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Project Report

Ka nanakia hoki ki te numeracy: Better than before

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Ako Aotearoa™

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Executive Summary

Abstract

Urgency to improve adult achievement in literacy and numeracy has emerged through the creation of a global adult literacy and numeracy crisis-rhetoric. The crisis-rhetoric has been promulgated and perpetuated through global administration of deficit-model assessment regimes that ultimately measure singular perspectives of what is deemed to be necessary literacy and numeracy knowledge and skills. Assessment is administered to diverse communities across the globe as if developed from generic, culturally and politically neutral assumptions. Rhetoric attached to such assessment assumes that literacy and numeracy performance of diverse communities across the globe can be analysed and compared accurately, validly and robustly enough to indicate which populations are 'ahead' and which are 'behind'. An issue that has emerged from this type of assessment regime is the perpetuation of deficit-constructing and labelling of certain populations, stigmatising communities as low-skilled, ill-fitting for societies' needs, and in need of fixing to better suit what a certain version of global society wants from them (rather than for them). Such crisis-rhetoric continues to perpetuate "unhelpful ideas of literacy and numeracy as a fixed set of abilities which are mastered or failed in an absolute way" (Black & Yasukawa cite Lo Bianco, 1989, p.127).

The "Ka nanakia hoki ki te numeracy: Better than expected" pilot project has utilised kaupapa Māori research theory and methodology to study and thereby mitigate the effect that such crisis-rhetoric has had on ākonga (learners) in an indigenous tertiary institution. This project has asked what ākonga say about their maths identities, attitudes and beliefs, how these have been formed, and what they desire for themselves in terms of numeracy and maths knowledge in their future studies and lives. Information shared by ākonga has meant considering thinking beyond a teaching-and-learning model of "knowing the learner, knowing the demands and knowing what to do" (Alkema & Rean, 2014, p.44). A deeper focus-shift has emerged from analysis of ākonga voice where we need to 'know' and understand ākonga and their relationship with numeracy and maths beyond 'knowing' their assessment results. Their messages are about wanting to dispel myths about themselves and their maths abilities, to make friends with numbers and maths, and to experience feelings of success that come with knowing and understanding a system/community that they have felt shut out of for most of their lives. Ākonga also express keenness and enthusiasm about co-developing their own learning tools for numeracy and maths.

Introduction to Ka nanakia hoki ki te numeracy: Better than expected

The ka nanakia hoki ki te numeracy project was an exploratory pilot project undertaken by a team of researchers at Te Whare Wānanga o Awanuiārangi with support from Ako Aotearoa. Researchers gathered across-discipline ākonga and kaiako (facilitator/s of learning) voice regarding maths histories and current needs and aligned this to data gathered from ākonga numeracy assessment results[1]. The purpose of this was to provide a map of affordances and barriers to ākonga numeracy achievement in an indigenous tertiary institution. The aim of this mapping was to gather evidence for co-designing

[1] The New Zealand national adult numeracy assessment tool was used to gather ākonga numeracy proficiency (according to the tool) data. https://assess.literacyandnumeracyforadults.com/

with ākonga an innovative and sustainable numeracy education model and tool. Part of the purpose was to also explore how mātauranga Māori and te Reo Māori could be woven through numeracy teaching and learning.

Ākonga have described to the team of researchers their maths education histories, how their past experiences have relevance to their studies and future goals, and the kinds of activities they would appreciate in a learning and teaching tool that would help them have ubiquitous access to what they want to learn and how they want to learn it. While their context for learning is noted as a motivating purpose, ākonga have also expressed a desire to move beyond narrowly contextualised numeracy exercises into a space where they feel positive levels of confidence and competence in ranges of situations where maths and numeracy might occur. This is the space where they have expressed being shut out of for most of their education lives. There is very little data that speaks to being Māori and the place of mātauranga Māori.

This report is a synopsis of the pilot research project. What follows is an overview of the methodology and method employed by the research team; a selection of literature that has been drawn from to support research assumptions, findings and analyses of findings; presentation of the data gathered from students; and discussion and conclusion where recommendations are offered for further research and development.

Recommendations summary

The project team has found that through adult numeracy teaching and learning there is potential to support adult learners to change negative views about their maths identities and that this process can be managed by their kaiako through a variety of ways. This report identifies three significant points to consider.

1. Broaden and deepen what it means to "know the learner", so that kaiako are learning more about what mathematics identities ākonga have historically built for themselves and how they might want to change those identities.
2. Use and continue to develop teaching and learning tools and strategies alongside ākonga that support them to learn numeracy for work requirements and mathematics that they identify they would like to learn and/or conquer.
3. Centralise ākonga and their histories, identities and aspirations; rather than centralise assessment. The value is in the person, not in the person's results.

Kaupapa Māori research theory, methodology and method

This project has drawn from Kaupapa Māori theory, methodology and method. Pihama, Smith, Taki and Lee (2004) define kaupapa Māori theory as a legitimate framework on which to build research method. The aspect of kaupapa Māori research theory that is centralised for this project is that of Māori identity and the impact of past educational mātauranga (knowledge) experiences that have had negative results on "the unique features that make up that identity" (Mead, 2012, p.10). This research is focused on creating positive outcomes for Māori communities and research participants by taking for granted Māori knowledge as being central to the communities and researchers involved (G. Smith, 2003; L. Smith, 1999; Pihama, 2001; Eketone, 2008; Graham, 2009; and Barnes, 2000). Another centralised aspect of kaupapa Māori theory utilized for this project is Eketone's (2008) Native Theory, where Māori communities construct their own realities from their own needs rather than centralising a more dominant 'other'. This is focussed on firstly by asking ākonga Māori to discuss their identities and the contribution of their past maths learning experiences to those identities, and secondly to identify what they want, and what is relevant to them to feel successful in their studies.

