$13,635
Religious services; civil, professional, and other interest groups	$10,989	$13,187
Sport and recreation services	$10,976	$13,171
Advertising, market research, and management services	$10,954	$13,145

The first assessment of regional impact we make is known as 'Value Added' (Table 3). Value-added can be thought of as a contribution to regional GDP. It is the level of value-added per unit of economic output. For example, a direct value-added ratio of 0.7 means that for every million dollars of economic output generated by Pūhoro, $700,000 of value is directly added to the regional economy. We also model indirect value-added. Indirect value added is the additional value added to the regional economy as supporting industries increase their economic output to serve Pūhoro's needs. Finally, we include induced value-added which quantifies the change in employee household personal consumption expenditures due to direct and indirect changes.

Table 3. Value Added

	Direct		Indirect		Induced	
	2020	2023	2020	2023	2020	2023
Wellington	$77,925	$93,510	$12,857	$15,429	$35,015	$42,018
Auckland	$389,626	$467,551	$67,039	$ 80,447	$214,278	$257,134
Manawatū	$363,651	$436,381	$ 20,782	$24,939	$71,202	$85,442
Canterbury	$220,788	$264,946	$27,430	$32,916	$83,888	$100,665
Hawke's Bay	$246,763	$296,116	$15,829	$18,995	$55,278	$66,333
Total	$1,298,754	$1,558,504	$143,938	$172,726	$459,660	$551,592

Based on this assessment, we find that Pūhoro's $1,711,000 economic output is stimulating the generation of over $1.9m value added to New Zealand's economy; this figure is projected to rise to over $2.3m by 2023.

We also considered the employment impacts of Pūhoro. Based on our data, we would have expected Pūhoro to employ 23 FTE (Full Time Equivalent) staff. We were told Pūhoro as around 20 staff at present, suggesting that it is relying on less staff than is typical for the sector they operate within (Table 4).

Table 4. Employment

	Direct		Indirect		Induced	
	2020	2023	2020	2023	2020	2023
Wellington	1.42	1.70	0.14	0.17	0.29	0.34
Auckland	5.77	6.93	0.79	0.95	1.83	2.20
Manawatū	6.52	7.83	0.32	0.39	0.77	0.93
Canterbury	3.94	4.73	0.39	0.47	0.84	1.01
Hawke's Bay	5.42	6.50	0.29	0.34	0.62	0.74
Total	23.07	27.69	1.93	2.31	4.35	5.23

We also consider indirect employment, which is the increase in employment in supporting industries stimulated by Pūhoro's operations and induced employment which is stimulated through additional household spending. Combined, Pūhoro is generating an additional 6.3 jobs in the New Zealand economy. This figure is expected to rise to 7.5 jobs by 2023.

Pūhoro is having a significant economic and social impact on regional economies, stimulating over $1.9m value added to New Zealand's economy per annum and 6.3 FTE positions outside of Pūhoro's direct operations. These figures only account for easily quantifiable impacts and do not account for a wide range of other beneficial impacts Pūhoro is stimulating. The impact of education on individual students is quantified through a CBA in Chapter 4, and the less quantifiable impacts are described and, where possible, quantified in Chapter 5. Combining these impacts makes it possible to reveal the extent of the socio-economic impacts of Pūhoro, illustrating that they are significantly larger than Pūhoro's costs.

4 Social Cost-Benefit Analysis

This report aims to measure the economic impact of the Pūhoro STEM Academy in part by performing a cost-benefit analysis (CBA) and by discussing the other impacts that Pūhoro Academy has on the welfare of the students that attend the Academy and the wider communities they operate in. For the purpose of this report, the Academy is separated into two sections, the high school program and the university program that is extended into postgraduate qualifications. The CBA impact discussed in this report considers guidelines published by the New Zealand Treasury and provides a conservative Cost-Benefit Analysis (CBA) for the Pūhoro Academy. The proposal for the CBA stated that:

> *The focus of the CBA will be on quantifying the lifetime earnings of an individual based on their potential educational achievement.*

It is expected that participants will accrue multiple economic benefits due to their participation in the Academy, particularly regarding Pūhoro's STEM focus and the subsequent higher salaries that careers in these fields can bring. However, the programme is recently established, and future economic benefits cannot yet be accurately determined. Therefore, the CBA presented in this report, like previous reports, makes conservative assumptions to demonstrate the impact of the Pūhoro Academy even in the absence of the additional significant economic benefits the programme is likely to create. Due to increased information available, some of the assumptions made in previous reports have been updated to reflect a more accurate impact while keeping to its conservative bias.

