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Te Tāhuhu o te Mātauranga

Mathematics

Pāngarau

18

Kei Tua o te Pae
Assessment for Learning:
Early Childhood Exemplars

New Zealand Government

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Project Administrator: Carolyn Jones;

Project Co-ordinators: Keryn Davis, Lesley Dunn, Stuart Guyton, Maggie Haggerty, Ann Hatherly, Anita Mortlock, Lesley Rameka, Vicki Sonnenberg, and Sarah Te One;

Project Advisory Committee: Lynne Bruce, Jeanette Clarkin-Phillips, Bronwen Cowie, Lester Flockton, Doreen Launder, Linda Mitchell, Rosina Merry, Jean Rockel, Mere Skerrett-White, and Rita Walker;

Te Rōpū Kaiwhakangungu: Mini McKenzie, Colleen Morehu, Kura Paul, Lesley Rameka, Mere Skerrett-White, Vicki Sonnenberg, Rita Walker, and Melody Witehira.

Authors of text and compilers of books: Margaret Carr, Wendy Lee, and Carolyn Jones, advised and assisted by Rita Walker and Bronwen Cowie

Co-author for this book: Sally Peters

Assistance with this book: Jane McChesney

Publication Project Manager: Jane Ferguson

Series Editor: Margaret Cahill

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Kei Tua o te Pae
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Pāngarau

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Introduction

He kupu whakataki

The exemplars in this book should be considered in conjunction with the discussion in Book 16. A definition of mathematics and statistics in *The New Zealand Curriculum* includes the statement:

Mathematics is the exploration and use of patterns and relationships in quantities, space, and time. Statistics is the exploration and use of patterns and relationships in data. These two disciplines are related but different ways of thinking and of solving problems. Both equip students with effective means for investigating, interpreting, explaining, and making sense of the world in which they live.¹

The National Numeracy Strategy uses this definition:

[T]o be numerate is to have the ability and inclination to use mathematics effectively in our lives – at home, at work, and in the community.²

The exemplars in this book record children participating in mathematical practices – exploring relationships and using patterns in quantities, space, and time – for a range of purposes.

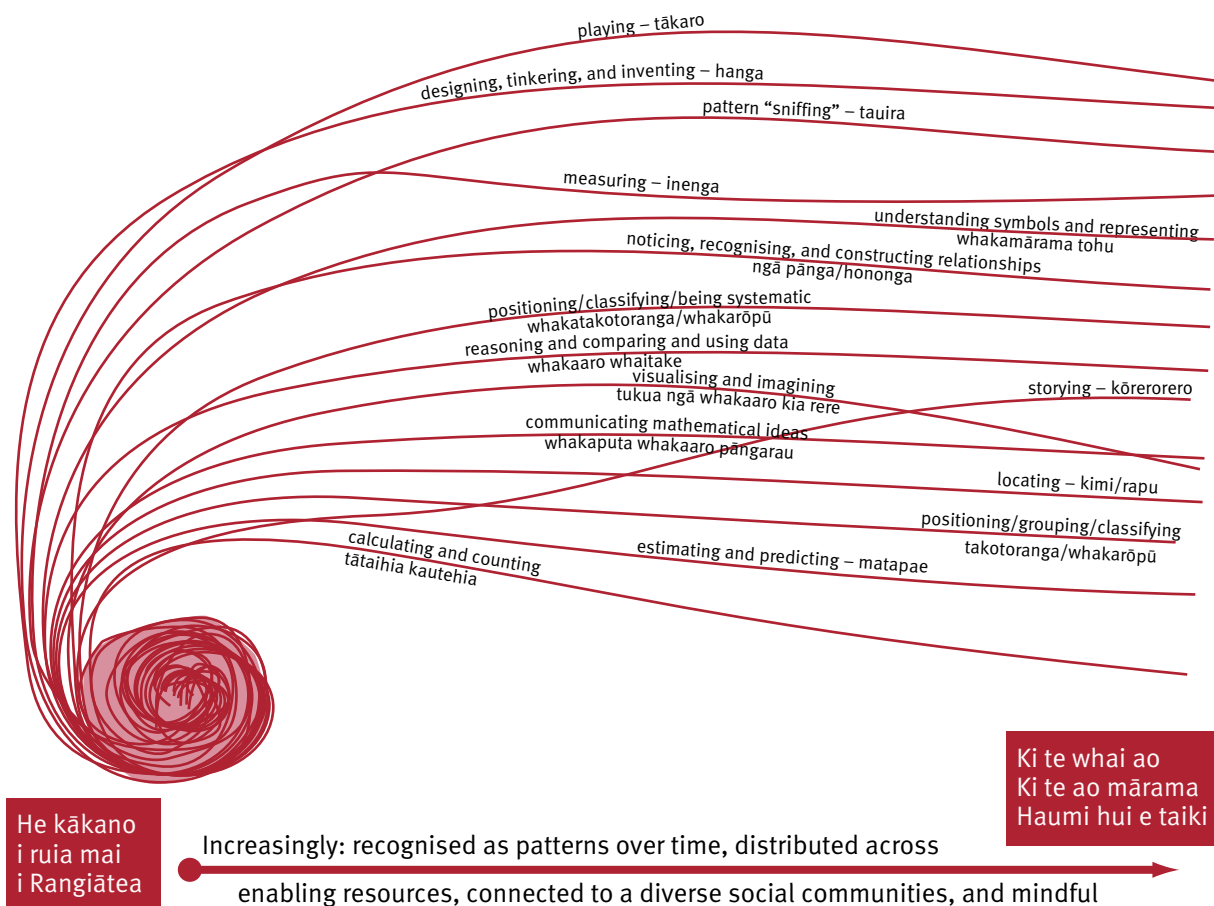
James Greeno has called this “situated knowing in a conceptual domain”, and he used the workshop or the kitchen as a metaphor (see Book 16). Alan Bishop, a leading writer and researcher in mathematics education, has emphasised a cultural perspective on mathematics education that is consistent with the approach to education taken in *Te Whāriki*. He sets out six activities: counting, measuring, locating, designing, playing, and explaining.³ He adds:

All these activities are motivated by, and in their turn help to motivate, some environmental need. All of them stimulate, and are stimulated by, various cognitive processes, and I shall argue that all of them are significant, both separately and in interaction, for the development of mathematical ideas in any culture. Moreover all of them involve special kinds of language and representation. They all help to develop the *symbolic technology* which we call “mathematics”.⁴

Discussing the importance of play to cultural life, Bishop comments, quoting Vygotsky, that “the influence of play on a child’s development is enormous”⁵ because it provides opportunities for abstract thinking. Barbara Rogoff also suggests that children supporting each other and learning together, a key feature of play, makes a powerful contribution to mathematical learning.⁶ Bishop emphasises the playing of games. He notes that playing is “indeed a most serious business”⁷ as well as a significant adult activity. Games model reality, and “it is not too difficult to imagine how the rule-governed criteria of mathematics have developed from the pleasures and satisfactions of rule-governed behaviour in games”.⁸ Bishop also elaborates on the activity he calls “explaining”, the purpose of which is to expose relationships between phenomena. He emphasises the explanatory relationships of meaning making: finding similarity, and connections and classifications, to explain events or experiences. He notes that the diversity of languages brings culturally diverse explanatory classifications and ways of explaining.

Similarly, within the context of Aotearoa New Zealand, an early childhood mathematics working group set up in 2003 by the Ministry of Education developed “te kākano”, a metaphor for describing the range of purposeful activities for developing mathematical tools and symbol systems in a bicultural environment.⁹ The metaphor represents the child as te kākano (the seed), embedded in a context. The range of mathematical purposes and tools that develop is influenced by the “fertiliser” or “soil” that surrounds te kākano. These influences include teacher pedagogy, teacher content knowledge, family/whānau knowledge, and resources, all of which interact with the child’s interests to privilege particular mathematical domains. The metaphor highlights the value of identifying the range of cultural purposes for mathematics within a setting.

Te kākano: Purposeful activities for the development and understanding of mathematics symbol systems and technologies



The strands in the diagram cross and interweave in different activities. For example, in one exemplar, calculating and counting, measuring, and designing might all overlap. In another, estimating and predicting might overlap with “pattern sniffing”. Therefore, the names on the seed strands indicate the sorts of strategies and dispositions a teacher might notice. Each of these strands includes possibilities for increasing mathematical complexity.