In terms of methodological assumptions, the research participants are Māori communities of learners who have expressed a need for their learning to be enhanced in ways that will work for them. The researchers are part of that community as members of the institute where the ākonga are learning, but not as direct members of the ākonga community. Benefit from the research outputs will be positive for both the research participants, the researchers and the institution where the research has been carried out. The project outcomes should also have a positive beneficial effect for other tertiary institutions where students struggle with past-constructions of their identities in relation to maths education. This aligns with Smith's (1999) kaupapa Māori research methodologies framework and concepts of engagement with whanau (extended family, extended teaching and learning family).

In terms of method, two main research tools were used to gather data for this project. Quantitative assessment data were gathered to provide an overview of ākonga strengths and areas for strengthening. The results were then used as a discussion tool with the students about their perceived maths/numeracy identities. Qualitative methods employed for this project aligned with kaupapa Māori research theory by employing community-based data collection tools. Firstly, kaiako and/or leaders of programmes were invited to take part in the research. When kaikao and/or leaders agreed, they invited the team to work with their ākonga. Ākonga were invited to participate in the project and volunteered by coming to specific sessions with the researchers, or by staying in sessions set up by

their kaiako. Kaiako worked with the research team to provide time for the ākonga to complete the national online adult numeracy assessment.

Semi-structured interviews were carried out with groups (Merriam, 2002). Research questions are added as an appendix (p.24). Students who wished to be interviewed individually were invited to do so in face-to-face or zoom[2] recorded meetings. One student chose to be interviewed in a face-to-face meeting. All students were given information forms and consent forms to sign. Ethics approval was gained through the Te Whare Wānanga o Awanuiārangi ethics committee. Before interview and workshop sessions ākonga were informed that if they did not wish to participate, they could leave, or ask for any recording devices to be turned off at any time.

Six ākonga from one programme volunteered to participate, and 28 from another. The six students are in a programme that attends the wānanga for one week each month rather than daily classes. The 28 students attend wānanga classes each week for four days a week. Data also includes three Kaiako and field notes.

Literature about adult numeracy teaching and learning

In this section there are five distinct areas of literature that have been drawn upon. Firstly, a critique of dominant discourses about numeracy success and/or failure discusses maths and numeracy education and assessment and their contribution to adult learners' history/ies of low esteem, confidence and competence in numeracy and maths. This critique anchors the outputs of this research project, providing a platform of how the issues that have been discussed by ākonga have originated, are perpetuated, and in effect cause the very conditions that the numeracy industry seeks to remedy. Secondly a focus on how numeracy and maths identities continue to be created over time is discussed. Thirdly literature is drawn on to discuss general issues adult learners bring with them to their studies that relate to their past experiences in maths education. The fourth focus is a brief glance at what literature and research is available to teachers and learners to support with numeracy in tertiary studies is provided. Finally, we touch on an issue that is generally not highlighted through literature and that is a sense of misunderstanding about what maths and possibly numeracy is in education.

[2] Zoom https://www.zoom.us/?zcid=1383&creative=200957049346&keyword=zoom&matchtype=e&network=g&device=c&gclid=Cj0KCQjw6rXeBRD3ARIsAD9ni9A9f2LmxzYU3xxM5IBfuYtTuoqpEg2mdxDaxnqeobt1Tna5ULKovQwaAnrEEALw_wcB

Critiquing dominant discourses

There is a body of literature that insists that for all people to live better and more fulfilled lives they need to be skilled in numeracy as this will mean better employment and/or tertiary study opportunities, see for example Awofala & Anyikwa, (2014); Ginsburg, (2017); Johnson, (2000); McNaught, (2013); Ministry of Education, (2010); Organisation for Economic Cooperation and Development (OECD), (2012); Tertiary Education Commission, (2010). In our current economic regime, this may hold some truth. However, this literature is built on flawed evidence that arises from narrowly defined adult numeracy needs that have arisen from questionable sources to create assessment tools that create the very crisis that the tools are purported to be designed to manage (Black & Yasukawa, 2014; Tsatsaroni & Evans, 2013). The OECD (2012) article for example demonstrates such circular logic. On p.36 there is a paragraph explaining that it is very difficult to capture the numerate behaviour of an adult within the PIAAC[3] assessment framework and that integral components of evaluating adult numeracy behaviours cannot be included/captured within the assessment. However, the purpose of the article is to support research, policy and funding decisions based on adult numeracy and literacy assessment results. On p.37 is a statement that says that mathematics (confusion between numeracy and mathematics is rife throughout this and other articles) is "ubiquitous in everyone's adult lives, the good management of money and time depends on a good sense of number and quantity". This is a conflation of mathematics with a utilitarian use of a small section of mathematics (calculation, measurement) and it fails to point out that what is ubiquitous are the parameters set for management of money and time developed in a market-driven economy. It is the economy that is driving distinct forms of calculating, quantifying and their associated problems to solve. Maths has a far better job to do.