4.1 Structure of the CBA

This report presents the results from the cost-benefit analysis. Section 4.2 describes the Pūhoro Academy and provides some background information on the participants; it also highlights limitations in the data available on which the Academy was assessed. Section 4.3 describes how the cost-benefit analysis was designed and the data that was used. This description has been written for a general audience. It focuses on the ability of the Pūhoro Academy to improve Māori NCEA achievement rates above the national Māori average and provide academic support to Māori at university. It also describes how the economic impacts of the Pūhoro Academy were quantified. Section 4.4 presents the results of the analysis. The net present value as July 2021 of potential economic benefits from tertiary qualification achievement by Pūhoro high school cohort of students is estimated to be above **$63 million** for its high school program with a total cost of approximately **$4.3 million** ascribed for the three years program. Thus, the analysis finds that Pūhoro high school has the potential to return around **14** times its cost in economic benefits.

For the tertiary program, the net present value as July 2021 of potential economic benefits from increased completion of tertiary qualifications by Pūhoro University cohort of students is estimated to be above **$34 million,** and total costs of approximately **$2 million** were ascribed for a 4-year program. Thus, the analysis finds that the Pūhoro university program has the potential to return around **16** times its cost in economic benefits.

The total economic benefit for Pūhoro adds up to a total benefit above **97 million with** a combined cost of **6.3 million** across both programs.

The Pūhoro Academy has been selected for analysis because it specifically aims to invest in the economic potential of its participants through educational development, which can be expected to produce lifetime benefits.

4.2 The Pūhoro STEM Academy Overview

The Pūhoro programme is best described by the 2017 Pūhoro Annual Report:

> *As we engage rangatahi in STEM with a Māori world view, our vision and purpose of building an indigenous science community that can positively impact whānau, communities, hapū and iwi is becoming a reality.*

Pūhoro was launched in 2016 and is a transformative programme aimed at advancing Māori leadership and capability to deliver a world-class science community. The programme works directly with secondary school students and their whānau across the country. It provides students and whānau with mentoring, tutoring, wānanga (experiential learning/field trips) within culturally appropriate settings to help them navigate career pathways into science and technology-related industries. The program has now launched its second phase, where it tutors and supports students through university and tertiary studies.

4.2.1 The Pūhoro Academy in Schools

Pūhoro commences with a three-year programme (Years 11 – 13) within secondary school. The Pūhoro Academy partners with a selection of secondary schools in the Manawatū, Bay of Plenty, Hawkes Bay, Ruapehu, Christchurch and South Auckland regions. Their mission is to operate a STEM (science, technology, engineering and mathematics) Academy to increase Māori student engagement in STEM programmes. Pūhoro seeks to support secondary schools to prepare their Māori science students for transfer to tertiary study and into employment. All students selected to be a part of Pūhoro are required to participate in and sit a minimum of three of the required external science achievement standards at National Certificate of Educational Achievement (NCEA) Level 1, 2 and 3. They are also required to attend Pūhoro at wānanga at Massey University each term. The Academy has many methods to engage with students, including career mentoring, study noho, wānanga, tutorials, expo's, study/exam workshops, and kaihautū mentoring.

4.2.2 The Pūhoro Academy in Tertiary Education

In 2020, the majority of Pūhoro students who completed Te Urunga Tū (Phase 1 High School programme) successfully transitioned into tertiary study, apprenticeships, the defence forces or employment in 2021. Te Urunga Pae (Phase 2 Tertiary programme) now have cohorts in their first, second and third years of tertiary, and Pūhoro are preparing for some of the founding cohort to move into postgraduate studies or Te Urunga Tapu (Phase 3 Employment) as they graduate university in 2022. Furthermore, the Academy seeks to support Māori access to STEM industry through internships with partners and access to research opportunities in STEM.

4.2.3 The Participants in Pūhoro

The Pūhoro Academy is relatively new in regard to educational providers, and data on the success of the participants are still limited. No tertiary students have had enough time to complete their studies and data have not been provided on NCEA achievement rates post 2017. Pūhoro staff have stated that in 2016, 75% of students were not on an academic pathway and therefore did not intend to enrol in external science achievement standards (Table 5).

Table 5. Information on Y11 NCEA achievement of Pūhoro students

	Pūhoro Student Numbers	Pūhoro Pass Rates (%)	National Pass Rate (%)
2016	97 (Y11)	98%	82% (Y11)
2017	110 (Y11) 80 (Y12)	92%(Y11), not available(Y12)	78% (Y11), 79% (Y12)

Source: Data provided by the Business Development Manager and the Business Manager – Pūhoro Academy Programmes. Anecdotal evidence from 2019 suggests similar pass rates to 2017.

Students enter the Academy in Y11 so that the benefits from participation are potentially enjoyed for a working life of four decades. This observation is a significant aspect of the cost-benefit analysis.