A lens can be placed at any point in the diagram to look in more depth at what is happening for a particular child or group of children. Within the lens, we can see the authentic context in which an activity takes place and the specific detail of the strategies, the dispositions happening there, and the mathematical complexity involved.

Effective Pedagogy in Mathematics/Pāngarau: Best Evidence Synthesis Iteration [BES] includes a chapter on mathematics in the early years, which is consistent with the approach taken here. It draws attention to the value of play and of everyday activities as meaningful contexts for mathematics learning, and it highlights aspects of the factors that nurture te kākano (teacher content and pedagogical knowledge, appropriate resources, and family/whānau mathematics).¹⁰

The mathematics exemplars in this book are viewed through one or more of the three lenses outlined in Book 16:

- a lens that focuses on assessment practices, referring to the definition of assessment as “noticing, recognising, and responding”, from Book 1 of *Kei Tua o te Pae*;
- a *Te Whāriki* lens;
- a lens that focuses on the symbol systems and tools described as “mathematics”.

A lens focused on assessment practices

He āta titiro ki ngā mahi aromatawai

Assessment that notices, recognises, and responds to mathematics learning in the wider sense will ensure that the mathematics in measuring, locating in space and time, designing (form, shape, and pattern), playing, and explaining are also on the curriculum agenda. Frequently the mathematics in an exemplar was not part of the teacher's analysis of the learning and has been added to the annotation for this exemplar book. The "mathematics" may not always be the focus in an analysis of the learning; sometimes other aspects of *Te Whāriki* may be recognised as important at a particular time in a child's educational journey.

However, highlighting the mathematics in documentation is an aspect of effective mathematics teaching. It encourages teachers and children and families revisiting children's portfolios to recognise and develop children's mathematical competence and continuity. Assessments can illustrate the view in *Te Whāriki* that mathematics is about symbol systems and tools for making and representing meaning and for solving and posing problems. *Te Whāriki* includes the learning outcome that "Children develop the expectation that numbers can amuse, delight, illuminate, inform, and excite".¹¹ Play is one way in which children will realise this expectation, and teachers will contribute to this expectation in a range of ways. A key finding from a New Zealand research project on mathematics teaching and learning in early childhood settings indicated that pedagogical documentation enhances the teaching and learning of mathematics in early childhood.¹²

A lens based on *Te Whāriki* – He tirohanga mai i *Te Whāriki*

Mathematics is woven throughout the strands in *Te Whāriki*. It is found specifically in the Communication/Mana Reo and the Exploration/Mana Aotūroa strands. The latter strand includes mathematical processes such as "setting and solving problems, looking for patterns, classifying things for a purpose, guessing, using trial and error, thinking logically and making comparisons".¹³ This strand also includes spatial understandings.¹⁴ The Communication/Mana Reo strand includes "familiarity with numbers and their uses" and "skill in using the counting system and mathematical symbols and concepts, such as numbers, length, weight, volume, shape, and pattern".¹⁵ This strand emphasises mathematics in referring to "activities that have meaning and purpose for children" and in the phrase "for meaningful and increasingly complex purposes".¹⁶ As for the other domains of symbol systems and tools for making meaning and communicating, the principles in *Te Whāriki* mean that family "voices" will be sought and that "funds of knowledge"¹⁷ from home and community will be acknowledged and included in the children's portfolios.

The *Te Whāriki* perspective is that children will participate in the symbol systems and tools of mathematics for personal, social, and cultural purposes: for becoming confident and competent in culturally valued enterprises, expressing emotion, making connections across place and time, contributing their own abilities and viewpoints to the community, communicating with others (including appreciating the ways in which the available cultures communicate and represent), and making sense of their worlds.

At the same time, the possible pathways for learning that derive from the four principles of *Te Whāriki* (see Book 10) can help teachers to identify dimensions of strength as children become more interested in and involved with mathematics. Learning episodes associated with mathematical practices take on

dimensions of strength as these episodes become:

- more strongly integrated into recognised patterns, regular events, and social practices over time. The exemplar “Jack explores space” includes a number of stories about Jack’s exploration of space and of his place in it. There are many everyday opportunities for him to explore his body in space (in boxes, in tunnels, and up and down steps) and to explore things in space (posting, stacking, rolling, and hiding). These opportunities provide increasing levels of challenge.
- distributed or stretched across a widening network of helpful people and enabling resources. In “Ezra explores height, balance, measurement, and number”, Ezra is exploring ways in which he can be taller by trying different units for measuring his height and trying a range of ways in which he can change his height.
- connected to a greater diversity of purposes, places, and social communities.
- more mindful (as children begin to take responsibility and make up their own minds).

These last two dimensions of strength are illustrated in “Playing with repeated patterns”. Jessica begins her interest during a visit to the Māori Gallery at the Auckland Museum (diversity and place). There she observes the patterns, including kōwhaiwhai, and draws them. She later constructs a complex pattern with its own personal purpose and meaning and its own unique rules and relationships (mindfulness).

A lens focused on mathematics

He āta titiro ki te pāngarau

The following are some aspects of participation, in the domain of mathematical symbols, tools, and practices, that might be noticed, recognised, responded to, recorded, and revisited. Not all these aspects are represented in the exemplars, but teachers may be able to identify them in their own local settings and write their own exemplars. In particular, when episodes are documented and revisited, children will be able to recognise their own mathematical competence.

A repertoire of mathematical practices

An indicative repertoire of practices is set out here, using the four practices outlined in Book 16 as a framework. These four practices also intersect and interconnect.

Observing and listening in to mathematical symbols, tools, and practices

Observing and listening in to mathematical symbols, tools, and practices includes watching and listening in to adults and children engaged in a range of mathematical activities. It also includes noticing cultural and local conventions to do with ways of classifying and describing patterns and relationships, using ideas like number, shape, space, time, and distance. In the exemplar “Preparing a budget and playing with numbers”, a group of children and their teacher are using mathematics for a purpose: to select from a catalogue and to budget for an equipment grant. Achieving this purpose calls for using some mathematical tools, including symbols (numbers) and a calculator. Lute observes and listens in to this purposeful activity, and she later plays with the calculator, writing the numbers that appear.



Playing with mathematical symbols, tools, and practices

Playing with mathematical symbols, tools, and practices includes playing with and noticing numbers, shapes and sizes, and quantities of things. It includes trying out tools for exploring number, shape, space, time, and distance and finding out what these tools can do.

In the exemplar “Quin and quarters”, Quin has been playing with symmetry and quarters, painting a pattern that she “appeared to be really happy with”.

Using mathematical symbols, tools, and practices for a purpose

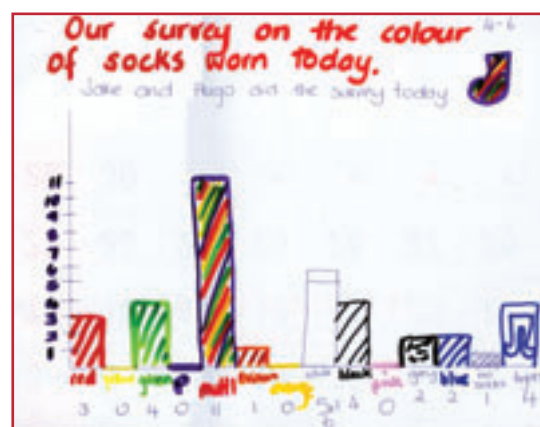
The “te kākano” diagram lists a number of purposeful activities for developing and understanding mathematical symbol systems and tools. This diagram has proved useful for exploring the mathematics programme in early childhood settings. Using mathematical symbols, tools, and practices for a purpose includes:

- setting and solving problems that use mathematical symbols and systems (as in the exemplar “Measuring the play dough”, where Tom uses a ruler and centimetres to compare the lengths of dough and to find how far his dough can stretch);
- looking for and constructing patterns that have a “rule” or relationship that establishes the pattern (for example, symmetry; or as in the exemplar “Playing with repeated patterns”, where in Jessica’s repeated and sequential pattern, the legs become longer as the figures become smaller);
- connecting with a range of ways in which family and whānau do mathematics and classifying things for a purpose (as in the exemplar “Ezra explores height, balance, measurement, and number”, which includes contributions about mathematical practices in Ezra’s family);
- guessing, using trial and error, thinking logically, and making comparisons (as in the exemplar “Jake’s survey”, where Jake checks an earlier survey and systematically records the colours of bags hanging up over the lockers);
- noticing, recognising, and understanding cultural patterns (as in the exemplar “Playing with repeated patterns”, where Jessica explores the koru pattern);
- noticing and recognising the purpose of significant cultural designs (as in the exemplar “Collaborative building with unit blocks”, where the children explore aspects of geometric shapes);
- using mathematical systems for making meaning (as in the exemplar “Ordering by size”, where Nick uses numbers and ordered sizes to make meaning and to tell a story).



