An Introduction to Books 17–20: Symbol Systems and Technologies for Making Meaning

He Whakamōhiotanga ki ngā Pukapuka 17–20: Ngā Tohu Pūnaha me ngā Mahi hei Whakamārama

16

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

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

An Introduction to Books 17–20: Symbol Systems and Technologies for Making Meaning

He Whakamōhiotanga ki ngā Pukapuka 17–20: Ngā Tohu Pūnaha me ngā Mahi hei Whakamārama

Introduction

This is the first of five books on assessment in the domain of symbol systems and technologies for making meaning.

In the Reggio Emilia programmes in northern Italy, symbol systems are described as "one hundred languages" for making meaning and communicating.[1] Carlina Rinaldi writes about listening "to the hundred, the thousand languages, symbols and codes we use to express ourselves and communicate, and with which life expresses itself and communicates to those who know how to listen".[2]

> We have often heard the phrase from Reggio Emilia, "100 languages of children". What does this mean? It could refer to the 100 different ways children use their native language to express their general attitude toward something. Or, more literally, it could mean that there are 100 different symbol systems that qualify as protolanguages that children could use if the classroom culture would allow it … For example, several children choose to use gesture to retell the story of a lion capturing a gazelle; others use music and others use drawings.[3]

There are connections here too with the key competency "using language, symbols, and texts" in *The New Zealand Curriculum* (2007). The explanation of this key competency includes the following:

> Languages and symbols are systems for representing and communicating information, experiences, and ideas. People use languages and symbols to produce texts of all kinds: written, oral/aural, and visual; informative and imaginative; informal and formal; mathematical, scientific, and technological.[4]

The four symbol systems and technologies for making meaning discussed here – literacy (oral, visual, and written), mathematics, the arts, and information communication technology (ICT) – are a selection. Other systems, for instance, scientific systems for the classification of animals and plants, are not included.[5] Furthermore, these four are interconnected. "Reading" pictures, photographs, whakairo (carvings), and drawings includes art as well as reading. Recognising the meaning of culturally significant patterns (for example, tapa and tukutuku) includes language, mathematics, and art. These are *cultural* systems and technologies. Many of them have been handed down from previous generations, while some are newly constructed and evolving.

Occasionally these are all described as "literacies", although "literacy" is sometimes seen as being only about language, reading, and writing. A writer who discusses the changing nature of literacy in the 21st century is Gunther Kress.[6] He argues that because of the increase in information and communication technology in everyday life, children of today are growing up in a world where the ability to read complex and diverse visual images for meaning will be just as important to literacy success as their ability to read the written word. For example, electronic texts relying on a combination of visuals and words are playing an ever-increasing role not only in entertainment but also in communication and employment. The advent of these new symbol systems and technologies demands that we take a broader view of literacy than in the past. The concept of "multiliteracies" is relevant here. "'Multiliteracies' refers to multimodal ways of communicating through linguistic, visual, auditory, gestural, and spatial forms."[7]

Literacy is changing and young children are increasingly exposed to communication tools and situations that are multimodal rather than exclusively linguistic (Hill & Nichols 2006). This has required new thinking about the new forms of literacy. One of the ways that this rethinking has occurred is in the pedagogy of multiliteracies (New London Group 1996), which has expanded our view of reading, writing, speaking and listening to include the various multimedia symbol forms.[8]

Cultural tools and literacies from the past are also part of today's symbol systems and technologies for communication and meaning making. Hirini Melbourne, speaking in a lecture series in 1990 about Māori writing, asked:

> What constitutes "literature" in a culture that has traditionally been based on oral language? Moreover, the body of Māori writing we now have is incomplete because it is largely in English and involves a range of non-Māori forms.[9]

Melbourne commented that it is a common misconception that oral performance represents "a collective cultural heritage and allows no scope for individual invention".[10] He added: "What is important is the relation of the individual composer or writer to the culture as an entire living thing."[11] He used the whare whakairo (carved meeting house) to represent dramatically in Māori terms the place of traditions within the Māori world view: the integration of symbol systems and technologies through which Māori expressed, and express, their sense of the world.