Massey University has given Pūhoro access to their student data. The following graphs and data points illustrate Pūhoro impact over this reporting period within Massey University:

- Pūhoro now have Te Urunga Pae (TUP) students participating in 7 universities across Aotearoa, 1 international university, 4 polytechnics, 4 PTE's including the NZDF and a variety of paid apprenticeships and internships.
- First time Massey University enrolments are down in 2021 from the previous two years; however, there are still enrolments expected in Semester 2. Additionally, scholarships were unavailable for new Massey University enrolments in 2021 due to fiscal restraints, which further impacted students' choice to study with Massey. However, Pūhoro students are becoming more involved in tertiary study options outside of Massey and remain engaged in their education.
- Semester 1 2020 Successful Course Completion (SCC) rates for Pūhoro students were on par with, or exceeded, SCC rates for non-Māori students at Massey University.

4.2.4 Outcomes achieved by the participants

The Pūhoro Academy has had significant success in improving Māori educational performance rates; some key achievements include:

- Ninety-eight percent of Pūhoro Year 11 students passed at least one science achievement standard in 2016 (this includes internal achievement standards). This is a significant achievement for Pūhoro students increasing Māori student achievement in science subjects.
- Pūhoro now has rangatahi involved in universities, polytechnics, PTE's, apprenticeships and the defence forces throughout Aotearoa. The overall transition rate for Pūhoro students into the tertiary sector currently sits at 60%. This rate continues to exceed the national Māori tertiary transition rates, which sits at 48% and is on par with the national European transition rate at 62% (Education Counts, 2019).
- Ninety-two percent of the 2016 Pūhoro student cohort continued in the Year 12 Pūhoro programme and participated in science courses at NCEA level 2. While improving Māori participation in STEM subjects, the Pūhoro program also significantly enhances overall Māori NCEA pass rates.
- The 2020 Year 11 cohort had a wide range of career aspirations. Many of the students identified engineering, medicine, and science-related fields as aspirations.
- According to Pūhoro informational resources, Pūhoro students achieved high merit and excellence endorsements for individual external achievement standards.
- In 2017, 92% of Pūhoro Year 12 students achieved at least one science external achievement standard.
- Of the 97 Year 13 Pūhoro students who left school in 2018, 87% intend to enter tertiary studies at a bachelor's degree level. This is a 74% increase over the national Māori average.

4.3 Economic Benefits to Students from Pūhoro

The purpose of this section is to explain the mechanisms by which the Pūhoro Academy produces economic benefits. Section 4.3 brings together the data from Section 4.2 on the previous and current situations of the participants. Section 4.2.3 presents the income data used in the cost-benefit analysis of the following section.

4.3.1 Impact of the Pūhoro Academy

The analysis is based on 766 high school students and 271 University students.

The following assumptions have been made about the Pūhoro students.

- For simplicity, we have assumed the high school students have completed year 13, and university students are 1.5 years into their degree.
- We have assumed that all attend the program for three years for the high school program and 4 for university for calculating cost. This is a conservative assumption as some high school students will drop out of the program early or join at NCEA level 2 or 3, and most university programs are three years.
- The course pass rates correspond to all Pūhoro tertiary students and not just Massey students.
- The cost of students is spread equally among high school and tertiary students.
- The students included in the model represent the difference between the national average bachelor's degree qualification entrance rates for Māori Y13 NCEA students and the Pūhoro student's bachelor's degree entrance rates.
- Students that are in the Pūhoro Academy but would have been assumed to have entered a bachelor's degree qualification without the Pūhoro intervention are not included. This may underestimate the impact of Pūhoro, as the students brought into the program are likely to gain exposure to knowledge in STEM fields which could provide significant future benefits.
- It is assumed that students who are unsure or are moving straight to employment will gain no economic benefit from their participation in the Pūhoro Academy.
- Students with aspirations that do not require level 3 NCEA, such as hospitality, were assumed to go straight into employment and will gain no economic benefit from their participation in the Pūhoro Tertiary Academy.
- It is assumed that the pass rate of Pūhoro high school students through years 11-13 is 95%. This is based on information taken from previous reports as more recent data had not been made available at the time of the analysis.

It is assumed that the pass rates for Pūhoro high school students who enter university equal the national Māori pass rates of 80% (Education Counts, 2020a). This is a conservative approach as Pūhoro students were likely given skills that can be implemented in a university setting. This assumption and the assumption above combine to give an overall success rate of 76%.

The economic benefits of the students' educational achievements will only be realised in the future. Thus, the analysis will determine the potential economic benefits on the assumption that those currently engaged in the Pūhoro Tertiary Academy will benefit through increased income.

4.3.2 The Income Data Used in the Analysis

The New Zealand Treasury (2020) provides a spreadsheet model for social cost-benefit analysis and other resources offering guidance for analysts using this tool. This CBAx model incorporates a list of publicly available data organisations can use to value the impacts of an intervention, such as the Pūhoro programme. The Impacts Database of the Treasury's CBAx model includes impacts on marginal annual income data categorised by qualification level rebased to 2021 values. The impacts database is highly generic in estimating the value of educational achievements, providing only one level of impact of the marginal value of no qualification to upper secondary qualification.