Critically questioning or redesigning

Critically questioning or redesigning in mathematics includes critiquing the options for classifying and representing data for making meaning. It includes using mathematical symbols creatively and reflectively and representing the world of numbers, shapes, time, and space in personal and unique ways. In the exemplar “Jake’s survey”, the teachers have demonstrated a number of ways to display data from surveys. Jake has reflected on these and makes up his own mind by choosing and adapting one of the methods.



Quin and quarters

Child: Quin

Teacher: Carlotta

Quin was really interested in using the ruler and pens. She got a little frustrated with using the felt tip along the edge of the ruler and chose to paint on the paper I had just ruled into quarters. She followed the ruled lines with a crayon before painting each individual quarter. This resulted in a symmetrical look which she appeared to be really happy with. “I’ve got four rectangles – they’re quarters, aren’t they, Carlotta?”



What’s happening here?

This activity begins with the teacher noticing Quin’s interest in using a ruler and pens. The teacher has ruled some paper into quarters, perhaps to see what Quin will do with them. Quin’s response is to paint a symmetrical pattern.

What aspects of noticing, recognising, and responding to mathematics learning does this assessment exemplify?

The teacher has noticed an interest in rulers and pens, and her response stimulates a development of that interest into an exploration of aspects of geometry: quarters, rectangles, and symmetry. The teacher notes that Quin “appeared to be really happy with” her work and was her own judge of its merits. Quin’s question asks for confirmation: “[T]hey’re quarters, aren’t they?” There is no record here of what came before or what followed, but the documentation provides the opportunity for Quin to revisit the experience and to follow up on this exploration. The teacher analyses the learning with a mathematical lens, noting the “symmetrical look” to Quin’s work and providing what may be a new word to Quin, an addition to her mathematical vocabulary.

What does this assessment tell us about mathematics learning (using a *Te Whāriki* lens)?

For many children, learning begins by playing with tools with no apparent purpose in mind, and then a purpose or meaning begins to be explored. In this case, the teacher appears to have provided the stimulation with no specific outcome in mind. Quin initiates the direction that her learning takes. The Exploration/Mana Aotūroa strand of *Te Whāriki* includes outcomes to do with setting and solving problems, looking for patterns, and investigating spatial understandings. Quin explores all these processes in this exemplar.

How does this assessment exemplify developing competence with mathematics?

Both Carlotta (the teacher) and Quin (the child) appear to be exploring aspects of rectangles together: in this case, they are “four quarters”. Quin and her teacher may later explore different ways to represent quarters, or they may explore the horizontal and vertical symmetry of the pattern Quin has created. Quin has very carefully represented the symmetrical pattern: not just in shape but also in colours.

Hamish sews a corgi

Child: Hamish

Teacher: Julie

Date: 18 September

The corgi sewing project started today! After we had pinned the pattern (Hamish's fantastic drawing) to the fabric and cut it out Hamish said, "I can sew by myself – I don't even need any help!"



"Great, Hamish – there you go – you know what to do!"

Hamish did just that – total concentration – fully bent to the task. "I've done five stitches," and he had – very neat and right where they should be – I was

impressed. I stayed sitting by him talking with the other children and watching his progress. He did a lot more before he looked up and needed a break. "Look how many I have done now – I've just about used up all the wool!"

"Wow – so you have!" I said. "How many stitches do you think you've got now?"

"Maybe more than twenty," Hamish said.

"Great, let's count!" I replied.

We counted together – exactly twenty stitches. I rethreaded the needle and away the corgi maker went again – this time with me holding the fabric while Hamish did the sewing. After a little while Hamish said, "Look how much wool there is left," and he used the length of wool and needle to measure it against the end of the table, then the easel. I asked him to predict whether it would be longer or shorter than a few other things around us before he went back to his sewing – and he was often right in his estimations.



"This is the second corgi you have sewn, isn't it, Hamish?" I said. "Yes," he said. "But I can't find the other one – it's lost."

"Oh," I said.

"But that's OK," he said, "that happens," nodding his head with an accepting, wise look on his face.

Short-term review

This is only the second sewing project Hamish has done at kindergarten, so I was really impressed with his ability to sew so confidently and also so well!

His passion for and delight in his ability is wonderful – what a fantastic learning disposition – a real interest in and confidence to tackle a tricky task – and stick with it (persevering with difficulty).

Hamish was also exploring some mathematical concepts when making his corgi today.

And last but not least – Hamish has grasped the concept of impermanence: "But that's OK," he said, "that happens," nodding his head with an accepting, wise look on his face.

OH WOW!!!!!!!

Question: What learning did I think went on here (that is, what are the main point[s] of the learning story)?



What next?

Finish the corgi.

Last kindergarten day for Hamish this Friday, then off to school – we will be very sad to see him go.

What's happening here?

This entry in Hamish's portfolio is part of a series on making corgis, inspired by his pet corgi. Before this point, Hamish has already sewn one corgi and sculptured one in clay. He is very keen to sew another, and a few days before this exemplar is written, the teacher has recorded suggesting that he draw a corgi to be used as a pattern. He does this. The series of "corgi" assessments includes reading, writing, and oral literacy as well as mathematics, and the teacher models the use of these symbol systems and tools for everyday purposes.

What aspects of noticing, recognising, and responding to mathematics learning does this assessment exemplify?

The exemplar documents Hamish's use of symbol systems and tools for making meaning. His purpose is set in an everyday context, part of the process of getting a task completed. The teacher assists him with his explorations, while the interest and direction come from Hamish. This assessment indicates that the teacher values Hamish's work: he knows what to do and he remains focused.

What does this assessment tell us about mathematics learning (using a *Te Whāriki* lens)?

This exemplar illustrates some characteristics of a competent and confident learner and communicator in mathematics. Hamish explores a sustained interest over time, calling on a range of communication media along the way. He comments to the teacher on aspects of the task that interest him. Sewing, including pattern making, is a complex and difficult task, and the teacher comments on two dispositions that are evident here: "His passion for and delight in his ability" and his capacity "to tackle a tricky task – and stick with it". Hamish's learning dispositions are being connected to a diversity of purposes and social communities (see page 6): mathematical purposes and the social community of mathematicians.

How does this assessment exemplify developing competence with mathematics?

The purpose of this task is to make a corgi. Hamish is alert to the mathematical ideas in this task, to do with "how many" and "how much". The teacher picks up Hamish's mathematical initiatives and includes them in the conversation, helping him to explore them further. To complete this task, Hamish has made a pattern, counts his stitches early in the process, and estimates the number of stitches later in the process. Inspired by the length of wool left over, he measures the width of the table and the easel using a length of wool as a unit, and makes predictions about other comparisons of length (also using the length of wool as a unit). Modelling an everyday purpose of mathematics, the teacher first engages with the task by asking Hamish to estimate how many stitches he has completed with one length of wool (based on Hamish's initiating comment "I've done five stitches"). They then count, as part of the conversation, to see if his estimate is reasonable. The teacher extends his interest in using a length of wool as a unit of measure. Hamish predicts and compares, using the measure for increasingly complex purposes, developing a "number sense", exploring the shift from two dimensions (the pattern) to three (the sewn corgi), implicitly posing questions for mathematical exploration (for example, about how much wool is needed for the task), and comparing lengths. These are all purposeful mathematical practices.

Ordering by size

Child: Nicholas

Observer: Julie

Date: 14 March



\$29.95

Nick asked me how much this was.

"Twenty-nine dollars, ninety-five cents, Nick," I said.

"That's a lot of money - but I've got heaps of money. When my Nana died, she left me some money," Nick told me.

"What will you spend it on, Nick?" I asked.

"A motorbike!" he told me.

"How about drawing me a picture so I can see what sort of bike you'll buy?"

Nick drew several bikes and ordered them from small to large.

"The big one is a Harley-Davidson!" he said. "The Harley has stripes. I think the wee seatbelt is at the back for the wee person. I don't know why they have two aerals at the back!"

"Yeah, I don't know. Why would they have aerals?" I said.