> Let us now approach the whare whakairo. Above the door is the name, Ngā Kōrero Waihanga a Ngā Tipuna. This represents the cultural expressions of the ancestors. The maihi stretch out like open arms of welcome: "Nau mai, haere mai, tomo mai." When you enter the whare whakairo, you remove your shoes at the doorway, thus leaving outside what you have picked up along the way. This symbolizes the act of casting aside the accumulation of foreign material. You enter the house of Māori tradition respectful of the particular culture it represents.
>
> In the centre of the house is the poutokomanawa, the heart pole of Māori tradition. This pole represents the language and its cultural applications and relevancies. It indicates the inseparable connection between the language, the people and their history. We cast our eyes up to the tāhū. From the tāhū, the heke (or rafters) angle down to rest on the top of the poupou (or pillars) along the side walls of the house. The heke represent the knowledge pertaining to the creation of the cosmos. The poupou along the walls represent human ancestors and their interaction with other life-forms and the environment. The decorative art works of kōwhaiwhai, whakairo, and tukutuku represent the various formal devices at the disposal of composers, poets, and/or orators to clothe their ideas in seductive and elaborate styles and flourishes.[12]

In a Parent's Voice section in Book 17, a parent who accompanied the children from an early childhood centre onto a marae, and into the whare whakairo, comments on her son's response to the karanga, the waiata, and the whaikōrero. Her son remembered his koro speaking at a wharenui, reminding us of the role of elders in demonstrating and transmitting traditional symbol systems, genres, and technologies for making and expressing meaning.

Three lenses

Ngā tirohanga e toru

These books on symbol systems and technologies for making meaning employ three lenses to analyse the exemplars:

- a lens focused 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 technologies for making meaning – literacy (oral, visual, and written), mathematics, the arts, and information communication technology (ICT).

An example of assessments using the three lenses

He tauira aromatawai e mahi ana i ngā tirohanga e toru

In Book 4 of this series, "Jak builds a wharenui" is an exemplar of children making a contribution to their own assessment.

Jak builds a wharenui.

Jak approached me in the back room and asked if I could help him build something. We sat down together and talked about what he would like to build. Jak started to put a base down. "What could this be, Maya?" Jak asked me. "I'm not sure, but maybe it's the floor of a building," I replied. "Look around you, Jak. What could this be?"

Jak carefully looked at the pictures on the wall. "I know, it can be a Māori house," he said. "Do you mean a wharenui?" I asked. "Yes," he said, pointing to the photos on the wall. I brought out my book *New Zealand Aotearoa* by Bob McCree. Jak looked through the book. "My wharenui has lots of people, like the picture." Jak used the tall rounded blocks as people. "Why does it have a triangle pointy roof?" Jak asked. I explained to Jak that the wharenui was like a person and the posts on the roof were its back and spine, with lots of bones so it's strong and can stand. Jak continued to ask, "So it's like a skeleton?"

Jak did a lot of problem solving during this learning experience as he had to work out how he was going to balance the "ribs" so they could stand up and be pointed. Jak tried all sorts of blocks and decided to build a tall pile in the middle so that the ribs could lean on them.

Analysis from a lens focused on assessment practices

Jak uses pictures as a reference point against which to assess his construction for himself: he is able to make his own judgment about the quality of his block building. The ambitious design also provides its own evaluation: the roof, delicately balanced to come to a point, doesn't collapse. This is an example of self-assessment. It is also an example of the teacher writing down an occasion when she says "I'm not sure", modelling for Jak that being uncertain is part of the process of learning (and teaching). She includes her own voice here, setting the assessment in the context of the interaction between teacher and learner. The teacher and Jak have recognised the opportunity for the photos on the wall and in the book to add meaning and complexity to Jak's building. The teacher's responses to Jak's questions contribute to the meaning making, and she records the episode so that it can be revisited.