An interpretation of Farrell (2013) is that research and key policy and funding changes are mainly based on views expressed by employers/businesses about workplace literacy and numeracy. There seems to be very little information shared about how businesses and employers have gathered evidence for their views and how that allows them to lobby vigorously and successfully for their say in education. Nevertheless, businesses/employers have been very influential in contributing to the growth of an adult numeracy assess-and-gap-fill industry based on what Farrell (2013) describes as "essentially the Human Capital argument" (p. 62). Humans (employees) are investment input and cost who can be measured and exploited as capital/commodities. Whole communities of people can be stigmatised as poorly skilled, lacking in ability, of low intelligence, and only fit to be paid minimum wages. When this kind of focus on human capital for market gain supported by flawed assessment

[3] http://www.oecd.org/skills/piaac/

measurement results is fuelled by selective media reporting Black & Yaskukawa, (2014), it is no wonder that communities of adults come to tertiary study with well-developed deficit images of themselves and their abilities in maths and/or numeracy. The "dum at maths therefore stupid" image most hold about themselves has been deliberately and unconsciously fed to them and their whānau since they became entangled in education.

In order to co-develop learning and teaching tools by ākonga, for ākonga, this project sought to firstly uncover such issues, which are also implicated in notions of maths anxiety, maths identities, and the potential impact of failure in school mathematics on ākonga self-esteem, confidence and competence. The first step in the pilot project was to open up space for ākonga to feel free to discuss their own experiences and impacts on them and their studies, which have resulted from their maths education experiences. Kaiako need to understand ākonga maths and numeracy identities and behaviours intrinsically embedded within and beyond assessment tool results.

The constitution of numeracy identities (regimes of truth)

Adult learners come to tertiary study with identities that have been constructed by the systems that society creates for them or has allowed them to be, all the while believing that it has all been down to them and their ability or lack of ability. Black and Yasukawa cite Lo Bianco (1987, p. viii), who critiques the artificial and arbitrary implementation of a 'level three benchmark' used to label groups. The benchmark constitutes populations of people as above or below a desired level of achievement in literacy and numeracy and Lo Bianco talks about resisting the temptation:

> *to 'score' the population by arbitrarily devising a cut-off point and declaring a whole swathe of the population illiterate, thereby contributing to their stigmatisation and to the unhelpful ideas of literacy as a fixed set of abilities which are mastered or failed in an absolute way* … (Black & Yasukawa, p.127).

Education systems have consistently constituted and made judgements about individuals as students, who are then students who achieve or fail at certain levels, who are then placed on a scale where they are labelled as high to low needs, successful or failures, worthy or unworthy (Popkewitz, 2011). These layers of labels subsume identities and have the power to format people's beliefs about themselves, maths and numeracy and their future potential. Groups of ākonga have already been pre-constituted by various labels – Māori, Pasifika, low-skilled, disabled, priority learners that lead to a variety of pre-determined assumptions and prejudices about what they are, or are not capable of doing or being (Popkewitz, 2011).

Ideologies about the absolute necessity of numeracy to life abound and are fed by the insidious and ever-present myth that only those who pass certain types of assessments at certain levels can be deemed to be fully participating members of society as we believe it to be in the 21st century (OECD 2012; Black & Yasukawa, 2014; Farrell, 2013; FitzSimons, 2008). Because of the strength of the rhetoric, systemic failures are taken on by ākonga as personal failures due to their own negative traits. However, counter to that view, Greer & Mukhopadhyay (2012) make a very simple, yet profound observation when they say that:

> *the first "fundamental premise" is that: "All students must have a solid grounding in mathematics to function effectively in today's world." Really? Think about people you know. Aren't there many who do not have a solid grounding … in mathematics that are living full and productive lives? Isn't it offensive to tell such people that they are dysfunctional?* (2012: 240)

Constructing numeracy identities, attitudes and beliefs

FitzSimons (2008) points out that, "formalised assessment processes and measurable outcomes can never reflect actual learning taking place in terms of cognitive, affective, and social development." (p. 11). The adult literacy and numeracy teaching and learning model (Aiken & Rean, 2014, p. 48) refers to three main focus points for teaching and learning:

1. Knowing the learner
2. Knowing what to do, and
3. Knowing the demands

For this project "Knowing the learner" has taken a different view to that described in the model about what knowing the learner entails for adult learners in a kaupapa Māori institution. In Aiken and Rean (2014), it means knowing the results of the assessment. For this project, it means knowing the cultural, political, economic, social, spiritual and emotional history/ies of the learner. It then means setting up environments where learners can divest themselves of fear, avoidance and other negative emotional responses, and make choices about positive self-directed participation in maths and numeracy learning.

Avoidance of mathematical or numerical tasks due to maths anxiety is a recognised outcome of a history of maths education where maths and numeracy identities of ākonga are negatively influenced. As Safford-Ramus, Misra, & Maguire (2016, p.7) point out, "Many adult learners approach math with anxiety and frustration. Negative previous experiences with math instruction create legitimate barriers for many adult learners." A further theoretical link that has been made between identity and learning is through the concept of participation. Ākonga have been theorised to not only acquire

knowledge but also become a certain person through learning mathematics. Thus, ākonga have experienced a life-time of developing identities of inclusion and/or exclusion in communities of mathematical learners. Add to that the rhetoric of maths and numeracy being necessary to live full lives and be a worthy person and you meet again the judgement of oneself because of your results in a singular-measure assessment system.