Nick said, "The aerals are for the wee microphones in the helmets - so they can talk to each other - so the driver can hear the person at the back. Harleys can go really fast - about forty speed or ninety speed or something. The wee ones is ... One is a Honda, and there's a Ford and a Mercedes."

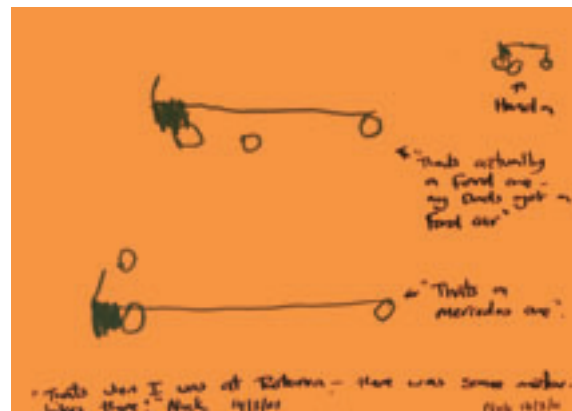
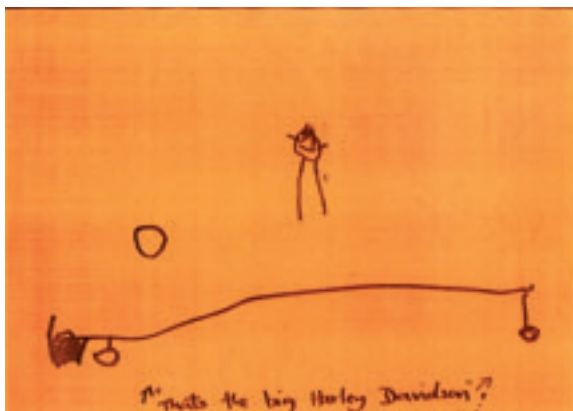
"Wow, Nick! You know a lot about bikes. Would you like to tell me more or is that the end of the story?"

"It's the end," said Nick.

Short-term review

I had *such* a lovely talk with Nick today - firstly about money and motorbikes and then later about some pictures he was interested in.

Nick shows he is aware that the symbols indicate an amount of money on the price label but he didn't know how much. He feels confident to ask for help when he needs it and he really seems to enjoy having a good in-depth talk from time to time. We probably spent at least half an hour chatting together today. When I see an opportunity to invite Nick to draw, I take it - and he is becoming more confident and willing to take risks with writing and drawing. I love the way Nick's first bike was very small, then he branched out and drew bigger and bigger bikes, culminating in the Harley. The ideas and inventiveness in his thinking about aerals was great I thought. "Wee microphones" in the riders' helmets so they can talk to each other!!! And obviously he has an understanding that aerals are needed for the transmission of sound.



What's happening here?

This is a conversation between the teacher and Nick. It begins with a number question and ends with a discussion about a drawing.

What aspects of noticing, recognising, and responding to mathematics learning does this assessment exemplify?

The teacher is using this opportunity to describe, and provide an example of, some of Nick's recent development with drawing and of his "inventiveness" (in his thinking about aerals). In her short-term review, she has been very explicit about what she means by "inventiveness". Nick explains what he is drawing and comments that he doesn't know why there are two aerals. However, he guesses that it is something to do with the microphones in the helmets. This is not just an interesting story: the teacher links it clearly to learning that is valued. She writes Nick's words as the text of the story to accompany his drawings.

What does this assessment tell us about mathematics learning (using a *Te Whāriki* lens)?

The teacher comments that Nick "feels confident to ask for help when he needs it and he really seems to enjoy having an in-depth talk from time to time". This is a specific commentary on his communication practices. She also writes that he is becoming "more confident and willing to take risks" with writing and drawing, and she notes

the way in which this exemplar illustrates his inventiveness with thinking about aerals. Nick is drawing and talking about what he knows from home experiences, a connection to the principle that family and community are an integral part of the early childhood curriculum. The Exploration/Mana Aotūroa strand includes mathematical processes specified in *Te Whāriki*, such as classifying for a purpose and making comparisons (ordering the bikes from small to large to emphasise the value of the Harley-Davidson). Nick's interest in the way in which numbers can denote value is an example of "familiarity with numbers and their uses", an outcome of the *Te Whāriki* Communication/Mana Reo strand.¹⁸

How does this assessment exemplify developing competence with mathematics?

This account begins with a question from Nick about the numbers on a price tag. The conversation with the teacher ("What will you spend it on, Nick?") moves the conversation on to motorcycles, a topic that Nick knows a lot about. When the teacher then suggests he draw a picture about this, he draws four bikes and "ordered them from small to large". The ordering is in terms of the size (length) of the bikes (and, perhaps, their status in Nick's eyes): Nick can name the type of each motorbike and he includes his mathematical ideas (about measuring their size and speed) in his account of his drawings.

Preparing a budget and playing with numbers

Child: Lute

Teacher: Karen

Date: 29 March

		Examples or cues	A learning story
Belonging Mana Whenua	Taking an Interest	Finding an interest here – a topic, an activity, a role. Recognising the familiar, enjoying the unfamiliar. Coping with change.	<p>This morning a group of children and I were looking through catalogues. The children were selecting equipment that they would like for their outdoor area. (We were applying for a grant.) They had great delight picking and choosing, and recorded their choices by drawing pictures to send with our grant application. I went to get a calculator to add up the cost of the children's choices. When I returned Lute had been busy writing letters on the blackboard.</p> <p>"I did my sister, my nana, my dad, my mum, my name, 'Lute', and my grandma," she told me as she pointed to the words she had written. I continued working with the group of children. We added up the cost of the equipment. I got called away to take a phone call and when I returned I couldn't find the calculator anywhere. I searched under all the papers under the catalogues and asked the children to help me look. We hunted everywhere. "Where could that calculator be?" I asked the children.</p> <p>Then I looked over to Lute. She was taking no notice of the other children and me. It was as if she was oblivious to her surroundings. She was very busy. She was pressing keys and watching the numbers come up on the screen of the calculator, reading them aloud, and then recording them onto her blackboard. Lute wrote the numbers in the same form they appeared on the calculator screen. When she had finished writing them on the blackboard she took my pen and copied onto paper what she had written on the blackboard. Lute was very proud of her writing and spent a long time writing numbers.</p>
Well-being Mana Atua	Being Involved	Paying attention for a sustained period, feeling safe, trusting others. Being playful with others and/or materials.	
Exploration Mana Aotūroa	Persisting with Difficulty	Setting and choosing difficult tasks. Using a range of strategies to solve problems when 'stuck' (be specific).	
Communication Mana Reo	Expressing an Idea or a Feeling	In a range of ways (specify). For example: oral language, gesture, music, art, writing, using numbers and patterns, telling stories.	
Contribution Mana Tangata	Taking Responsibility	Responding to others, to stories, and imagined events, ensuring that things are fair, self-evaluating, helping others, contributing to programme.	



Short-term review

Lute has a passion for writing: she is experimenting with numbers and letters. Lute has an understanding that numbers and words can be recorded and read.

What next?

Encourage Lute's literacy and numeracy skills through different media – the blackboard, whiteboard, magnetic letters and numbers, counting in dance and movement games.

What's happening here?

The teacher illustrates the use of a calculator, then temporarily loses it as one of the children takes it over for a purpose of her own.

What aspects of noticing, recognising, and responding to mathematics learning does this assessment exemplify?

Two events are illustrated here, both of them valued enough to be documented. The teacher records Lute's interest in the calculator, and she notes that Lute "was as if ... oblivious to her surroundings" when using it. Now that this story has been documented, other teachers (and Lute's family) can notice and recognise opportunities to strengthen Lute's interest – in both writing numbers and in using the calculator.

What does this assessment tell us about mathematics learning (using a *Te Whāriki* lens)?

This exemplar documents the participation of the children in an enterprise of great importance: applying for a grant for equipment for their early childhood centre. They belong to and are engaged in a learning community with connections to the world outside the centre

(the market – represented by the catalogue – and the funding providers). *Te Whāriki* emphasises using mathematics in activities that have meaning and purpose for children. It also has the learning outcome "Children develop the expectation that numbers can amuse, delight, illuminate, inform, and excite".¹⁹

How does this assessment exemplify developing competence with mathematics?

In this assessment, a group of children and their teacher are participating in a real-life mathematical activity. They are working together on the budget for an equipment grant. The children choose what they want from the catalogue, and the teacher uses a calculator to add up the cost of their choices.