Analysis from a lens based on *Te Whāriki*

This is an exemplar of learning that is distributed across or "stretched" over people, places, and things: the teacher, the place (in this case the photograph of a place), and the things (the blocks). Jak appears to be exploring how three-dimensional objects can be fitted together and moved in space, also ways in which spatial information can be represented in photographs and used as a guide for building. Jak uses analogy (it's like a skeleton) to make sense of the teacher's explanation. This exploration is what architects do and, in this case, what traditional Māori architects do, following the pathways and designs of those who have gone before. It may be that this event will be followed by a trip to a wharenui, or a visit from a Māori elder to explain more about the symbolic nature of the architecture and the whare whakairo, strengthening the view that Jak belongs in a wider bicultural world.

Analysis from a lens focused on symbol systems and technologies for making meaning

As Hirini Melbourne has explained above, exploration of the wharenui is an opportunity to introduce the language and symbolism of whakairo. Here, Jak is calling on an example of written literacy – a book – to add to his knowledge, as well as referring to a photograph on the wall. He asks, "Why does it have a triangle pointy roof?", and the teacher replies in terms of the symbolism of the design rather than the spatial mathematics of architecture; however, Jak is also exploring for himself the strength of a triangle as an element of architecture.

Focusing the lens on assessment practices

He āta titiro ki ngā mahi aromatawai

> Exemplars are examples of assessments that make visible learning that is valued so that the learning community (children, families, whānau, teachers, and beyond) can foster ongoing and diverse learning pathways.[13]

Book 1 of *Kei Tua o te Pae* defines documented and undocumented assessment as noticing, recognising, and responding. The first nine books of *Kei Tua o te Pae* provide some guidelines about what assessment to look for. They are assessments that:

- include clear goals (Book 1, page 9);
- are in everyday contexts (Book 1, page 12);
- protect and enhance the motivation to learn (Book 1, page 13);
- acknowledge uncertainty (Book 1, page 14);
- include the documentation of collective and individual enterprises (Book 1, page 16);
- keep a view of learning as complex (Book 1, page 18);
- follow the four principles of *Te Whāriki* (Book 2);
- are on the pathway towards bicultural assessment (Book 3);
- provide opportunities for the children to contribute to their own assessment (Book 4);
- provide opportunities for family and whānau to participate in the assessment process (Book 5);
- make a difference to: community, competence, and continuity (Books 5, 6, and 7);
- include infants and toddlers (Book 8);
- reflect and strengthen inclusion (Book 9).

Focusing the lens on *Te Whāriki*

A broad definition of the learning of symbol systems and technologies is provided by one of the goals in the *Te Whāriki* Communication/Mana Reo strand: "Children … experience the stories and symbols of their own and other cultures."[14] However, the learning that these four books focus on is not confined to this strand. The Exploration/Mana Aotūroa strand includes becoming competent with a range of tools for pretend, symbolic, or dramatic play. Listening to stories and using books as references are ways in which children learn strategies for active exploration, thinking, and reasoning. Another way is representing ideas and discoveries using creative and expressive media and the technology associated with them. In an exemplar in Book 18, a child, Jake, represents the data from a survey in picture form. Children develop working theories about the world from familiarity with stories from different cultures. Spatial understandings are often derived from maps, diagrams, photographs, and drawings. Children learn to "read" photographs at a very early age. Children learn about Contribution/Mana Tangata and social justice from a range of experiences with symbol systems and technologies, for example, reading stories and allocating "fair" shares using mathematics. Stories frequently encourage discussions about another's point of view. Multiple literacies have a place in the Belonging/Mana Whenua strand. They provide connections with the wider world of family and community, as the above example from Hirini Melbourne illustrates. This is what the rest of the world does – tells stories, makes pictures, writes, reads, uses symbols, maps, numbers, and so on. In Book 20, children use ICT to strengthen these connections: faxes and emails connect them with their families at work. Families send their children's learning stories electronically to extended family across the world.