To estimate the economic impacts more accurately, we have conducted a detailed analysis of the potential economic opportunities from different fields of study. As the Pūhoro Academy focuses on STEM achievement, this is an important distinction. From the cohort, 766 students indicated their intended future profession they will study towards, these professions were then mapped to the relevant bachelor's degree required to enter the profession. It is important to note that some professions indicated e.g., doctor, require multiple qualifications, as the analysis is done at a bachelor's degree level only, the CBA estimates the future economic benefit of a career in that field using the average income five years after their degree as the average for their lifetime earnings. This is believed to be a conservative approach as income is expected to rise beyond the five-year mark, thereby underestimating future earning potential. The following economic impacts (Table 6) are attributed to the Pūhoro programme to different degrees based on the number of students intending to enrol in these courses.

Table 6. CBAx impacts used to determine economic benefits

Description of increased values	Value	Unit
No qualification to Upper secondary school qualification	250	Per year
NCEA level 3 to Bachelor of Engineering	70635	Per year
NCEA level 3 to Trade Career	74205	Per year
NCEA level 3 to a Career in Commerce Accounting	65025	Per year
NCEA level 3 to a Career in Art and Design	46665	Per year
NCEA level 3 to a Career in Business	57885	Per year
NCEA level 3 to a Career in Education	52785	Per year
NCEA level 3 to a Career in Law	64750	Per year
NCEA level 3 to a Career in Logistics	66045	Per year
NCEA level 3 to a Career in Māori studies	52785	Per year
NCEA level 3 to a Career in NZDF including police	68085	Per year
NCEA level 3 to a Career in performing arts	42585	Per year
NCEA level 3 to a Career in Personal Services	53000	Per year
NCEA level 3 to a Career in Politics	56865	Per year
NCEA level 3 to a Career in Retail	50750	Per year
NCEA level 3 to a Career in Science Agriculture and Horticulture	60945	Per year
NCEA level 3 to a Career in Science Aviation	99750	Per year
NCEA level 3 to a Career in Environmental studies	59925	Per year
NCEA level 3 to a Career in Science forensics	62750	Per year
NCEA level 3 to a Career in Science General	56253	Per year
NCEA level 3 to a Career in Medicine	120105	Per year
NCEA level 3 to a Career in Science Space	62985	Per year
NCEA level 3 to a Career in Sports and Exercise	51765	Per year
NCEA level 3 to a Career in Tech IT	66045	Per year
NCEA level 3 to a Career in Social work	52785	Per year
NCEA level 3 to a Career in Veterinary Science	78285	Per year
NCEA level 3 to a Career after bachelor General	55845	Per year

Education Counts (2020b) is used to estimate the earning potential for each degree five years out from graduation. This is an early career salary and will likely underestimate the lifetime earnings of graduates. Age influences earning potential, as shown in Figure 1 below.

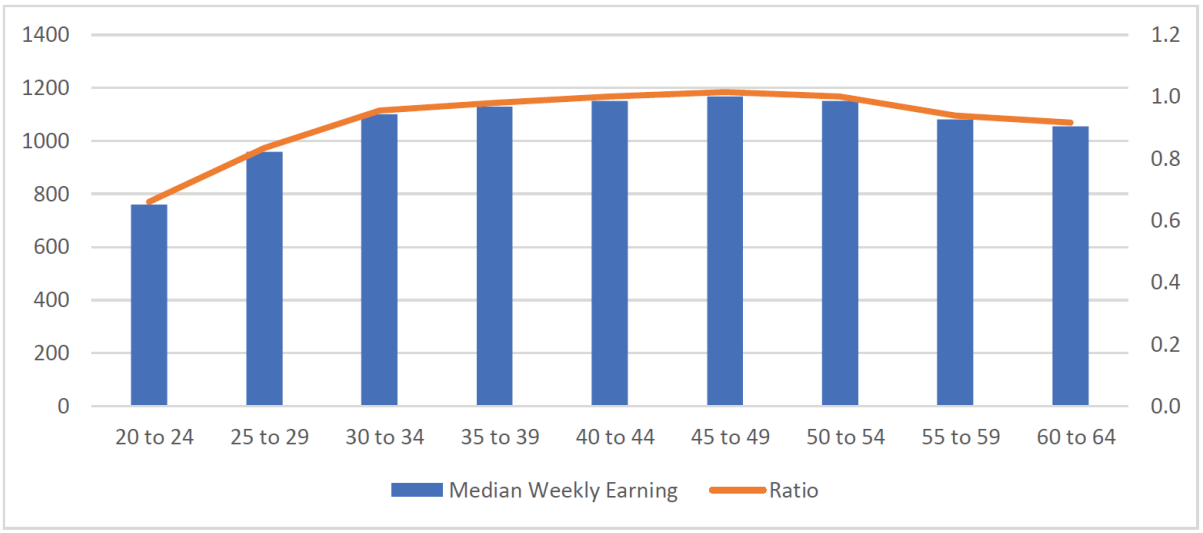

Figure 1. The impact of age on earning potential.