Lute writes the names of her family on the blackboard nearby during a halt in the budgeting enterprise. She then borrows the calculator to press keys, watching the numbers come up on the calculator screen, reading them out loud, and writing them down. She is developing competence with the symbols (numbers) of mathematics and with a mathematical tool (the calculator).

Measuring the play dough

Child: Tom Teacher: Rosie Date: February

A learning story

Tom held up a long piece of play dough he had squeezed from the piping equipment and exclaimed, "Look, Rosie - it's sooo long!"

"Yes, you're right, Tom, it sure is! Let's get a ruler and measure it to see how long it really is," I suggested.

Tom placed his play dough strip along the tape measure.

"Can you see the numbers, Tom? They tell you how long it is," I explain.

After studying the numbers carefully, Tom cleverly announced, "19 long."

"Yes, 19 centimetres," I add.

"I'll make another one - but even longer this time. Look, this one is ... 22 centimetres," he continues.

"Wow, can you make the strip as long as the ruler - 30 centimetres long, Tom?"



After much squeezing and slight adaptation, Tom successfully makes the strip reach from one end of the ruler to the other.

"Look - it's 30 centimetres long now!" he announces proudly.



It's 19 long!!



This one is 22 centimetres.



I've made it 30 centimetres now!!

Short-term review

Tom is always so interested and captivated by whatever is happening at kindergarten. His number recognition is superb. He easily tells me the numbers on the ruler as he reads them. Measurement is a constituent of the maths curriculum at school - clearly Tom has already mastered a fundamental use of the ruler. He made sure the edge of the dough strip corresponded with the beginning of the ruler so that the dough length could be measured accurately.

Well done, Tom. We'll have to measure you to see how tall you are now. That would be a great big number!!



What's happening here?

The teacher suggests measuring a length of play dough when Tom comments that “it’s sooo long!”

What aspects of noticing, recognising, and responding to mathematics learning does this assessment exemplify?

This documented assessment in Tom’s portfolio records in detail the sequence of his measurements, including photographs that Tom will be able to read himself. Tom can therefore revisit this process. The short-term review even includes a photograph of part of a ruler. The teacher notes the specific mathematics learning and suggests a possible next step – measuring Tom himself.

What does this assessment tell us about mathematics learning (using a *Te Whāriki* lens)?

This record illustrates responsive and reciprocal relationships between Tom and his teacher. This is a good example of pedagogy that incorporates outcomes from the Communication/Mana Reo strand. The teacher is helping Tom to develop skill in using the counting system and to strengthen his learning about the mathematical symbols and concepts of numbers and length. The initiative is shared. She adds a tool for measurement, adds the word “centimetres” to Tom’s measurement, sets a challenge (30 centimetres), documents the process, and suggests a next step.

How does this assessment exemplify developing competence with mathematics?

This assessment is about using units of measurement as Tom sets himself the task of making piped lengths of play dough longer and longer. The teacher introduces the idea of measuring by numbers of centimetres using a ruler, and Tom readily practises this task. He learns that, by using a ruler, he doesn’t have to compare the lengths of dough against each other. He can remember the length in centimetres of the longest one so far. If the proposed next step is taken (measuring how tall Tom is), it might well be preceded by some estimation (the teacher has already signalled this possibility when she predicts “That would be a great big number”). Tom is learning the use and value of a mathematical tool (a ruler) while learning about a unit of measurement (centimetres). The teacher also records that Tom has used an accurate method of measuring by his making sure that the edge of the dough strip corresponded with the beginning of the ruler. The photographs in the assessment provide a record of this method for Tom to refer to on future occasions.

Ezra explores height, balance, measurement, and number

28 February

Ezra wanted to be really tall today. He was walking around with the sawhorse held up high over his head. Later I noticed him under the tree house positioning the sawhorse in different ways, trying to reach the bottom ledge.

He tried standing on both the bottom and top of the sawhorse.



The sawhorse is upside down with its legs standing up.



Ezra works out how to reach the ledge more easily.

Then with intense concentration he walked around the playground. "I'm going to reach that tree." But he placed the sawhorse on the concrete path.

I asked, "What would happen if you fell off?" He looked around without answering and moved onto the grass until he decided on a spot. He reached up and could just reach the leaves. Then he said, "You get some string and measure me." I found some

lovely red ribbon and together we spent some time measuring and cutting lengths while he stood either on the grass or on the sawhorse.



An audience came to watch while we compared lengths. Ezra decided he wanted the string tied to the branch so he could "swing".

"You pull out the little stool so I can swing," he insisted.

We did a countdown. "3 ... 2 ... 1 ...Go!!" And he jumped.

"Who wants to jump with me?" he asked the audience.

Several children wanted to join in and Ezra said, "This is going to be fun, eh?" The children agreed.

I left them to "swing" and they spent some time negotiating the process and how to hold the ribbon.

Short-term review

Ezra showed amazing problem-solving skills and a real interest in measuring. This solitary activity ended up being quite a social experience. Ezra is developing ways to include others in his play. Ezra needs more opportunities to expand his interest in measuring and maths concepts that also include his peers.

Voice from home

When this story was shared with Ezra's mum and her partner, Ezra's mum said that she had measured him against the wall a very long time ago. She didn't use string! Gareth (her partner) commented that they often tell Ezra if he eats up all his food he will grow big and strong. Ezra also gets up on a chair to see if he is as tall as Gareth.

Child's voice

When Sandra shares the story and photos with Ezra, Ezra responds, "I am trying to reach that branch, eh?"

"I'm measuring myself with a piece of string."

"I was holding the piece of string and I was **SLIDING** down, eh?"

"Hey, that's me," he said pointing at his name. "There's me, 'E' 'Z' 'R' 'A'," he said, pointing to each letter.

11 March – several days later

Ezra wanted to balance on the building bricks. He tried standing on just three but they kept falling. He then spent some time standing up all the bricks in a group. Finally he stood on them, arms outstretched and said, "I'm balancing."

Sandra: "Wow, look at you! How many bricks did you have before when you kept falling down?"

Ezra thought for a while and held up four fingers.

Sandra: "Was that enough to balance on?"

Ezra shook his head.

Sandra: "So how many bricks did you need to balance?"

Ezra got down and counted, touching each brick as he said a number.



"I'm balancing!"

Short-term review

Ezra problem-solved this task all on his own. He realised more bricks were needed to support his weight and the outcome was successful.

16 March

Several days later when playing outside, Ezra found a long tube. He ran over to me and asked, "Am I taller than this?"

"How might you work that out, Ezra?" I questioned.

Ezra stopped for a moment. He stood up straight against the wall and held the tube against himself. "You can look and tell me," he said.

"Good idea," I said. "No, it is just slightly taller than you."



"Hmm," said Ezra, "what about Eisak? Is she taller?"

Ezra held the tube against Eisak as he had done against himself and he compared.

"Yes, Eisak is taller!" he declared.



What's happening here?

This is a series of stories about Ezra as he experiments with ways to make himself taller, to balance, and to measure height.

What aspects of noticing, recognising, and responding to mathematics learning does this assessment exemplify?

The continuity of Ezra's explorations is documented as he uses a number of tools (sawhorse, ribbon, bricks, cardboard tube) to change and measure height. The teacher observes carefully, adding suggestions or resources at appropriate times. A voice from home is included in the documentation, connecting Ezra's measuring experiences at home with those at the centre. The teacher revisits the documentation with Ezra, and he describes his experiences by reading the photographs. He also recognises the letters of his name.

What does this assessment tell us about mathematics learning (using a *Te Whāriki* lens)?

Connections with home are included here as the family make links with the curriculum at the centre. When the assessment is shared with Ezra's family, they make a contribution to the record of continuity over time and place. Ezra uses a successful strategy for including others in the play: inviting them to jump with him.

This exemplar is an example of a mathematical pathway that is linked to the *Te Whāriki* principle of reciprocal and responsive relationships with people, places, and things. The Communication/ Mana Reo strand emphasises mathematics learning through "activities that have meaning and purpose for children".²⁰ The mathematics in this assessment is sited in events that absorb Ezra and hold meaning for him.

How does this assessment exemplify developing competence with mathematics?

This documented assessment records Ezra's developing understanding of the concepts of height, measuring height, and number. Ezra experiments with tools that help him to reach a greater height and then with artefacts that help him to measure height. Throughout this process, he demonstrates the activity of "playing" when other children join in the jumping game he has instigated.