In Book 5, the exemplar "Sharing portfolios with the wider community" shows how an invitation written to residents in a nearby hospital widens the local community. Learning and being immersed in the cultures' symbol systems and technologies for making meaning can be demanding. It requires a particular capacity to pay attention, maintain concentration, and be involved over time (a feature of the Well-being/Mana Atua strand).

Dimensions of strength

The ways in which assessment contributes to the strengthening and continuity of learning over time are discussed in Book 10. The possible pathways for learning that derive from the principles of *Te Whāriki* have a role to play in these five books as well. The principles (holistic development, relationships, family and community, and empowerment) can provide a guide for identifying dimensions of strength as children become more interested in and involved with literacy, mathematics, the arts, and ICT practices. Possible pathways associated with the use of symbol systems and technologies include:

- stronger integration into recognised patterns, regular events, and social practices ("Flopsy and Mopsy" in Book 17, for example);

- distribution across a widening network of helpful people and enabling resources ("Ezra explores height, balance, measurement and number" in Book 18, for example);

- connection to a greater diversity of social communities ("Rangitoto" in Book 19, for example);

- mindfulness as children begin to take responsibility and develop their own projects ("The photographer at work" in Book 20, for example).

These pathways are discussed on pages 9–10 of Book 10.

Ezra measures Eisak.

Focusing the lens on symbol systems and technologies for making meaning

The sociocultural framework that informs *Te Whāriki* (see Book 2) is a useful perspective for understanding the teaching and learning and assessment of symbol systems and technologies in the early years.[15] Young children learn languages, literacies, symbol systems, and communication technologies by participating in them in a range of family and community contexts (including early childhood settings outside the home), where the purposes and ways of "doing" literacy, mathematics, the arts, and ICT are as varied as the contexts themselves.[16] This view has far-reaching and important consequences for the way we go about assessment for learning because it acknowledges that competence is not just a matter of cognitive ability. Competence is about "access and apprenticeship into institutions and resources, discourses and texts".[17] It also depends on how much the knowledge, skills, and interests children acquire from their families and communities are recognised and valued by educators within early childhood settings. Assessment practices will include making connections with family and whānau.[18] Books 1–9 of *Kei Tua o te Pae* (see especially Book 5) illustrate how narrative assessment can be particularly effective in creating opportunities for families to share their literacy and communication practices with teachers. When family members read stories about practices that involve their child in early childhood settings, they will often be prompted to describe related experiences going on within the family context. They may also let teachers know about the symbol systems and technologies they value.

Daniel and his books.

The exemplars selected for these books have been chosen to reflect a diversity of interests and practices. They are also about assessing children at times when they are active participants in everyday events and real-life situations that are meaningful to them. Wherever possible, narratives that feature the sharing of expectations and practices across contexts such as home and centre have been included. This enrichment of the knowledge in an early childhood setting with "funds of knowledge"[19] from the children's homes contributes to the "noticing, recognising, and responding" process that is formative assessment (see Book 1).

A repertoire of literacy practices

Being a participant in literacy events has been described as participating in a set of roles or practices. Combining a framework set out by Peter Freebody and Allan Luke[20] with ideas from Barbara Rogoff [21] and *Te Whāriki*, we might say that being a participant in the culture's symbol systems and technologies includes the following repertoire of practices (not in any particular order). This repertoire parallels the principles of *Te Whāriki* (community, relationships, holistic development, and empowerment) and the four dimensions of strength outlined in Book 10 and referred to on page 6 above.

Observing and listening in[22]

This is what children do before they begin to actively participate in the activities of the *community*. Ruby is actively involved in going shopping and, at the same time, she is observing an adult making a list.
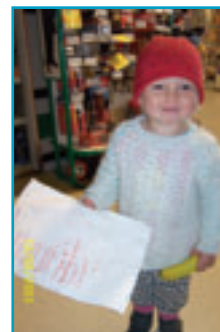
Ruby goes shopping while an adult makes a list.

