

Learning Stories: Making Mathematics Learning Visible

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In early childhood settings narratives that capture children's learning as they go about their day-to-day activities are promoted as a powerful assessment tool. However, in the New Zealand context there is increasing concern that learning stories currently downplay domain knowledge. Data from teacher interviews and samples of learning stories suggest that many teachers prefer to document and analyse mathematics learning that occurs within explicit mathematics activities rather than within play that involves mathematics.

Assessment practices in early childhood education reflect a shift away from a deficit perspective employing check lists of skills towards a growing use of narrative and credit modes of assessment (McLachlan, Flear, & Edwards, 2013). In New Zealand, a survey of early childhood centres noted a trend towards "more qualitative and interpretive methods of documentation that are able to capture the learning within contexts of relationships and environment" (Mitchell, 2008, p. viii). In particular, the use of learning stories (used by 94% of centres) was endorsed as an effective way to assess learning dispositions that are deemed central to the sociocultural framing of the early childhood curriculum, *Te Whāriki* (Ministry of Education (MoE), 1996). But where does mathematics feature in a culture of assessment dominated by attention to learning dispositions? Given an expectation that mathematics will be assessed within the context of close observations of children as they go about their day-to-day activities within the early childhood setting we wondered how mathematics fared within narrative assessment practices, specifically learning stories.

Curriculum and Assessment Practices

Organised as a framework rather than a prescriptive curriculum, the New Zealand early childhood curriculum *Te Whāriki* emphasises children's competencies, dispositions, and theory building through active participation within the social world. As such, curriculum is defined broadly as "the sum total of the experiences, activities and events, whether direct or indirect, which occur with an environment designed to foster children's learning and development" (MoE, 1996, p. 10). Mathematical experiences are woven into the goals and learning outcomes (known as knowledge, skills and attitudes) of the Communication and Exploration strands. For example, teachers are urged to provide experiences for children to

develop spatial understanding, including an awareness of how two- and three-dimensional objects can be fitted together and moved in space and ways in which spatial information can be represented, such as in maps, diagrams, photographs, and drawings. (MoE, 1996, pp. 74-88)

Experiencing mathematics is also implicit in the other strands (e.g., developing skills in food preparation (Well-Being); understanding routines and discussing and negotiating fairness (Belonging); and discussing/explaining ideas (Contribution)).

Aligned with socio-historical cultural views concerning the provision of opportunities to learn and develop mathematical concepts, *Kei Tua o te Pae. Assessment for Learning:*

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Early Childhood Exemplars (MoE, 2009) advocates an assessment *for* learning position. Teachers need to be aware about ‘what’ they are teaching children through play and the role of their deliberate interactions in children’s play (Anthony & Walshaw, 2009; Hedges & Cullen, 2012). The mediating actions of noticing, recognising, and responding to children’s learning are integral to assessment:

These three processes are progressive filters. Teachers notice a great deal as they work with children, and they recognise some of what they notice as ‘learning’. They will respond to a selection of what they recognise. (MoE, 2009, Book 1, p. 6)

Importantly, the difference between noticing and recognising lies in the application of professional expertise to recognise the significance of what is noticed in relation to the learning and wellbeing of the child. This ability to recognise learning is linked, in turn, to the ability to make a professional response to that learning, and in doing so, to enhance the child’s opportunity to learn either through reinforcement or extension. Mediating actions by an adult are also central to a dynamic view of assessment promoted by early childhood researchers Fleer and Quiñones (2013):

Underpinning a dynamic view of assessment ... is the idea of adult mediation, which has allowed the assessor to move beyond a static and individual construction of the assessment context. That is, rather than measuring what a child can do on her/his own, dynamic assessment seek to assess the child and the adult working together at a higher cognitive level, where the extent of the mediation is measured alongside what is achieved. (p. 238)

Narrative assessment practices such as advocated by the learning story framework developed by Carr (2001) are the mainstay in early childhood settings in New Zealand and more recently have been promoted in Australia (Perry et al. 2007). Closely linked to Te Whāriki (MoE, 1996) the learning story framework suggests a documented account of a child’s learning event structured around five behaviours: taking an interest, being involved, persisting with difficulty, expressing a point of view or feeling, and taking responsibility. Typically learning stories are presented as a one page document written by the teacher, but may include input from parents and children. They often include photographs as a record of an aspect or incident of a child’s or group of children’s learning.