Ezra measures using string and a cardboard tube, and he compares his results of different trials (measuring himself and then Eisak against the tube). He uses vocabulary of comparison. "Am I taller than this?" The teacher includes counting in Ezra's activities by leading him in a backwards countdown of three for jumping and then by encouraging him to count the number of bricks that he needs to create a firm foundation for standing and balancing.

Jack explores space

Child: Jack

Teacher: Sue

18 March

Jack was sitting in the block corner stacking Duplo blocks on top of one another. He then reached for the train and tried to stand a piece of Duplo on top of its funnel. This did not work so he went back to stacking the Duplo.

Jack noticed another child approaching but carried on stacking. The child watched him and then helped him stack by handing him a block. Jack took it and stacked it. He then tried to stack the Duplo upside down but found this didn't work, so he went back to stacking them the right way up.

The child helping Jack brought hand puppets but Jack wasn't interested in the puppets. Jack then sat the Duplo on the sill of the floor-to-ceiling window, stacked them, then left to play elsewhere.

Interpretation/Analysis

The amount of time Jack spent at this activity stood out for me, eight minutes in all. The fact that Jack did notice the other child, but did not really interact with her even when she brought the hand puppets over, showed that he was really involved in the task at hand.

What next?

Provide Jack with a variety of resources that can be stacked or used to build things (different sizes and shapes of blocks, large cardboard bricks).

19 March

While all the toddlers were asleep Jack explored the toddler area.

The large wooden tunnel took his fancy. He put his head inside it, laughing. He was laughing louder when he took it out again.

Jack played peek-a-boo with a staff member. On the completion of this game Jack went through the tunnel.



Teacher: Cilla

4 October

Jack loves balls. Today he found a ball outside, put it in a trolley and pushed it around the playground. He made a growling noise at his trolley if it did not go the way he wanted it to go. Jack spent 5 minutes taking the ball for a ride, then he picked up the ball, took it up the fort, and rolled it down the slide. I helped Jack come down the slide. He giggled, retrieved the ball, and repeated his slide game several times.

Interpretation/Analysis

Jack initiates his own games with items that interest him. He is playful with equipment and expresses his feelings verbally and through gestures.

15 October Jack tackles the steps

Today under the watchful eye of one of his larger mates, Jack tackled the wooden stairs. His socks were proving to be a little problem as he kept standing on them, so off they came. Claire stayed behind Jack as he made his way to the top of the steps, calling out “Jack, Jack” once he got to the top.



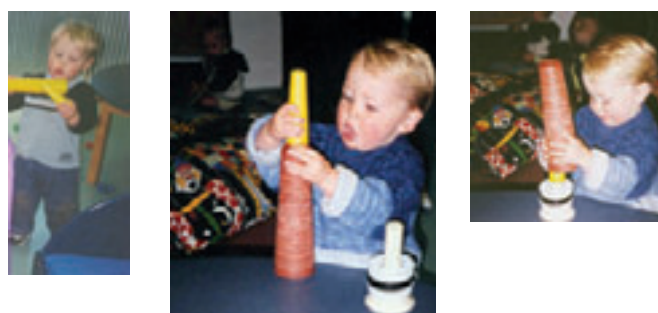
Teacher: Sandi 23 October

Today I was delighted to see Jack and Georgia initiating play with each other. Georgia first got Jack’s attention by squealing at him as he walked past. She then crawled to the end of the wooden box. Jack then came over and peeped right back. They took turns looking and laughing at each other. Jack then crawled through the box and Georgia followed. They did this several times, laughing and “talking” as they played.

Interpretation/Analysis	What next?
Jack and Georgia were able to play together. They took turns responding to each other’s ideas and were involved together for some time.	Keep noticing the friendships made in the nursery.

Teacher: Sandi 4 November

Jack has shown an interest in posting objects. Today he was putting shapes in and out of containers and then hiding them under the cushions. Jack showed delight when the objects/shapes were tipped out of the container. He smiled and repeated the task.



Interpretation/Analysis	What next?
Jack chooses play of interest to him. He plays around with equipment and gains much satisfaction from this type of exploratory play.	Increase the range of posting and heuristic play time and equipment to support Jack's interests.

5 December

As a toddler Jack's interest in stacking and manipulating objects continues. On many occasions Jack has been observed stacking a selection of cones one on top of another.

Teacher: Cilla

12 December

Jack loves hiding in boxes. Today he emptied out the sand toy-box to as far as his arms could reach, then climbed inside the box. He smiled at his teachers, then spent a few minutes searching through the toys, every now and then throwing something out until he found a sponge piece. He got out and returned this to the water play. Later on he was seen hiding in the toy oven and playing "peek-a-boo" with another child, using the playhouse window as a screen.

Short-term review

Jack enjoys discovering hiding holes. He will spend time each day in a private space – corner, box, tunnel, basket – by himself or with one other child.

What's happening here?

This is a series of stories about Jack exploring space.

What aspects of noticing, recognising, and responding to mathematics learning does this assessment exemplify?

A number of these assessment stories focus on Jack exploring space and his place in it. Another illustrates his interest in posting and stacking. These assessments provide Jack's teachers with ideas of "what next?" for Jack.

What does this assessment tell us about mathematics learning (using a *Te Whāriki* lens)?

Jack crawls, climbs, and stacks and posts objects. His explorations with these resources, along with his exploratory play with other children, are recorded in these assessments. They indicate the range of resources Jack has available to enable him to explore spatial relationships.

The Exploration/Mana Aotūroa strand of *Te Whāriki* includes learning outcomes that support: children's confidence in moving in space, their increasing control over their own bodies, and their manipulative skills, agility, co-ordination, and balance.

How does this assessment exemplify developing competence with mathematics?

Jack is exploring ways of using space, especially in relation to his own body. Through such exploration, he is developing his perception of depth and distance. He is also exploring the shapes and properties of materials and play equipment. *The New Zealand Curriculum* describes geometry as involving "recognising and using the properties and symmetries of shapes"²¹ and includes "Sort objects by their appearance" as a level 1 achievement objective. Within this strand of Geometry and Measurement, geometry also involves "describing position and movement".²²

Jake's survey

Child: Jake **Teacher: Shelley** **Date: 6 June**

Jake arrived, walking up the ramp, saying he would like to do a survey on bags. He came to me and we talked about how he would need to go about this. Jake thought this topic was a good idea for a survey as he didn't have to ask anyone any questions!!

Jake had a clipboard and worked on the yellow table. He drew bags and coloured them. "Look, this one doesn't have a handle," he said.

I asked if he was going to include multicoloured bags. Jake explained that there were no multicoloured crayons. I suggested he go and have a look at the sock graph to see how I had depicted multicolour socks. He came back still stumped. Finally I asked if he needed help. I showed him how I drew lines of different colours. At the table the other children discussed what made "multicoloured". Two colours were two-tone, so you needed three or more to be multicoloured. Jake also drew a big bag with a cross through it to signify "no bags".

He worked through looking at the lockers. Then he came to get me. He was not sure if he had got them all and said there were a lot with no bags. I asked if he had started from the top and worked along.

Jake looked horrified. "I started from the bottom and worked along." I explained that that was fine, and that I was just checking that he had worked in a line to make it easier and it didn't matter where he started. Jake was fascinated that there were some bags the same as each other.

Short-term review

This boy works to a plan. He is systematic and likes to complete a job. Jake has become very involved in surveys and likes to discriminate, sort, match, count and record. Jake is absorbed in thinking up ideas of what he would like to survey.

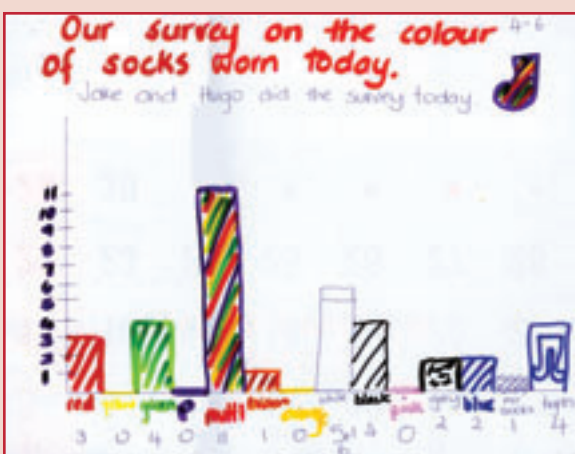
What next?