According to Di Martino & Zan's (2011) data analysis of student experiences with maths three main dimensions were identified as affecting participation and success in maths and/or numeracy;

- student's emotional dispositions,
- their view of mathematics and
- their perceived competence in mathematics.

These dimensions are crucial to the development of people's relationship with mathematics because lack of recognition of them creates a black box approach to teaching and learning. The black box approach can manifest as a set of assumptions made by kaiako about ākonga attitudes. Di Martino & Zan (2011) found that ākonga who were not engaging with maths activities were labelled as merely having a negative attitude towards maths. This approach was not based on ākonga cognitive abilities, but merely on kaiako personal perspectives, which were exacerbated by kaiako lack of patience or knowledge of how to conduct a precise diagnosis of ākonga needs (which could be due to kaiako understanding of maths). Based on this approach, kaiako assumed ākonga were not interested in mathematics. The impact of this assumption was to teach in ways that were perpetuating ākonga negative emotional dispositions towards maths.

OECD (2012) supports Di Martino & Zan's findings by pointing out that not only cognitive skills but also dispositional elements such as beliefs and attitudes, are necessary for effective and active coping with situations involving numeracy. Their work suggests that the way in which a person responds to a numeracy task depends not only on knowledge and skills but also on attitudes towards mathematics, beliefs about mathematical skills, habits of mind, and prior experiences involving tasks with mathematical content.

> *"Some adults, including highly educated ones, decide that they are not "good with numbers" or have other negative feelings towards mathematics. Such attitudes and beliefs stand in contrast to a desire to be "at home with numbers" and can interfere with the motivation to develop new mathematical skills or tackle mathematics-related tasks and may also affect test performance. Adults with a negative mathematical self-concept may elect to avoid a problem with quantitative elements, address only a portion of it, or delegate it to someone else by asking a family member or salesperson for help. Such decisions or actions can serve to reduce both mental and emotional loads but fall short of autonomous engagement with the*

mathematical demands of real-world tasks and carry negative consequences". (OECD, 2012, p.39)

A maths community in a wānanga would encourage ākonga by reducing emotional and cognitive load and supporting them to seek support from others in ways where they learn over time. The assumption, without proof that only negative consequences arise from delegating certain tasks to others and asking for support from others is one based on an assumed society where one can only thrive as an individual and autonomy is conflated with individuality. A kaupapa Māori community of learners supports individual learners until they are autonomous and make their own choice to be so.

Clarity of maths and numeracy definitions

Research and literature concerning adult numeracy has not yet provided clear definition or clarity about how researchers, experts, kaiako and ākonga are meant to make connections to mathematics. Mathematics that is taught in a classroom is often taught as a subject (with a time limit for each student to complete tasks) meaning contrived problems are required to be solved in a matter of minutes. Mathematicians however, create or draw on existing knowledge; select problems to be worked on; choose the time frames over which problems are worked on and choose the purpose of the learning - for personal or to add to public knowledge (Beswick 2011). In addition, kaiako deliver mathematics according to the curriculum and based on their beliefs and ideas of what mathematics is, which influences the way they teach it. As Beswick (2011, p. 2) points out, "One's conception of what mathematics is affects one's conception of how it should be presented. One's manner of presenting it is an indication of what one believes to be most essential in it". Kaiako beliefs in mathematics originate from personal experience, experience with schooling and instructions, and experience with formal knowledge. This circles back to the black-box notion of maths and numeracy teaching and learning, where it becomes even more pertinent to the past experiences that ākonga and kaiako have had with maths teaching and learning that are driving their present assumptions, which further links into any future impacts and influences if we are not careful with our research and research findings now.

What literature is available to us to help understand numeracy issues?

Unfortunately, there is not a lot of information about numeracy teaching and learning for adults, (McNaught 2013). Often, when the word numeracy is used in articles concerning literacy and numeracy, what is mainly discussed is literacy. We found this to be common across articles that have been reviewed for this project. For example, Alkema & Rean's (2014) annotated bibliography shows a word count of 209 for numeracy and 309 for literacy; Black and Yasukawa (2014) shows a word count of 44 for numeracy and 161 for literacy. In the OECD (2012) article the chapter dealing with literacy is

11 pages long with ten different subheadings, while numeracy is seven pages long with four subheadings. In a recent study by Bidois, Te Maro, Earle & Lane (2017) numeracy, which was meant to be part of the study, was left out, because only literacy data had been gathered for ākonga. This study will at least add to literature supporting numeracy and maths teaching and learning for adults.

DATA AND FINDINGS – what did we find out?

Findings indicate that New Zealand's national assessment tool is useful as a starting point for kaiako and ākonga to discuss the notion of numeracy and maths ability. If done well, it can be a way in to maths and numeracy that fits with the context for the ākonga being at the wānanga, their programme demands, and possibly their opportunity for simply learning. Supporting ākonga to realise their potential goes beyond contextualising numeracy and maths to fit with ākonga future employment potential and/or culture. While context and culture are hugely important, there is a desire expressed by ākonga to have access to tools that allow them to experience success in maths and numeracy that they missed out on. For others who did not struggle with maths there is a desire to have further opportunity to experience the joy of maths again through a tool that they have helped to develop. Listening to students during the interviews and again when transcribing them has been an impactful experience that all kaiako would benefit from. It would be powerful to provide the reader of this report with links to the interview recordings to be able to experience the voices, the laughter, the pain, the sarcasm, the frustration and the excitement that is evident in them. What is presented here are small snippets of that experience, which it is hoped can convey the depth of passion that was shared in these learner communities.