4.4 Results of the Cost-benefit Analysis

This chapter uses Treasury (2020) resources to undertake a consistent and systematic cost-benefit analysis of the Pūhoro Academy, using information available in June 2021. The analysis also takes direction from previous cost-benefit analysis done for Pūhoro STEM Academy by the lead author in 2018 and 2019, who provided guidance for this analysis.

It begins in section 4.4.1 by describing the counterfactual, that is, the assumed outcomes in the absence of the Pūhoro Academy. Section 4.4.2 presents a detailed account of how the potential economic benefits of the initiative have been calculated, including an explanation of the 'discount rate' used. Section 4.4.3 then presents the estimated economic costs. Section 4.4.4 reports the results of a sensitivity analysis, examining the impact of changing key assumptions in the cost-benefit analysis.

4.4.1 The counterfactual

The Guide to Social Cost-benefit Analysis explains that the counterfactual is the situation that would exist if a policy does not go ahead (Treasury, 2020, p. 10). In the absence of the Pūhoro Academy, it is expected that 48% of Māori students would enter tertiary, according to Education Counts (2019). Based on the information provided by Pūhoro, 60% of Pūhoro Academy Y13 graduates transition into tertiary studies at a bachelor's degree level.

As the program is relatively new and not enough time has passed for students to progress from the programme to the workforce, it is not possible to determine which STEM fields students may enter. The analysis is conservative in that it assumes that economic benefits will accrue to students based on the average marginal benefits per annum from different qualification levels.

In the absence of Pūhoro, 367 out of the 766 students would have been expected to move onto tertiary studies. The analysis assumes that economic benefits will accrue to 25% (91) of the students. That is, the 460 students entering tertiary study minus 48% (368) students who would have been expected to enter tertiary studies without the Pūhoro intervention.

Consequently, the assumed counterfactual is that in the absence of Pūhoro, a participant would gain no economic benefit from their participation in the Pūhoro programme but would return to their likely previous career path of a person without a secondary school qualification. For the tertiary model, the assumed counterfactual is that 25% of the tertiary studies cohort would gain no additional economic benefit from their participation in the Pūhoro programme but would return to their likely previous career path of a person with a higher secondary school qualification. Therefore, the counterfactual is the difference between average bachelor's degree enrolment and achievement for Māori students and bachelor's degree enrolment and achievement for Pūhoro students.

We have been provided data on intended enrolments and academic fields of enrolment; therefore, the CBA assumes that the Pūhoro cohort enrols in the indicated fields and achieves qualifications at the Māori national average rate of 80% (Education Counts, 2020a). The CBA conducted for Pūhoro tertiary students assumes the pass rate is 92% as this is halfway between 85% and 100%, which is the lowest and highest pass rate for Pūhoro students as indicated in the graph above.

To keep the analysis conservative, it is assumed that students who are not expected to pass a qualification level will get no future benefit from higher educational achievements. Additionally, the economic impact for each degree field is quantified using average earnings five years after graduation. This salary level is often significantly lower than professionals in these fields will earn as they progress in their careers.

4.4.2 The estimated potential economic benefits

Unlike previous reports, the 271 tertiary students analysed in this chapter can be grouped into categories based on their field of study, all of which contribute to the estimated potential economic benefits. We have used the pass rate indicated above of 93%. These pass rates are the ones shown for the university students for which we have data. We have assumed the pass rate of 80% as the counterfactual as this is the Māori national average pass rate of university students. This gives us a marginal impact of 13%.

The 766 high school students analysed in this chapter are grouped into one category as there is little economic benefit between NCEA levels 1-3. We have assumed the pass rate of 95% as this was the pass rate in previous years. This means out of 766; only 728 are assumed to pass NCEA Level 3 and derive economic benefit from the program; furthermore, it is assumed that 48% who passed NCEA Level 3 and entered university would have done this without the intervention. This gives us a marginal impact of 12% for those who wish to enter university. For NZDF the graduation rate is between 86%-97% (the Ministery of Defence, 2015) and therefore the success rate can be assumed to be at approximately 92%.

The potential economic benefits come from the marginal impact of students on a higher income path due to the qualifications they are expected to obtain due to the Pūhoro intervention. Students who are not expected to pass or would have been expected to pass in the absence of the Pūhoro programme are not included in the analysis. Based on their age group (Y13 students), it is possible to calculate for the remaining years of their working life.

The bachelor's degree programmes considered are either three or four years in duration. Because the intervention targets young people, the economic benefits continue for a long time, up to 50 years. Hence the total benefits to a participant are substantial. Second, larger gains come from the successful completion of higher levels of qualifications. In addition, Pūhoro is targeting STEM qualifications which tend to attract larger salaries than other fields.