Jake seems totally in charge of this!



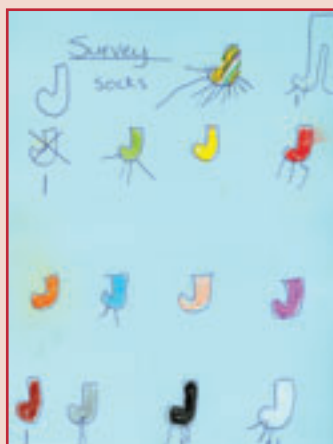
What's happening here?

This assessment is one of several items in a series on doing surveys at the early childhood centre. Children carried out surveys on the colour of their socks and tops, on pets at home, on where they love to play, and on their bags. The teachers helped them to convert the data into graphs. In this exemplar, Jake surveys the children's bags hung up over their lockers in the cloakroom.



What aspects of noticing, recognising, and responding to mathematics learning does this assessment exemplify?

The surveys were displayed on the wall so that the children could compare different ways of displaying survey data. Individuals' surveys, like Jake's, were also included in the children's folders so that they could revisit them. The teacher responds to Jake's initiative to do a survey by prompting him to refer to previous work when he gets stuck. She provides advice on request and encourages discussion among the children when Jake can't discover a solution to his problem. These strategies for "finding out" have been documented and can serve as reminders for the children about what to do when they're "stuck". The teacher checks Jake's system for recording the bags and verifies that his method will provide accurate data.



What does this assessment tell us about mathematics learning (using a *Te Whāriki* lens)?

In *Te Whāriki*, being a learner – and in this case being a learner of mathematics – includes calling on the resources of people, places, and things to assist with making sense of the world. This is exemplified here. Jake consults the teacher, and one of the aspects of difficulty (multicoloured recording) also becomes a topic for discussion by the children. Jake also uses the wall display (*things* in the environment that help with learning) and is participating in a *place* where surveys are of interest and are carried out in a range of ways. Jake's engagement in the process of doing surveys illustrates the learning outcome in *Te Whāriki* that children will develop the expectation that numbers can "amuse, delight, illuminate, inform, and excite".²³

How does this assessment exemplify developing competence with mathematics?

Jake's purpose in this learning story is to gather information about his environment, and he uses a mathematical tool (surveying) to do this. *The New Zealand Curriculum* states: "Statistics involves identifying problems that can be explored by the use of appropriate data, designing investigations, collecting data, exploring and using patterns and relationships in data, solving problems, and communicating findings."²⁴ While Jake is mainly collecting data in this assessment, he is also considering how to record data (on multicoloured bags) appropriately. Also, his choice of a recording method that ensures that the survey will include all the bags shows that he has thought about the design of his investigation. The teacher records that Jake "likes to discriminate, sort, match, count and record".

Collaborative building with unit blocks



‘O le ‘āmataina lenā o le fauina o le fale ta’avale. ‘Ua fa’atutū i luga pou, ma tu’u i ai laupapa e fola ai.

‘O lenā ‘ua o’o i le fauina o le taualuga. Tu’u i ai isi laupapa e ato ai.



‘Ua fa’ai’uina le gāluega, ‘ua tū mai le fale ta’avale. ‘Ua fa’asolo atu ta’avale i totonu e fa’amomoe.

‘O le faitoto’a lenā e pito i luma e o atu ai ta’avale i totonu.



Name: Trujon

‘O le tulimanu o poloka sa tā’a’alo ai Trujon ma tamaiti mātutua. Sā filifili mai na ‘o laupapa lāpopo’a muamua ma fa’apito i lalo e ‘āmata ai le gāluega.

‘O lona iloina o lana gāluega ‘olo’o fai na fiafia ai ma fa’aaogā lona māfaufau e fa’ailoa i ana gāioioiga.

Fai i tamaiti e tāofi, fa’atū, va’ai i pā’u’ū. ‘O le fale ta’avale. Tu’u i luga le taualuga.

Na pā’u’ū laupapa ma toe fausia i luga ma fesoasoani i ai isi tamaiti. Na mana’o e fesoasoani tamaiti ‘iā te ia.

E tasi le itulā ma le ‘afa na fai ai le gāluega ma mae’a lelei le fauina o le fale ta’avale.

Points of interest/learning take place

‘O le ‘umi e galue mālosi ai ona lima i le faiga o le gāluega. Tautala mai fa’ailoa lana mea ‘olo’o fai. Fa’atonuga i tamaiti mana’omia le fesoasoani – taliaina isi tamaiti.

Ideas to be developed

‘Ia toe fa’alauteleina pea lona iloa o le fa’aaogāina o peni, vase, pepa e tusitusi ai nūmera, ma mata’itusi e ‘āmata ai ‘upu o ana gāluega fai.

How your child is progressing at the centre ...

E tele ni vaega fa’alea’oa’oga ‘ua mafai ona a’oa’oina ai Trujon. ‘O se tama e mālosi lona tino ma mālōlōina. E fiafia o ia e tā’a’alo ma gālulue fa’atasi ma isi tamaiti. Na te iloa mea ta’alo e tataua ona fa’aaogā i lea taimi ma lea taimi o le aso. ‘O Trujon ‘ua mālmalama lelei i tulāfono tataua, po’o mea e lē tataua ona fai. E tautala i tamaiti ma ta’u i ai le mea e fai. ‘O se tamaititi e fai ma ta’ita’i lelei, ma e ‘avea fo’i o ia o se fa’ata’ita’iga i isi tamaiti. Na te tōina pese e ‘āmata ai le ā’oga po’o pesepesega fo’i. ‘O ona mālosi’aga o ta’aloga e pei o polo, fa’akāmuta, oneone, vai ma gāluega e fa’aaogā ai lona māfaufau.

Parent comments

‘O Trujon o se tamaitiiti e fiafia i le pese o pese Sāmoa ma pese lotu. ‘Āfai e fai atu se isi iā Trujon e pese, e lē mā Trujon, e pese leo tele. E matala lelei ‘upu, ma ‘a fa‘apea ‘ou te tau pese atu ‘ae ‘ese ‘upu ‘ou te pese ai, e fa‘atonu mai e Trujon le sesē. E fiafia Trujon e alu i le Ā‘oga Aso Sā. E iloa ma manatua e Trujon ana tauloto i tausaga ‘uma. ‘A fa‘apea ‘e te fesili i ai po ‘o le ā lau tauloto i le tausaga lea ‘ua te‘a, e fa‘alau mai e Trujon. ‘O le isi mea e fiafia ai Trujon, ‘o le ta‘alo ma polo ta‘alo, po‘o le polo lakapī, po‘o le polo soka, po‘o le tā polo, po‘o le voli polo, po‘o le polo tēnisi, ‘aemaise le pasiketipolo “basketball”. E lelei lana togi, sapo ma le kiki. (E lelei le ta‘i ma le “hand-eye coordination”. ‘Ua ‘āmata ona fiafia Trujon i le valiina/tusiina o ata. E fiafia tele Trujon i mea fa‘akāmuta (fauina o roketi). E fiafia Trujon e fai e ia ana mea, po‘o le faiga o ona ‘ofu, po‘o lana mea‘ai. ‘Ua ‘āmata ona viga Trujon e fia alu i le ā‘oga a tamaiti ‘ua ‘ātoa le 5, ‘ae le‘i taitai – toe tasi le tausaga.

What’s happening here?

Trujon is building a garage with a group of children. Photographs of the work in progress and of the completed work were taken and annotated. A learning story about this activity is also documented.

What aspects of noticing, recognising, and responding to mathematics learning does this assessment exemplify?

This assessment in Trujon’s folder reflects the learning community (his teachers and his family) noticing, recognising, and responding to Trujon’s learning. The photographs are annotated in Sāmoan, and the learning story and parent comment are also in Trujon’s home language. The comments beside the photographs may have been dictated by Trujon. The note beside the third photograph says: “The garage is completed. The cars are brought in to sleep. That’s the front entrance where the cars come in.” The teacher writes an evaluation of Trujon’s progress at the centre, commenting on him working with other children and his interest in carpentry. An invited parent comment describes what Trujon enjoys doing at home, noting that his interests include carpentry. This is a collaborative record.

What does this assessment tell us about mathematics learning (using a Te Whāriki lens)?