The research team encountered a tripping point in engaging with participant cohorts for the study. It was difficult to gain access to some ākonga from two different programmes. One kaiako expressed what that tripping point might be by saying, "I can't see the relevance." This was a barrier to implementing the research fully. It is hoped that through the evidence of ākonga voice that has been gathered, the relevance to this type of mahi can be reasonably justified.

The following – Table 1 - shows how 34 ākonga responded when asked about their experiences of maths, their maths identities, and what it means for them in their programme of study. After that is a summary of the ideas that ākonga across programmes contributed for developing an app for ubiquitous maths and numeracy learning. Links are made from ākonga voice to literature. Table 2 then shows an analysis of quantitative data garnered from ākonga numeracy assessment results. The way

that the data is analysed and presented is further summarised and aligned with ākonga qualitative data.

This process of cross-referencing (mapping) ākonga assessment results and expressions of maths experiences was a beginning point for making decisions about what maths content is most important for them. The reasons for such inclusion means demonstrating the use of both affective qualitative data and quantitative assessment results data.

How do ākonga describe their numeracy experiences and identities?

Table 1 ākonga descriptions of numeracy experiences

Maths Experiences – negative
You have to think on the spot, not allowed to use support tools like calculators, pen and paper, or help from your friends.
Things like mixing numbers and letters together, algebra, yeah, out the door, out the gate, down the road… It doesn't make sense.
I found it quite anxious when it comes to numbers and I used to copy a lot at maths time, (lots of laughter in the room – recognition and 'me too') cause I didn't know the answers and also, like strategies
We got called out when we were young, so it was like, "Oh, J, what do you know about this, or how do you solve this?" "I don't know." "Why don't you know?" and then you had to stand up and be embarrassed about it. Just bad experience.
Getting it right, was about being put on the spot by the teacher, and it matters, a lot.
It used to matter.
I loved maths, but if you didn't get it right it means pressure, people laughed at you, and you feel stupid.
Teaching style doesn't suit, you don't learn. Algebra, measurements- measuring tapes, measuring areas, cubes and squares, rulers are ok, but how do you measure cube and square with just a ruler. Couldn't figure out how to get the answer.
I used to love maths, but one day, I was copying some work from the girl next to me and the teacher came up behind me and strapped me across the back of my head, and on my ear.
... I was good at numbers, but it was boring, if we did more activities it would be much better, I might have learned more.
I was never into maths, I failed school c maths big time. Maths was never my forte.
That's been the same for me too, because we didn't learn anything beyond that (you know, multiplication) can't hear all of the conversation, but snippets. So it might have been our teacher, because we didn't learn about fractions, you know, I love numbers, and we had our multiplication down pat, but we never ever went beyond that. Because we were really good at our work, our maths. As we went on, we didn't do algebra
We were regimentally taught, you know, 2min. Get it done, do it wrong, do it again.
when it felt like it was getting harder, it was like nah. It's all because we don't have that understanding.
Trigonometry was bad, was the subject I hated (others are in agreement). I couldn't wrap my own head around it AT ALL. I did pythagorus theorem, yeah, yeah, pythagorus, algorithms, tangent, tan, sines, cosines, because I'd guess, I didn't understand it, so, sohcahtoa, all sorts of small snippets like yeah, nah, shock-ing! Start to talk about not being able to do it, using algorithms, but now seeing all the new ways of doing things, seeing how they work, how you can break them down, but not knowing it.

Things like trigonometry and pi, and how frustrating it was because I missed that one little connection that if I could have picked it up, but I missed just that one little bit of information I needed to understand that. It wasn't quite... right, it was just so frustrating! It changed my attitude towards maths. (Voice is expressing absolute frustration, because he just missed that one little bit of information).			
it was about getting it in the first few seconds, and there were some of us that could have gotten it if they were given that bit of information a third or FOURTH time. (Others are agreeing with what she is saying, "Yeah, but we've given up by then", about needing information to be repeated). But while they are doing that, the other kids keep moving on and then you start playing a kind of guessing game. But they move on, they just move on to the next thing (him saying yeah, and that missing piece, where you can't sort of progress, you can't learn, if you don't know, others talking in agreement again, you can't progress eh? Yeah).			
In our day you could pull out the stick and whip them and so, you just stay frustrated, and oh, I don't know what to do with this (others in the background agreeing still).			
For me it was just like, I'll get it, I'll get it, I'll get it if I just try.			
So that's how much, if numeracy is taught badly, it can have a negative impact (agreement).			
Maths experiences – positive			
I think it's just really logical and kind of straight forward, it's no real hard kind of concepts to grasp apart from it goes into algebra and other stuff, but the kind of thing I like about it, is you can apply it to just every day in your life and everything, so that's yeah, that's why I enjoy it.			
but once I get a strategy, I'm just like oh choice, this is good.			
I loved maths, but if you didn't get it right, that's pressure, people laughed, and you feel stupid. But if you do get it right, yep. (Somebody else yells out, 'I know, I know, pick me", and that person giggles, others are doing the same,excitedly waving their hands in the air, as when you put your hand up to say the answer).			
I loved maths, to make sense of it.			
How does it feel to get it? Oh, it was like, wow, neat, I can do this, oh I got it, bring it on here, (lots of calling in to the conversation with laughter and enthusiasm).			
If the app was to give you that kind of feeling (success), even if you are not going to need numeracy or maths in your study, how would you feel? Yaaay, i can do it, I got it, I'm not stupid.			
How does it feel to be in that space as a student, you're not here to do a maths degree, so how much of a difference does it make for you? Great feeling. Go home with some feeling of accomplishment eh, enjoy my weekend, you feel good about yourself. (Lots of enthusiasm in the notion that they can "crack" that maths). Whāea, I want to know how to do fractions.			
Mathematics/numeracy identities and feelings			
Anxious	Confident or not	Dum	Embarrassed
Fluke if you get it right	Stupid	Accomplish or not	Achieve or not
Good or not	unskilled	weaknesses	scared
Īnadequate for their study	Haven't cracked it	Really ? (you mean I succeeded?)	You get a complex to the max
Could do it if we just have that extra chance, that third or fourth time, that snippet of information we missed out on.			