Learning stories serve multiple purposes. More than just describing learning, they can facilitate discussions about the child’s learning, document learning over time, and support planning decisions about ‘where to next’. However, there is a growing level of critique as to whether the learning story framework, as it is being implemented by teachers, is sufficiently robust for capturing evidence of concept formation or being utilised effectively in planning future learning opportunities. For example, Nuttall (2005) contends that many of the exemplars presented in *Kei Tua o te Pae* lack appropriate interpretations of children’s engagement in sophisticated literacy practices, preferring instead to emphasise dispositions such as collaboration and exploration. Blaiklock (2008) and Fleer and Quiñones (2013) express concerns about the propensity of early childhood educators to interact and assess in the ‘here and now’, looking back on what has been achieved or what is currently being enacted, rather than considering changes in learning over time. It is with these concerns in mind that we look at how mathematics is made visible within learning stories. Our research question is focused on how early childhood educators document and analyse the mathematical abilities/disposition of the child as part of their narrative assessment practice.

Research Overview

The presented findings are drawn from a larger studyⁱ examining assessment practices involving children’s mathematical learning within early childhood settings. The study was organised around case studies of three kindergartens—Manuka (M), Kauri (K) Rimu (R)—representing high, middle, and low socio-economic communities. Teachers were requested to nominate six portfolios containing learning stories that include mathematics experiences and or from children who have demonstrated ability and interest in learning mathematics. Mathematics-based learning stories (66 in total) were selected across the 18 portfolios by the first author. In focusing our attention on those learning stories we hoped to gain access to ‘what’ mathematics was made visible and regarded by the teacher as important to document for the learner and parent audience. All of the teachers participated in an interview with the first author focused on their current assessment practices and perceptions about mathematics learning and assessment in early childhood settings. As part of the larger study parents were also interviewed.

Findings

In recounting important elements of a learning story, teachers commented that a learning story should include a combination of child, teacher and parent voice, as well as photos to help the child recall the experience. However, variations in the ways learning was documented could be linked to different philosophical positions concerning assessment. For example, the teachers in Manuka kindergarten felt that it was important for them to *interpret* the learning that was going on within an activity. MT3 explains:

Making learning very visible to parents such as linking learning to research and showing parents what I see children doing and how I relate it to learning. Because as a teacher I can relate playing to learning but it might not be the case for the parents.

To make learning visible their learning stories typically included a description of what happened followed by an analysis that highlighted the valued learning as illustrated in the following extract:

No story title Written by MT3 on 03/02/2011

MC3, today you were enjoying grouping various science resources into same family groupings. You and A worked together, and were very precise about where you placed each of the creatures after carefully looking at the colouring, patterning and size of each one. You were delighted to find a large monarch butterfly figurine—excitedly telling me that you have seen some monarch butterflies and caterpillars at your house. MC3, you are confident in using a variety of strategies for exploring and making sense of the world—including looking for patterns, classifying things for a purpose and thinking logically. This work is expanding your maths concepts as you collect, organise, compare and interpret different objects and materials. I wonder where else this fascinating seriation and grouping is occurring at kindergarten?

From a different perspective, Kauri teachers’ learning stories were framed by the belief that teachers should not assume what they see means what the child is doing. As teachers, they questioned their right to interpret, for example, ‘doing a jigsaw puzzle’ as an indication of ‘spatial awareness’. Thus, unless the learning was visible and recognisable as part of a mathematical activity (e.g., counting in a numeracy game, sorting in a grouping activity), it was unlikely that the learning story would be interpreted and analysed to highlight specific mathematical learning. This approach is evident in the following two learning stories: the first one is devoid of any interpretation of mathematical learning; while the second one includes an analysis of explicitly observed mathematics skills.