This learning story illustrates Trujon learning from experience how to design a stable construction. Trujon learns from mistakes (the building falls

down a number of times). He remains involved and focused on a task. (He works for one and a half hours on this building.) Trujon also displays leadership skills, managing the group with instructions like “Hold onto this”, “Don’t let it fall”, and “Put this on top.” This exemplar shows how children supporting each other and learning together, a key feature of play, makes a valuable contribution to mathematics learning.

How does this assessment exemplify developing competence with mathematics?

In this assessment, Trujon undertakes the collaborative and purposeful task of building a garage for the toy cars. He leads the building process by giving instructions on how to create a solid structure from unit blocks. The different lengths of the blocks are utilised to make a structure that doesn’t fall down. This is accomplished by using long blocks down the sides and half blocks across the top. The decorative design is created with triangles placed on small rectangles. Working with unit blocks gives Trujon the opportunity to gain a working knowledge of geometric shapes. *The New Zealand Curriculum* highlights “using the properties and symmetries of shapes”.²⁵ Unit blocks provide just such an opportunity. A level 1 achievement objective for position and orientation is “Give and follow instructions for movement that involve distances, directions, and half or quarter turns.”

Playing with repeated patterns

Child: Jessica **Teacher:** Anne **Date:** 29 April – 16 May

Jessica began sketching with enthusiasm, and with great experimentation. She played with the koru pattern by connecting it in an interesting way. She even added spirals in the writing of her name.

Her sketching also includes pictures that have meaning for her, i.e., a person and a house. Her black and white painting is a reflection of her sketch, as is her final PVA picture.

A few days later her mother showed me a fascinating drawing that Jessica had worked on at home. I looked at the series of photograph frames. “Look, these make them stand up” (she pointed to the stands) “and this is one person,” said Jessica.

Short-term review

Jessica is observant and creative. She loves to draw and focuses on detail. I remember showing her how the koru patterns were repeated and we discussed this. One can only wonder if she is experimenting further with repeating a pattern in this very mathematical drawing.



What’s happening here?

This exemplar summarises some of the work in Jessica’s folder as she experiments with patterns, inspired by a visit to the Māori Gallery at Auckland Museum. During this visit, the children observed and drew the patterns, including the kōwhaiwhai. Not all Jessica’s artwork is included here, only the drawing that came from home and some of the koru pattern drawings.

What aspects of noticing, recognising, and responding to mathematics learning does this assessment exemplify?

This drawing was done at home, but her mother recognised its connection with the artwork of patterns and people that Jessica had been exploring at the early childhood centre. The teacher adds the home drawing to Jessica’s folder, and she comments on the development of her artwork over time. She also acknowledges the uncertainty of her analysis: “One can only wonder if she is experimenting further with repeating a pattern ...” Jessica’s voice is here too. She explains that she has drawn stands on the photograph frames. “Look, these make them stand up ...”

What does this assessment tell us about mathematics learning (using a *Te Whāriki* lens)?

In *Te Whāriki*, outcomes are summarised as working theories and learning dispositions. In terms of learning dispositions, the teacher comments that Jessica is “observant” and

“creative”. Jessica is also exploring a working theory about patterning, in a range of contexts. A principle in *Te Whāriki* is that the wider world of family and community is an integral part of the early childhood curriculum. There is a family contribution to Jessica’s work, and her exploration of pattern has been inspired by a visit to the local museum. Her mathematics understanding is becoming connected to a greater diversity of purposes, places, and social communities (see page 5).

How does this assessment exemplify developing competence with mathematics?

Jessica has been playing with connected patterns, and her drawing is one example of this interest. The teacher points out the mathematics in her analysis of the drawing: she records that she and Jessica have discussed koru patterns and implies that Jessica has been motivated by her observations and these discussions; she sees connections with Jessica’s other work on repeated patterns. *The New Zealand Curriculum* states that algebra “involves generalising and representing the patterns and relationships found in numbers, shapes, and measures”.²⁶ Jessica’s repeated and sequential pattern displays a “rule” or a relationship: as the figures get smaller, the legs get longer. Such “rules” are part of explaining, one of the six activities identified by Bishop that are responsible for the development of mathematical ideas in any culture.²⁷

Reflective questions

He pātai hei whakaaro iho

Which assessments from our setting make valued mathematics visible to teachers, children, families, and whānau?

What opportunities for experiencing mathematics practices from the wider community are included in the children's assessments?

In what ways do our mathematics assessments and their contexts indicate that we are on the pathway towards bicultural practice?

How do teachers include in their assessments the mathematics practices the children are experiencing outside the centre?

What opportunities do children have for participating in mathematics learning through the routines and practices of maintaining our centre? Is this view of mathematics represented in our assessments?

Do our assessments reflect the contexts and opportunities included in the "te kākano" metaphor?

What aspects of assessment practices and of the wider *Te Whāriki* curriculum strands are represented in our mathematics exemplars?

Endnotes

Kōrero tāpiri

- 1 Ministry of Education (2007). *The New Zealand Curriculum for English-medium Teaching and Learning in Years 1–13*. Wellington: Learning Media, p. 26.
- 2 Ministry of Education (2001). *Curriculum Update*, no. 45. Wellington: Learning Media, p. 1.
- 3 Alan J. Bishop (1988). *Mathematical Enculturation: A Cultural Perspective on Mathematics Education*. Dordrecht: Kluwer. See also Bert van Oers (2001). "Educational Forms of Initiation in Mathematical Culture". *Educational Studies in Mathematics*, vol. 46, pp. 59–85.
- 4 A. Bishop, op. cit., p. 23.
- 5 *ibid.*, p. 43.
- 6 Barbara Rogoff (2003). *The Cultural Nature of Human Development*. Oxford: Oxford University Press, p. 256.
- 7 A. Bishop, op. cit., p. 57.
- 8 *ibid.*, p. 45.
- 9 One of these tools and systems is "pattern sniffing", an evocative expression included as a "habit of mind" in *Habits of Mind: An Organizing Principle for Mathematics Curriculum* by Al Cuoco, E. Paul Goldenberg, and June Mark (see www.edc.org/MLT/ConnGeo/HOM.html). Patterns in the Pacific are explored by Susanne Küchler and Graeme Were (2005). *Pacific Pattern*. London: Thames and Hudson. They comment, "While pattern is conservative, in as much as it functions through repetition, it is also a key aspect of innovation. Its reproduction will be more convincing when executed by the mind and tempered by its inevitable transformation. Abstract and, frequently, unspecific in nature, pattern is akin to a 'burial place of memory', where all pasts are equally present and where to recall means to transform. This is similar to the way in which classical poetry utilized the theme of the underworld to issue forth ever new, and yet instantly recognizable, versions of events that made history by being retold over and over again" (p. 173).
- 10 Glenda Anthony and Margaret Walshaw (2007). *Effective Pedagogy in Mathematics/Pāngarau: Best Evidence Synthesis Iteration [BES]*. Wellington: Ministry of Education.
- 11 Ministry of Education (1996). *Te Whāriki: He Whāriki Mātauranga mō ngā Mokopuna o Aotearoa/Early Childhood Curriculum*. Wellington: Learning Media, p. 78.

- 12 Maggie Haynes, Carol Cardno, and Janita Craw (2007). *Enhancing Mathematics Teaching and Learning in Early Childhood Settings*. Wellington: NZCER, p. 80. Available on www.tlri.org.nz See also Janita Craw and Maggie Haynes' 2007 paper in the Early Childhood Research Folio. (Specific title and reference for this folio is required)
- 13 Ministry of Education (1996), op. cit., p. 88.
- 14 *ibid.*, page 90.
- 15 *ibid.*, page 78.
- 16 *ibid.*, page 78.
- 17 For the value of connecting with the knowledge and ways of being in home communities, and the expression “funds of knowledge”, see Norma Gonzalez, Luis C. Mol, and Cathy Amanti (2005). *Funds of Knowledge: Theorizing Practices in Households, Communities and Classrooms*. Mahwah, NJ: Lawrence Erlbaum.
- 18 *ibid.*, p. 78.
- 19 *ibid.*, p. 78.
- 20 *ibid.*, p. 78.
- 21 Ministry of Education (2007), op. cit., p. 26.
- 22 *ibid.*, p. 26.
- 23 Ministry of Education (1996), op. cit., p. 78.
- 24 Ministry of Education (2007), op. cit., p. 26.
- 25 *ibid.*, p. 26.
- 26 *ibid.*, p. 26.
- 27 A. Bishop, op. cit.