These quotes from ākonga are from both groups. Feelings and identity shaping words and word sequences have been highlighted in red. Ākonga stories show how past experiences have influenced their maths and numeracy learning. Interview conversations articulated what ākonga would like, why they would like it, and later, they talk about how it could happen.

What do ākonga results show us about their numeracy achievement?

For the scope of this pilot project the data from the numeracy assessment tool results was given a light analysis. Firstly, the analysis listed where ākonga did not answer questions, or where their answers were incorrect within each of the numeracy domains. The domains have been highlighted and grouped to be able to scrutinise where students might have experienced most difficulty. Additional data would offer a more robust interpretation over time and across populations as would a deeper probing of the existing data. As a pilot project, all that is desired for now is a look at potential starting points for making decisions about teaching and learning numeracy/mathematics content, pedagogies, resources and tools.

Most of the 34 students' assessment results were at level three or above. Three students had results below level three. The table below shows the maths/numeracy domains where students answered questions incorrectly. A summary, with students' responses to their results is then provided.

Table 2 results, by domain and questions missed, of numeracy assessment

fractions	**division**	**multiplication** (strategies)	**subtraction**
add to make 1 (2)	rounding strategies	2 digit & 1 digit partitioning (3)	partitioning 3digit - 2digit numbers.
1/4 of amount in dollars and cents	division 1000s by 10s	percentages of 3digit numerals	whole & decimal numbers (2)
Place value 3 dig+	multiples of 100	check division through multiplication	decimals to 3digit numbers (2)
multiply x 1000, 10000	multi-digit division	express multiplication facts (3)	2 multi-digit numerals
100's in 3 digit numbers (3)	4digit division by 2digit numbers	estimate (rounding)	subtract from tenths
size of decimal numbers	2digit by 1digit (2)	calculate yearly rent from weekly amount	
decimals to nearest 100	3digit by 1digit	1digit numbers with decimals (2)	

100th to nearest whole number	mixed division and subtraction	1digit and multiple digit numbers	**number facts**
100s in 5digit numbers	**number sequence**	product of 2 and 3digit numbers	exponential numbers (2)
10ths in 1digit numbers (2)	decimals and percentages (x2)	3digit by 1digit numbers	writing powers (6)
10s in 3digit numbers (2)	order volumes - decimals (3)	percentages of 2 whole numbers	decimal + decimal = 1
decimal conversion of gms to kgs	sequence decimals to 1decimal place	decimals x 1digit numbers	convert fractions to percentages (2)

2digit numbers 10s and 1s	unit fractions on number line	whole number x decimal	multiply 20 and by 50
place value - 1digit in 2digit numbers	fractions to percentages	round division of money	multiples of 10 divide by 10
word forms - 6digit numbers	order fractions (5)	3 numbers - multiples of 10	200s in a given number
round to 2 decimal places		decimal numbers	
write number from 10ths and 100ths, 1000ths (2)		**Percentages/ratios**	
measurement	**addition strategies**	Scaling (3)	
time calculations (4)	partition 3digit + 2digit numbers	percentage of discount	
Perimeter	decimal numbers (2)	percentage of a given amount (2)	
volume	add 3digit and 4digit	Cost to unit of time	
identify objects measured in cms	coins to $'s and c's	percentage of a 3-digit number	
analogue to digital (2)	best estimate 3digit numbers	Fraction of given ratio	
objects measured in mls (2)		¾ of given number	
objects measured in lengths (2)		Group arrays (2)	
Angles		1/4s of a whole	
temperature to 1decimal place		Fraction of 2-digit no (2)	
measurements for objects			
understand area			

Key: Green shows the numeracy domains that questions in the assessment align to. Light salmon shows any items that involve fractions, dark salmon shows any items that involve percentages, light blue shows any items that involve decimals. A number in brackets next to the item shows the amount of times that a question was incorrectly answered. Although domains are integral to each other anyway, there are key areas that can be picked out for discussion.

Table 2 shows that there were 30 issues with fractions, 23 with decimals, 14 with percentages, 12 with multiplication strategies, 2 with subtraction, 3 with addition, 7 with operating with 3-digit numerals, 11 with number facts and 16 with measurement – which generally includes decimal numbers in calculations of (for example), volume, area, length, and reading scales. The question that had the most incorrect responses or non-responses was in number facts where students are asked to write about powers, six students either did not answer this question, or answered it incorrectly. Again, the numbers are small, with no hugely quantitatively significant analyses to be made from them, however, they were able to be used by the researchers as conversation openers in one of the interviews.