### Playing with symbol systems and technologies

Children and adults often play with the tools, artefacts, and discourses to do with symbol systems and technologies in order to find out what they can do. (The tools, artefacts, and discourses are the "things" in "responsive and reciprocal *relationships* with people, places, and things"[23].)
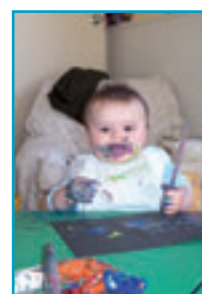
Playing with paint.

Using the symbol systems and technologies for a purpose

Skills are useful in a *holistic*, meaning-making context. This is about noticing, recognising, and using the culture's symbol systems for making meaning. Making meaning includes understanding or breaking the codes – recognising and using the fundamental units, symbols, patterns, and conventions of literacy, mathematics, the arts, and ICT.
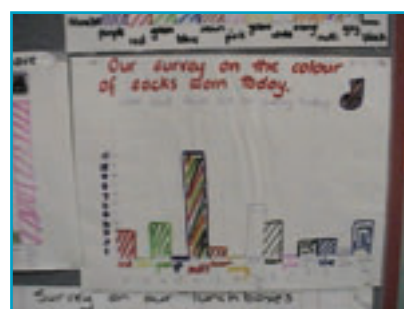
Counting and recording the colour of the children's socks.

Critically questioning or transforming

Critically questioning or transforming the units, the conventions, or the stories of meaning making systems (including inventing units, conventions, or stories, and choosing a tool from among several that might serve the purpose) involves using symbol systems and technologies with competence and agency. Both are actions of *empowerment*, which position children as having a valued viewpoint and being able to make changes.[24]

These processes can be summarised in another metaphor, from James Greeno:[25] to think of the domains of literacy, mathematics, the arts, and ICT as resources in purposeful environments. Greeno comments that "in this metaphor, knowing the domain is knowing your way around in the environment and knowing how to use its resources".[26]

And he adds that "kitchens and workshops are small human-made environments with materials and tools for specialized activities".

Learning to use resources to make things also involves social as well as individual activities. In a kitchen or workshop, a person can learn how to put materials together and perform operations on them (e.g. various mixing operations, different methods of cooking, ways to attach parts, and how to make adjustments and repairs) by helping a more experienced worker, by being shown how to do things and then trying them with coaching by a mentor, or by following written instructions and observing the results.[27]

A kitchen is a small, deliberately constructed environment, developed for solving specific kinds of problems. Although Greeno is writing about an aspect of mathematics – number sense – this metaphor is a useful one for all symbol systems and technologies. The purpose of entering the kitchen, for instance, is not to use the tools, but it might be to make a batch of scones. The tools chosen will be those apparently most useful to complete the task. But the cook needs to be familiar with the tools available to make the choice and may need to be inventive or adaptive when the "right" tool is not available. Sometimes the cook will play with the materials or the tools or the recipes in order to see what they can do. Occasionally someone in the kitchen will watch the cook and decide (perhaps later) to have a go at cooking something similar or to try out the tools. In the exemplar "Preparing a budget and playing with numbers", for instance, a group of children and the teacher are selecting from a catalogue and budgeting for an equipment grant.   This purpose calls on some mathematical tools for its achievement, including symbols (numbers) and a calculator. Lute watches this purposeful activity and later plays with the calculator, writing the numbers that appear on its screen.

1   C. Edwards, L. Gandini, and G. Forman, eds (1998). *The Hundred Languages of Children: The Reggio Emilia Approach – Advanced Reflections*. Westport, CT: Ablex, 2nd ed.