No story title Written by KT3 on 09/05/2011 – KC4, today I saw you and A spending time at the water trough filling up the different sized water beakers with water. I watched as you worked together to ensure that each one was filled to the top before moving on to the next one. I really liked the way that you took turns at tipping water into each beaker and how you listened really well to your friend A when he called out for you to stop putting water in when the beaker was filled. From just watching you I felt that you were both just getting enjoyment out of pouring and filling beakers. Perhaps if I see you doing this again it would be a good opportunity to introduce you to some maths concepts such as volume, size, and measurement.

No story title Written KT4 on 24/5/2011 – KC6, I am so impressed, I watched you today on the large mat with the number puzzle and you showed great knowledge as you placed each number in order along with the correct amount of objects. This puzzle was no challenge to you at all, you just whizzed through it so quickly. I can see from other stories KC6 that you have an interest in numbers and mathematics and are often at these types of activities. You showed me that you knew the ordering of numbers from 1 to 10 and could recognise the numerals easily.

From yet another perspective, the Rimu teachers' focus was to link the child's learning to the development of dispositions:

...looking through a dispositional lens. We talk about the interest and from there it might be dispositions that feed into that interest, e.g., children keep going back to that same thing. [RT3]

Although RT3 mentioned in her interview that her interactions with the child in question involved a lot of mathematical language the mathematical learning, as featured in the following learning story, was frequently back-grounded in preference to the dispositions:

U-tonu-tanga/Perseverance Written by RT3 on 14/06/2011

Today RC6, you really enjoyed working your way around the variety of challenges in the outdoor kindergarten environment. It was great to see the way children embraced the challenge of physically working their way over the obstacle circuit. I was intrigued to see the way each child persevered and challenged themselves to manoeuvre up, over and along the course including some great balancing. When I reflect on our curriculum document Te Whāriki, Contribution/Mana Tangata clear links can be made to Essential Learning Areas of Health, Physical Well-Being. Children participating in group physical activities, children develop responsible relationships and respect for cultural perspectives and the contributions of others.

However, from our analysis of all the learning stories it was apparent that teachers across all kindergartens were keen to highlight dispositions (see Table 1), most notably dispositions related to courage, curiosity, and confidence. It is also noted that some references were relatively removed from the perceived mathematical activity referring, for example, to a child's propensity to share with friends or fun making oneself dizzy.

Table 1

Learning Dispositions Referenced in Learning Stories in each of the Kindergartens

Learning Stories (LS)	Manuka (23)	Kauri (24)	Rimu (19)	% of 66 LS
Courage and curiosity	9	10	13	48%
Trust and playfulness	2	2	1	8%
Perseverance	8	4	4	24%
Confidence	8	14	13	53%
Responsibility	1	10	2	20%
Others (e.g., creativity problem solving, pride)	3	2	4	14%
Relative freq. per LS	1.34	1.75	1.95	

In exploring ‘what’ mathematics was made visible within the learning stories the mathematical practices/process and content were coded by categories (Table 2) derived from the curriculum and assessment resources combined with categories linked to the powerful mathematical ideas proposed by Perry, Dockett and Harley (2007). As was the case with references to learning dispositions, the frequency and nature of the references to mathematical practices and content was relatively consistent across the kindergartens. Description of the activities associated with number sense, mental computation, spatial and geometric reasoning and measurement typically involved building/carpentry with blocks, sandpits, baking, jigsaws and board games. Activities were categorised as mathematisation where there was reference to using problem solving and tools to display thinking. Of note was the infrequent reference to data or chance experiences.