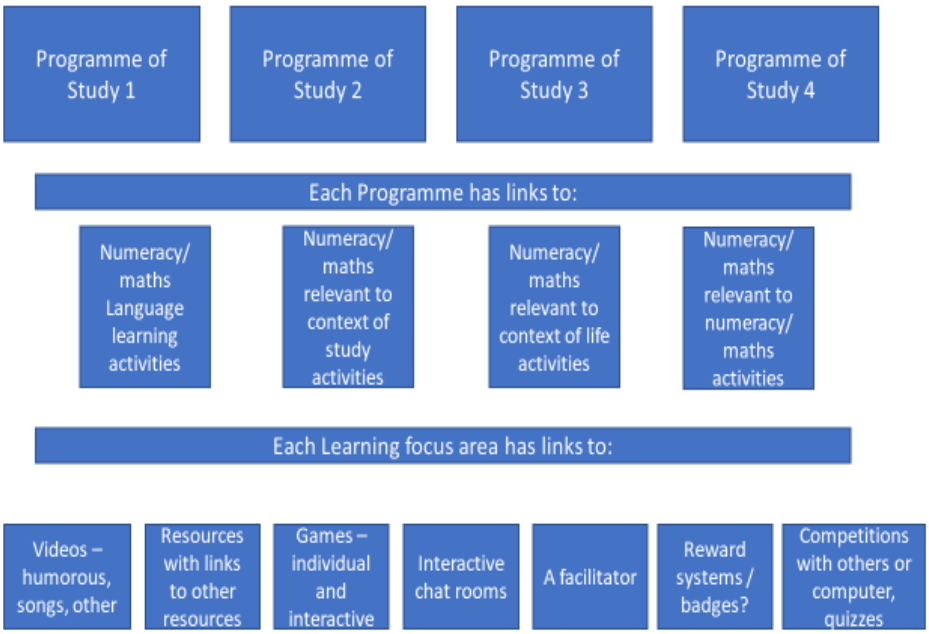
The first thing that the small group of ākonga wanted to do in the interview/workshop session was to see their results. They were showed their individual results and how table 2 had been developed. They were told that their results were at 'benchmark' and above for their programme requirements and they expressed surprise at that.

> *they all start a buzz of noise questioning the results, "oh wow", "but", "yeah", "lovely to know", and there are looks on some people's faces that the researcher needs to ask about. Researcher asks, "why are you looking the way you do?". Their reaction is to say "really?"(looking incredulous). The researcher responds, "so why is your reaction like that, why is your face like that?" One responds, "Because, yeah, I did not think, I didn't think I did" (do very well). The researcher shows the table and explains the colour coding. Then the researcher begins with, "My guess is that decimals are always going to" and is interrupted with, "oh my gosh", "oh yes", laughter, agreement around the room, researcher continues, "that decimals and fractions are seen to be problematic. My guess is always that it is going to be decimals, fractions and percentages, is that true?" The response is, "Definitely!" and other noises of agreement go through the group. The researcher carries on to ask, " is it about doing the assessment itself, was it the way it was written, or ...?" The response comes back again, "just the actual decimals", again with agreement from the others.* (Taken from transcription of recording of workshop with small group).

What have ākonga told us they want?

The ākonga positively responded to designing an interactive application (app) for learning maths and/or numeracy. When approached with the notion that usually such tools are designed by researchers and experts without much consultation with ākonga, they responded with nods of agreement and affirmation of the idea of being a part of the group who would participate in workshops to design the app. In one group six ākonga agreed to participate in a workshop, and one had already designed a picture of a pathway into different types of activities she has imagined being a part of the app. In the other group the interview included asking about what they would like to see in an app. tailored for their maths and numeracy learning. The following diagram, Figure 1 shows a synopsis of what each group said they would like.

Figure 1 Ākonga expressed categories and headings for a teaching and learning app.



Firstly, ākonga asked to be able to click into their specific programme so that they could have direct access to the maths and numeracy learning that would be relevant to their study. (Top layer of the diagram). They talked about what they felt they needed to know for their programme of study, as well as what they would like to learn about numeracy and maths. This means having a way to

1. articulate their maths and numeracy knowledge,
2. use maths and numeracy relevant to their study,
3. use maths and numeracy relevant to their lives, and
4. to simply learn about the maths and numeracy they missed out on learning through their education. (Second layer of the diagram).

Ākonga then talked about what sorts of vehicles and tools for learning they thought would help them the most to learn. Even with the app being a ubiquitous, largely individual learning tool, ākonga were adamant that they would prefer a tool that allowed them to interact with others in varieties of ways – be it through chat rooms, gaming either together or competitively (Fortnight style), or through forum discussion. They were also adamant about being motivated through humorous/fun activity, competition, and some sort of system of rewards and "levelling-up".

Summarising and concluding discussion

Giving opportunity for ākonga to talk about their own numeracy identities and how they have been constructed provides space for them to have honest conversations about how maths and numeracy

plays a part in their current learning. By talking about what sort of numeracy they will need for their studies and eventual careers ākonga are enabled to be open about what they will need, rather than hide what they consider to be an area of weakness. The conversation is then able to turn to considering what tools they would like to see developed to support their personal learning in numeracy, and surprisingly maths.