This report follows Dalziel et al. (2017 p.20) in the selection of an appropriate discount rate. To calculate the total net present value of these benefits, it is necessary to determine a suitable discount rate, acknowledging "that most people would prefer receiving a dollar today over receiving a dollar in a year's time" (Treasury, 2015, p. 34). This preference is linked to interest rates earned on savings, and so the discount rate is set to reflect current interest rates and the risks of social investment of this nature. The discount rate recommended by the Treasury

in 2020 is 5 percent, which is the rate used in this study. Based on these assumptions, the total net present value of the potential economic benefit at July 2021 is calculated to be above **$79,169** per high school student and above **$121,035** per tertiary student. This means the net benefit for the high school program is above **$60 million** and **$32 million** for the tertiary program.

4.4.3 The estimated economic costs

Information on costs for the programme was limited to a single estimate for 2020 of capital and operational cost. Pūhoro indicated that they expected costs to rise by approximately 20%, which gave a total cost of **$2,094,264** for the program for 2021, which includes a 2% inflation factor. The costs per year was divided evenly per student between the university and high school program, this was used to derive a cost of approximately **$1,970** per student per annum. The total cost per student was adjusted to reflect the time each member is assumed to spend in the program, which gave us a total cost of **$5,636** and **$7,338** per high school and university student, respectively.

Due to the high pass rates (between 95-98%) the analysis takes a conservative approach in assuming that the costs for each student in Y11 will remain through to Y13. This is likely to overestimate costs as some students will drop out of the programme. The analysis conservatively uses a flat rate for the cost of each student across all years. This means it is assumed that the cost is equally distributed among high school and tertiary students.

All the fixed costs are assigned to the current cohort of participants, although it is hoped that the initiative will continue to operate with new entrants as time proceeds. This represents another conservative assumption in the analysis. Marginal costs would likely decrease as new students come into the Academy.

Based on the assumptions made above, the total net present value of the economic costs associated with all participants in July 2021 is calculated to be **$2 million** and **$4.3 million** for the high school and university programmes, respectively, giving a total cost of **$6.3 million.**

This cost is well below the estimated net present value of potential economic benefits in Section 4.2.3 (above **$97 million**). Thus, the Pūhoro initiative is producing potential economic benefits beyond its costs.

4.4.4 Sensitivity analysis

The cost-benefit analysis reported in sections 4.2 and 4.3 suggest that the net potential economic benefits of the Pūhoro Academy are:
$97m - $6.3m = $90.7m
Which can be separated into an individual cost of
$64.96m - $4.32m = $60.64m for its high school program and a cost of:
$34.79m - $1.99m = $32.80m for its university program.

The final step in a cost-benefit analysis is to reflect on whether the assumptions in the analysis have unintentionally incorporated an 'optimism bias', leading to overestimation of future benefits or underestimation of costs (Treasury, 2015, p. 31). The alternative is to consider pessimistic scenarios to understand the sensitivity of the result to key assumptions (Dalziel et al. 2017).

For the high school program, we altered two different assumptions to test the robustness of the conclusions. These assumptions are similar to the assumptions made in previous reports, although interpreted slightly differently. First – enrolment rates drop to 44% of 2021 enrolments while keeping total cost the same. Second - only 32% of the cohort pass their qualifications (half the national average). Third - only 44% of the students enrol, and only 32% pass.

Table 7. Sensitivity analysis of three scenarios of Pūhoro's impact - High School program

	Base Scenario	44% enrolment	32% pass rate	44% enrolment with 32% pass rate
40-Year NPV ($m)				
Total marginal impact	64.96	28.6	27.5	12.1
Total cost of initiative	-4.32	-4.3	-4.3	-4.3
Net economic benefits	60.64	24.3	23.2	7.8
CBA Ratio	14.0	5.6	5.4	1.8

Table 7 shows that in all cases the Pūhoro Academy high school program covers its costs by a factor of 1.8 to 14.0 times.

For the University program (Table 8), we again altered two different assumptions to test the robustness of conclusions. The first assumption we alter is that the pass rate is shown to be between 85-100% while the national āori pass rate sits at 80%. Decreasing this pass rate to the lower bound of 85% gives us a marginal impact of only 5%. The second assumption is that all the students are in their first year of university, meaning that the economic benefits are further away.

Table 8. Sensitivity analysis of three scenarios of Pūhoro's impact – University program

	Base Scenario	85% pass rate	All year 0	85% pass rate with all year 0
40-Year NPV ($m)				
Total marginal impact	34.8	14.6	30.7	11.8
Total cost of initiative	-2.0	-2.0	-2.0	-2.0
Net economic benefits	32.8	12.6	28.7	9.8
Average net economic benefit per cohort member (40y)	121,035.8	46,670.7	106,061.1	36,277.0
CBA Ratio	16.5	6.4	14.5	4.9

Table 4 shows that the Pūhoro Academy university program covers its costs by a factor of 4.9 to 16.5 times in all cases.