2   C. Rinaldi (2006). *In Dialogue with Reggio Emilia: Listening, Researching and Learning.* London: Routledge, p. 65. *The Hundred Languages of Children* was the name of an exhibition conceived by Loris Malaguzzi. "Since 1981, the Reggio exhibition – 'The Hundred Languages of Children' – has travelled the world, accompanied by speakers from Reggio: in this time, it has had well over a hundred showings in more than 20 countries" (p. 19). Rinaldi asks why this local experience (at Reggio Emilia) has such global appeal. She adds: "The appeal, in part at least, arises from the alterity of Reggio, and the provocation it offers … Reggio speaks to those of us who long for something else, another belonging. It gives comfort and hope by being different, by showing the possibility of different values, different relationships, different ways of living. For example, visitors to Reggio are usually coming home with a strong feeling that children, parents and politicians are really participators in the schools, that Reggio has managed to involve them and created an interest and participatory engagement. To create such an interest, pedagogical documentation has been a fantastic mediator and tool" (p. 19).

3   G. Forman and B. Fyfe (1998). "Negotiated Learning through Design, Documentation, and Discourse". In C. Edwards et al. (1998), op. cit., chapter 13, p. 248.

4   Ministry of Education (2007). *The New Zealand Curriculum for English-medium Teaching and Learning in Years 1–13.* Wellington: Learning Media, p. 12.

5   Barbara Rogoff (2003). *The Cultural Nature of Human Development.* New York: Oxford University Press. Rogoff adds these to literacy and mathematics as "cultural tools for thinking" (p. 258). She writes a chapter about them, together with other conceptual systems and technologies that "support and constrain thinking".

6   Gunther Kress (2003). *Literacy in the New Media Age.* London: Routledge.

7   Susan Hill (2007). "Multiliteracies: Towards the Future". In *Literacies in Childhood*, ed. L. Makin, C. Jones Diaz, and C. McLachlin. Australia: MacLennan and Petty, 2nd ed., p. 56.

8   ibid., p. 57. The references included in this quote are: S. Hill and S. Nichols (2006). "Emergent Literacy: Symbols at Work". In *Handbook of Research on the Education of Young Children*, ed. B. Spodek and O. Saracho. Mahwah, NJ: Lawrence Erlbaum, pp. 153–165; and New London Group (1996). "A Pedagogy of Multiliteracies". *Harvard Educational Review*, vol. 60 no. 1, pp. 66–92. See also N. Hall, J. Larson, and J. Marsh (2003). *Handbook of Early Childhood Literacy.* London: Sage.

9   Hirini Melbourne (1991). "Whare Whakairo: Maori 'Literary' Traditions". In *Dirty Silence: Aspects of Language and Literature in New Zealand*, ed. G. McGregor and M. Williams. Essays arising from the University of Waikato Winter Lecture Series. Auckland: Oxford University Press, p. 129.

10 ibid., p. 137.

11 ibid., p. 137.

12 ibid., p. 134.

13 Early Childhood Learning and Assessment Exemplar Project Advisory Committee and Co-ordinators, 2002.

14 Ministry of Education (1996). *Te Whāriki: He Whāriki Mātauranga mō ngā Mokopuna o Aotearoa/Early Childhood Curriculum.* Wellington: Learning Media, p. 72.

15 ibid. A sociocultural framework has been defined for *Kei Tua o te Pae* by the principles of curriculum and assessment in *Te Whāriki*, the national early childhood curriculum for Aotearoa New Zealand.

16 In a 2003 paper entitled "Opportunity to Learn: A Language-based Perspective on Assessment", *Assessment in Education*, vol. 10 no. 1, pp. 27–46, James Gee makes the following comment about reading and writing:

"Reading and writing in any domain, whether it be law, biology, literary criticism, rap songs, academic essays, Super Hero comics, or whatever, are not just ways of decoding print, they are also caught up with and in social practices. Literacy in any domain is actually not worth much if one knows nothing about the social practices of which the literacy is but a part. And, of course, these social practices involve much more than just an engagement with print … But knowing about a social practice always involves recognising various distinctive ways of acting, interacting, valuing, feeling, knowing, and using various objects and technologies, that constitute the social practice" (pp. 28–29; ellipsis in the original).