We all have a right to be able to access information in the world, no matter how that information is presented (whether through numerical and mathematical communication systems for example). As Greer and Mukhopadhyay (2012) point out:

> *many aspects of contemporary life, both beneficial and harmful, are mediated by mathematical constructions that are often inaccessible to most people they affect – if they are even aware of what is going on … people generally are ill-prepared to react critically, and with agency, to these circumstances and are underserved in this regard by their education, and by forms of discourse within society. As a consequence of this lack of critical agency, people are subject to many forms of control, resulting in a combination of powerlessness and uncritical compliance.* (p. 233)

This statement makes a point about critical agency (informed sovereignty) that is afforded to those given access to information through understanding maths education and numeracy that is relevant to this study.

The Ka Nanakia Hoki ki te Numeracy – Better than expected project has given us a set of initial data to support the presentation of initial recommendations for supporting adults and their participation in relevant, contextualised numeracy activities that will also develop their skills in everyday problem solving (OECD, 2012). We have identified some literature that has been explored to this point in the development of potential numeracy teaching and learning tools. The data collected along with the literature is used to support our conclusions and recommendations for such tools.

Many of the Ka nanakia hoki ki te numeracy research participants came to tertiary study with negative views about their maths ability. When interviewed about learning numeracy ākonga identified wanting to take the opportunity to rid themselves of the stigma of being labelled “low-ability, or low skilled”, or “dum”, or “stupid”. The normal conversation highlighted in literature about context for learning numeracy that serves a practical function in ākonga daily lives is somewhat interrupted by this research. Ākonga have expressed wanting to divest themselves of the negative image they have built about themselves because of their lack of achievement in maths at school. Therefore, this project has gone beyond finding ways to support ākonga to learn the daily-living-numeracy required in their

jobs and home-life and has proposed providing opportunities to learn the kinds of maths that ākonga never thought they could do.

We are now asking about our responsibility to not only give opportunity for ākonga to experience learning about the day-to-day type of numeracy that people will meet in their jobs and homes, but to also offer opportunity to experience success with some of the elements of maths learning that ākonga feel they have missed out on and have long been frustrated about. Ākonga express excitement about being able to prove to themselves that they were never stupid, that they actually always could do maths. The scope for opening these kinds of self-selecting, self-motivating opportunities is huge if a ubiquitous teaching and learning tool were to be developed where the formal, fear filled, high-stakes classroom environments described by ākonga are mitigated by student-developed, ubiquitous activities, resources and tools. The next steps for this project would be to offer this kind of learning by using design theory research to develop a maths and numeracy learning app where ākonga from a variety of programmes have been consulted as major contributors to its components.

We use the word numeracy to talk about calculations, measurements and planning that we do every day, and employers want to ensure that they are employing people who can cope with the numeracy demands of their employment. This can include the ability to solve a variety of problems that can require the use of numeracy. Now that we have a broader view of numeracy demands across various sectors, employment, employers and employees, we have enough information to create iterative systems and processes for developing relevant, contextualised training tools able to be adapted to what ākonga want. Ākonga should be included in the development of tools that will best suit their needs and wants for their future careers, lives and judgements about themselves. If they do not yet know what their future might hold, then the experiences that can be provided through a multi-faceted tool has potential to support and/or initiate thinking about possibilities and choices.

Recommendations:

Given what this pilot project has found, we can assume that our current system is not providing a curriculum that allows future ākonga and kaiako to be creative in maths and numeracy. Being creative means being able to use strategies such as searching for examples and counter-examples, cases and constraints, patterns and systems of rules, the use of justification and proof and the framing of problems Beswick (2011 pg129). Part of the constraints placed on ākonga and kaiako learning and creativity arise from the very system that is meant to support learning, which is the type of system that in reality stigmatises and develops anxiety, shame, deficit-identity and fear. The findings of this

pilot project recommend that in alignment with kaupapa Māori theory, methodology and pedagogy we:

1. Broaden and deepen what it means to "know the learner". Alongside assessment tool measurement of ākonga skills, proficiency, knowledge and competence in maths and numeracy we simultaneously and deliberately open conversations with ākonga about their maths identities. In this way we better understand both the cognitive AND affective load that ākonga bring with them to their studies, and we do not make assumptions on their behalf about relevancy or appropriateness.
2. Continuously and iteratively re and co-design with ākonga the tools that we have developed and can continue to co-develop with them for their opportunities to learn ubiquitously.
3. Centralise ākonga and their histories, identities and aspirations; rather than centralise assessment. The value is in the person, not in the person's results.

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Appendices

Appendix 1 – research questions

Te Whare Wānanga o Awanuiārangi
Whakatane

Ka nanakia hoki 'ki' te numeracy. (Better than expected).

Piki Mai, Kake Mai Rā, Homai te Waiora!
He mihi maioha tēnei nā mātou ko,

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Semi-Structured Interview Questions to Focus Groups/Students:

1. Can you tell us about your experiences with numeracy?
2. What would you see TWWoA being able to provide for you in terms of numeracy?
3. What part does numeracy play in your learning at TWWoA?
4. What do you think are best ways of learning numeracy?
5. If you were to create an app for learning numeracy at TWWoA, what would you include in the app?