Due to the significant lifetime benefits that are possible through higher educational achievement, the Pūhoro Academy covers its costs under all scenarios considered and provides a significant economic benefit under the primary scenario. Hence the fundamental conclusion of the analysis, that the Pūhoro Academy is likely to continue generating a positive economic impact is robust.

The stated intentions of the Pūhoro Academy students suggest that the Academy has had a significant impact on their future educational pathways. The analysis has assumed that these students will continue to receive support from the Pūhoro Academy throughout their tertiary studies. However, even in the absence of this support, it is likely that these students have been put on an educational pathway they are unlikely to have followed without the support of Pūhoro.

5 Review of Social Impacts

The CBA provided in this report has focused on the private benefits to the individual students involved with the Pūhoro Academy; however, there are likely to be significant and widespread social benefits that are being generated. Quantifying social benefits is complex, and the available data do not provide a complete picture of the wider social benefits of education. However, financial data tends to be more easily obtainable. The financial data that is available focuses on costs rather than benefits. While the avoidance of costs can be a significant benefit, it provides a narrow window into the benefits of education.

The Treasury (2017) has considered the potential service costs that at-risk children may attract. These costs include income support payments, costs associated with serving sentences administered by the Department of Corrections, and costs associated with the services provided by CYF in childhood. In 2016 dollars, projected costs are less than $50,000 per person for children and youth who are not considered to be at risk, while they are at least $180,000 and as much as $410,000 for different risk groups by the age of 35 (Treasury, 2017). There are four key indicators of risk, the more indicators that a child has, the more they are likely to require additional services. Having a mother with no formal qualifications is one of the four indicators which emphasises the important role of education in intergenerational wellbeing. A child exposed to just one risk indicator is expected to require an additional $65,000 in services by the age of 35. This cost increases exponentially with additional risk factors.

In a recent data science presentation, data from a cohort of all people born in New Zealand in 1990 were used to measure the cost of services eight years out from high school completion. From the cohort, the top 16% required more funding than the remaining 84%. This 16% represent people in the most disadvantaged socio-economic position. The top 1% required $160million in services over the eight years after completing high school. The majority of these people did not have NCEA Level 2. While a lack of NCEA Level 2 cannot be described as causing the need for more services, it is an important associated factor. The ripple effects of low educational achievement can be vast and last a lifetime. A report from Whitehead & Walker (2021) demonstrates that a parent's aspirations for their children's educational achievement is one of the main variables that can predict whether their child will go on to own a home. In turn, homeownership has been shown to have significant health and wellbeing benefits for families and helps to create intergenerational wealth.

A significant body of research exists which describes the non-market benefits of education. For example, Wolfe & Haveman (2002) describe:

- a likely positive link between one's own schooling and the schooling received by one's children;
- a likely positive association between one's own schooling and the health status of one's family members;
- a likely positive relationship between one's own education and one's own health status;
- a likely positive relationship between one's own education and the efficiency of choices made, such as consumer choices (the efficiency of which contributes to a wellbeing similar to the contribution of money income);
- a relationship between one's own schooling and fertility choices (for example, decisions of one's female teenage children regarding nonmarital childbearing); and
- a relationship between schooling in one's neighbourhood and youth decisions regarding their level of schooling, nonmarital childbearing, and participation in criminal activities.

There are also non-financial and somewhat more personal benefits that can be generated by increased education as described by Baum & Payea (2013) such as:

- Increased job satisfaction and associated wellbeing.
- Increase likelihood to vote in elections.
- Less likely to smoke.
- Decreased obesity rates.
- Increased family involvement and associated wellbeing.

Higher levels of education can be assumed to bring higher levels of benefits. We do not try to quantify these benefits here as robust data are not available. However, the Pūhoro Academy is generating significant social benefits in terms of health, education, whanau relationships, wealth creation and the avoidance of social service costs. These benefits have intergenerational impacts that extend far beyond an individual's lifetime. A parent's level of qualifications and expectations for their children's educational achievement has been shown to generate significant future impacts for their children. Through a small intervention in a child's educational pathway, the Pūhoro Academy has the potential to generate significant financial and wider socio-economic benefits.

5.1 Home Ownership

Homeownership is a significant challenge facing all of New Zealand; however, Māori are disproportionately affected by low homeownership rates. Māori are experiencing significant declines in homeownership. In 1926 around 74 percent of Māori owned or partly owned their own home; in 2013, homeownership rates for Māori had declined to 28 percent . The positive associations between homeownership and socio-economic and health outcomes are well established across multiple societies.

Homeownership may protect against unemployment, decrease crime rates, reduce welfare dependency and offer a greater chance for low-income families to create asset wealth (Waldegrave & Urbanová, 2016). The relationship between housing tenure and a number of independent variables like health, crime, and education is becoming more accepted as being significantly associated with homeownership. In general, Māori measure more poorly against socio-economic measures than the general population.