Table 2

Mathematics Referenced in Learning Stories in each of the Kindergartens

Learning Stories (LS)	Manuka (23)	Kauri (24)	Rimu (19)	% of 66 LS
Mathematisation	14	10	9	50%
Connections	3	9	9	32%
Argumentation	10	12	7	44%
Sequencing	3	6	2	17%
Number sense	7	13	9	44%
Algebraic reasoning	9	5	5	29%
Spatial and geometric	6	3	11	30%
Measurement	7	5	9	32%
Data and probability	1	1	0	3%
Relative freq. per LS	2.6	2.7	3.2	

But this data set does not tell the full story. Many of descriptions of children’s activities made only passing reference to mathematics or working with mathematics resources. As MT3 reminded us learning stories need to capture significant moments of learning in relation to the child and thus it may well be valid that mathematics is back-grounded:

...for that particular child, it might be that they entered the group of children and they learned to share that equipment. So for them that will be the significant thing that you would write about and you might be talking about their language they are using while they are still doing fantastic number work or they are still grouping or sorting, They are still learning about colours and shapes but your focus might be on the other element. So, it’s knowing those children and seeing what’s significant.

However, for many learning stories evidence of interactive discussions with adults to support mathematisation and argumentation (including the introduction of mathematical language) that builds on the child’s thinking was limited. The analysis of the mathematics learning, either current or future, was frequently absent or vague in nature. For example, KT2 writes “I saw you looking at the pump and I think your were trying to work out what was going wrong. I’m not sure how but you must have realised that the water in the lower level wasn’t high enough to move through the pump”. Likewise, in relation to planning, learning stories often contained very general statements of intent (e.g., “We did lots of sorting, matching, comparing and classifying with the fish today. Let’s go fishing again soon” [MT1]; “I’m glad you enjoyed all the predicting we did, especially with the water as we saw such amazing results! Maybe we could do it again another time.” [KT2]).

Discussion

In looking to understand why the documentation of mathematics is not visible in ways that reflect a dynamic assessment approach (Fleer & Quiñones, 2012), nor appears to motivate significant forward planning (Perry et al., 2007) we revisit the teacher interviews. For the majority of teachers a lack of confidence in understanding young children's mathematical development meant that many resorted to descriptions of skills that they observed from a distance. As KT4 noted "watching out for new ways of behaving was evidence of learning". However, she expressed a concern about her ability to judge whether the child's activity was 'truly' mathematical:

I suppose that is a shame that I have not had any training on maths, in terms of 'is it maths that they are doing or is that saying that I think they are doing maths'? So unless I actually see them doing, like is that because a child is playing with a puzzle, it is not necessary that they are experimenting with shapes and size in the way things fit into the spatial, or is it because they just enjoy doing the puzzles?

Despite awareness that mathematics was embedded in many activities several teachers acknowledged that they "did not include enough mathematics in learning stories". As KT4 reported she includes mathematics "say once or twice a week if I am lucky. If I have got a maths lens on it will be more". RT3 also agreed: "If it is really evident in that teachable moment, I think I probably need to get more of a numeracy lens to see it happening." Possibly because mathematics was potentially everywhere the teachers felt that they could be selective about when and what to document. However, in having a choice it appeared that many chose learning that was easily recognised as part of a developmental trajectory. For example, RT2 commented that she more often picked up "those foundational mathematical skills and concepts such as numbers, shapes, colours, grouping and seriation". Unanimously, teachers argued that working with numbers and grouping and patterning were more easily seen and documented, especially if "they are actually working with numbers and using the language as well. So you can definitely say that they are counting out loud or they are talking about shapes or size" (KT4).

Those activities that were noted as more difficult to document as mathematical included weight and measurement, as well as the more generic spatial activities. Teachers were concerned with the dual purposes of these activities:

When a child is doing a puzzle with blocks, is she exploring the mathematical concepts or is she just enjoying sticking the blocks of different sizes together? If she is using the language as well then you can actually document it as mathematical learning, but then I am not too sure if it is so easy to pick up the child's language. I mean I probably can say you are looking at different sizes and you know that the big blocks had to go on to the bottom before you put the little blocks on. But that is what I am seeing and that is not necessary what the child is doing. (KT4)

When asked to reflect on a particular learning story they had written several teachers recounted interactions with the child that had not been documented. For example, MT1 noted in reference to a learning story featuring MC3 creating a ladder from mobile pieces that, "I talked about the extension ladder, how many pieces there were and how long it was, or if it was taller than Emma and so on. This contrasted the record in the learning story as: "You were happy for me to take a photo of your Fire Engine and demonstrated how long the extension ladder was too". So while there was an awareness that children's working theories should be used to mediate and extend children's understandings more often the teachers expressed a reluctance to engage in explicit interactions around mathematical talk

with the children. MT2 for example, linked this reluctance directly to her lack of confidence in mathematics:

If you are confident, you can ask the questions, you can wonder with the children even if you don't know the answers but it does help to have the content knowledge, to know where you are heading.