17 Allan Luke and Peter Freebody (1999). "A Map of Possible Practices: Further Notes on the Four Resources Model". *Practically Primary*, vol. 4 no. 2, p. 5. See also Peter Freebody and Allan Luke (2003). "Literacy as Engaging with New Forms of Life: The 'Four Roles' Model". In *The Literacy Lexicon*, ed. G. Bull and M. Anstey. Frenchs Forest, NSW: Prentice Hall, 2nd ed., chapter 4, pp. 52–65.

18 Research in Australia that investigated the literacy practices in seventy-nine early childhood services found that even in centres deemed to have high-quality practices, teachers tended to make assumptions about children's home experiences that were based on stereotypes rather than actual knowledge gleaned from the families themselves. See L. Markin, J. Hayden, A. Holland, L. Arthur, B. Beecher, C. Jones Diaz, and M. McNaught (1999). *Mapping Literacy Practices in Early Childhood Services*. NSW: University of Newcastle.

19 L. C. Moll, C. Amanti, D. Neff, and N. Gonzales (1992). "Funds of Knowledge for Teaching: Using a Qualitative Approach to Connect Homes and Classrooms". *Theory into Practice*, vol. 31 no. 2, pp. 132–41; and N. Gonzalez, L. C. Moll, and C. Amanti (2005). *Funds of Knowledge: Theorizing Practices in Households, Communities and Classrooms*. Mahwah, NJ: Lawrence Erlbaum. For a connection with New Zealand research, see C. Jones (2006). "Continuity of Learning: Adding Funds of Knowledge from the Home Environment". *Set: Research Information for Teachers*, no. 2, pp. 28–31.

20 Peter Freebody and Allan Luke (2003, op. cit., p. 56), suggest that "effective literacy in complex print and multimediated societies requires a broad and flexible repertoire of practices. This repertoire we have characterised as a set of 'roles', later 'practices', that participants in literacy events are able to use as a 'resource'". These practices are (not in any particular order): breaking the codes (recognising and manipulating the units); participating in the meanings (for example, composing narratives using the tools, see Leone Burton, 2002); using texts functionally (participating in the social practices, see James Gee, in endnote 16 of this book); and critically analysing and transforming texts (understanding that texts represent viewpoints that can be changed). The Leone Burton (2002) reference is: "Children's Mathematical Narratives as Learning Stories". *European Early Childhood Education Research Journal*, vol. 10 no. 2, pp. 5–18.

21 Barbara Rogoff (2003), op. cit.

22 Barbara Rogoff (2003, op. cit.) includes "observing and listening in", p. 317, as a significant part of "intent participation in ongoing shared endeavours", p. 299.

23 Ministry of Education (1996), op. cit., p. 14.

24 James Greeno writes, "Acting with conceptual agency in a domain means treating the concepts, methods, and information of the domain as resources that can be adapted, evaluated, questioned and modified." In J. G. Greeno (2006). "Authoritative, Accountable Positioning and Connected, General Knowing: Progressive Themes in Understanding Transfer". *The Journal of the Learning Sciences*, vol. 15 no. 4, pp. 537–547.

25 James Greeno (1991). "Number Sense as Situated Knowing in a Conceptual Domain". *Journal for Research in Mathematics Education*, vol. 22 no. 1, pp. 170–218.

26 ibid., p. 175.

27 ibid., p. 176. The metaphor of a kitchen has also been picked up by Schoenfeld in A. H. Schoenfeld (1998). "Making Mathematics and Making Pasta: From Cookbook Procedures to Really Cooking". In *Thinking Practices in Mathematics and Science Learning*, ed. J. G. Greeno and S. V. Goldman. Mahwah, NJ: Lawrence Erlbaum, pp. 299–319.