Whitehead and Walker (2021) analysed the primary factors that predicted homeownership for Māori. This study showed that a small number of socio-economic variables are of significant importance for homeownership. While income was found to be a key variable, as would be expected, non-economic variables such as parents' aspirations for the children's education and relationship status also demonstrated significance in predicting homeownership (Figure 2). The role of education is a critical determinant in all five factors affecting Māori homeownership.

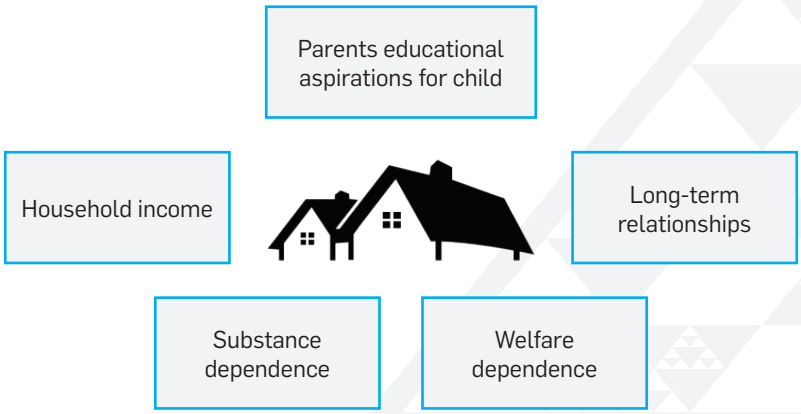

Figure 2. Factors predicting Māori homeownership.

Of the five, the one factor that is of explicit interest for our analysis of the Pūhoro STEM Academy is 'parents educational aspirations for child'. Parents who expected their children to get a good education, i.e., parents who would be more likely to enrol their child in the Pūhoro STEM Academy, significantly enhanced their child's homeownership potential. Based on these five variables alone, Whitehead and Walker (2021) predicted the likelihood that a cohort member would own a house.

Figure 3 below breaks the cohort into five groups ranging from least advantaged (Group 1) to most advantaged (Group 5). We see that those in the most advantaged group had rates of homeownership that were more than eight times higher than those in the least advantaged group.

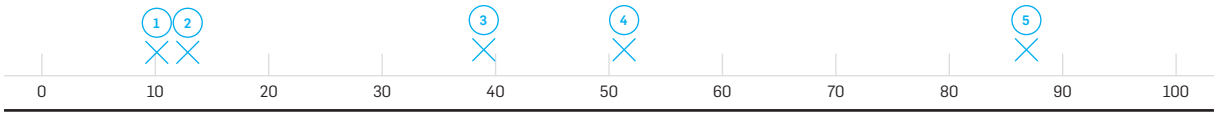

Figure 3. Likelihood of owning a home

The findings suggest that homeownership origins for Māori were primarily explained by exposure to family expectations, individual mental health, and socio-economic wellbeing. Each of these factors is heavily influenced by education. While there is little research on direct correlations between Māori educational achievements and wellbeing outcomes, this research on housing demonstrates the potentially significant impact on life outcomes that improving Māori educational achievement can have.

6 Conclusion

The cost-benefit analysis for Pūhoro STEM Academy's high school and university programmes calculates that the potential economic benefits outweigh the economic costs by a factor above 14 to 1 and 16 to 1, respectively. The analysis illustrates the power of a successful intervention in a young person's life; in this case, the initiative has the potential to increase the lifetime earnings of all its students. The sensitivity analysis reveals that even at more conservative impact rates, the potential economic benefits outweigh the economic costs by a minimum of 1.8 to 1. This more conservative assumption would still result in over $23,000 extra income per student over their working career. The conservative assumptions used throughout the report likely underestimate the direct economic impacts that Pūhoro has on its students.

The sensitivity analysis indicates that the results from the cost-benefit analysis are robust. The Pūhoro Academy is delivering economic benefits above its costs. These benefits are being realised by students obtaining qualifications that they would not have been likely to obtain in the absence of the Pūhoro Academy. The benefits considered in this analysis will likely ripple out through whānau, both in the present and future.

We quantified a small proportion of these ripple effects. We found that Pūhoro is having a significant economic and social impact on regional economies, stimulating over $1.9m value added to New Zealand's economy per annum and 6.3 FTE positions outside of Pūhoro's direct operations. These figures only account for easily quantifiable impacts and do not account for a wide range of other beneficial impacts Pūhoro is stimulating.

The unquantifiable impacts include multiple wellbeing outcomes in health, employment, social participation, crime, family welfare and many more. We are confident of the impact higher levels of educational achievement have on these wellbeing outcomes; however, few data are available to quantify a direct connection between the Pūhoro STEM Academy and these outcomes. Despite this limitation, the research has demonstrated a clear and significant positive impact generated by the Pūhoro STEM Academy on young Māori, whanau communities, regional economies, and Aotearoa.

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