KT4's preference to structure the analysis of mathematical learning around "the things that I can see" was tempered with "I should probably do more than just write this up as a description, I should go back to them [and say] 'I saw you doing this today, can you tell me what you are doing?'" Without further support we predicate that this would be unlikely to happen given her belief that children find it difficult to engage in mathematical talk:

It can be hard to ask a child what learning you think is taking place for you. Maybe because we don't use it enough and so they are not used to answering that question. They can't really sort of verbalise what they are actually learning, they can't say what they are doing on the monkey bars, you know.

From RT2's discussion about the process of analysis we can see why moving away from a descriptive approach would be challenging both mathematically and timewise:

If I want to pinpoint what learning is going on and I want to word it without me just describing what happened, then I look in the Number Framework book or go back to reading and so I can pinpoint what the child was actually doing, what knowledge they had.

In discussions about planning, teachers elaborated that the activities featured in the learning story were frequently targeted activities from previous planning, or that observations of one child's new skills sometimes prompted them to encourage other children to engage in similar activities. Explicit planning of next steps for individual children as follow up to learning stories was less evident. As HT4 noted:

I kind of get a bit stuck on the whole 'where to next' question, which is quite difficult for me because I want it to be something that is really complex and complicated where I am thinking that actually I don't think it is. It's just kind of what happens as part of daily actions and events.

Implications and Conclusions

Despite appreciating that mathematics was embedded in a range of everyday activities within the centre, the nature of a particular activity (e.g., whether they perceived the underlying maths to be implicit or explicit—a distinction often related to by accompanying mathematical language)—appeared to influence 'what' teachers would choose to document as mathematical learning. Sarama and Clements (2009) suggest that mathematical experiences for young children occur in two forms, "play that involves mathematics and playing with mathematics itself" (p. 327). Our teachers for the most part, felt more comfortable documenting mathematics learning that occurred in the latter context. Where documentation of mathematics learning in the first context occurred, teachers often lacked confidence in their ability to recognise how the children represented their mathematics knowledge and to then build on that understanding through prompting and questioning.

Our concern is that this restricted documentation of mathematical learning could mirror restricted opportunities for mathematics learning. Given that most of the learning experiences in our kindergartens involve well-planned, free-choice play, it is critical that teachers are able to utilise free-choice play to support mathematics learning. Moreover, documenting how free-play opportunities can support mathematical learning may be significant in creating educative partnerships with family/whanau. As Sarama and Clements (2009) note, one of the best ways to help low-income children who are the most

disadvantaged in mathematics is “to help children discuss and think about the mathematics they learn in their play” (p. 332), and this can be applied to both centre and home settings.

The findings of this study, while reflecting only three kindergartens, suggest that teachers would like and need more guidance concerning the assessment and documentation of mathematics learning. We note the use of a Numeracy Matrix developed by Perry and colleagues (2012) in the Australian context that provides guidance in pedagogical practices that support mathematisation and argumentation in particular has proven effective in supporting assessment and planning practices. Without support teachers like RT2 will continue to undervalue the role of ‘sandpit play’ when we know that if mathematised can provide a valuable opportunity for mathematics learning:

I think what sticks out for me is number knowledge and a child is showing me that she understood numeral recognition or one-to-one counting, doing patterns. I write learning stories about that, but if a child was in the sandpit making a road, using a spade to do that, I probably would write about something else rather than maths even though there is maths going on.

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ⁱ The larger study was Rachel Lim’s doctoral work. The data collection for this study was completed along with some preliminary analysis before Rachel’s untimely death from cancer. The second and third authors, Rachel’s supervisors, are honoured to be able to posthumously present her findings.