REFERENCES

Adams, R. & Khoo, S. (1993). *Quest: the interactive test analysis system.* Hawthorn Vic: Australian Council for Educational Research (ACER)

Anton, M. (1999). The discourse of a learner-centred classroom: Sociocultural perspectives on teacher-learner interaction in the second-language classroom. Modern Language Journal, 83 (3), 303-318. (Abstract from ERIC Document Reproduction Service No EJ591 392).

Arievitch, I. & Stetsenko, A. (2000). The quality of cultural tools and cognitive development: Gal'perin's perspective and its implications. *Human Development 43 (2)*, 69-92. Abstract from PsycINFO Database Record 08260-001.

Ashman, A. F. (1992). Process-based instruction: Integrating assessment and instruction. In H. Haywood & D. Tzuriel (Eds.), *Interactive assessment* (pp. 375-395). New York: Springer-Verlag.

Asimov, I. (1969). *Realm of numbers.* London: Gollancz.

Australian Council of Educational Research (A.C.E.R.) (1996-7). *Psychological tests and materials catalogue.* Camberwell, Vic.: Author.

Australian Council of Educational Research (A.C.E.R.) (2001). *Psychological tests and materials catalogue.* http://www.acer.edu.au/acerpress

Australian Education Council (A.E.C.) (1991). *A national statement on Mathematics for Australian schools* Carlton, Vic.: Curriculum Corporation.

Australian Education Council (A.E.C.) (1994). *Mathematics: A curriculum profile for Australian schools.* Carlton, Vic.: Curriculum Corporation.

Banerji, M. (2000). Construct validity of scores/measures from a developmental assessment in mathematics using classical and many-facet Rasch measurement. *Journal of Applied Measurement, 1 (2),* 177-198.

Baroody, A. (1987). *Children's mathematical thinking: A developmental framework for preschool, primary and special education teachers.* New York: Teachers College Press

Bazzini, L. (1993). The teaching/learning process and assessment practice: Two intertwined sides of mathematics education. In M. Niss (Ed.). *Cases of assessment in mathematics education* (pp. 99-106). Netherlands: Kluwer Academic.

Bednarz, N. (1996). Language activity, conceptualization and problem solving: The role played by verbalization in the development of mathematical thought in young children. In H. Mansfield, N. Pateman & N. Bednarz (Eds.), *Mathematics for tomorrow's young children* (pp. 228-239). Netherlands: Kluwer Academic.

Bednarz, N. & Janvier, B. (1988). A constructivist approach to numeration in primary school: Results of a three year intervention with the same group of children. *Educational Studies in Mathematics, 19,* 299-331.

Beesey, C., Clarke, D. & Clarke, B. (1997). Making "on balance" judgements using rich assessment tasks and classroom assessment practices. In N. Scott & H. Hollingsworth (Eds.), *Mathematics: Creating the future: Proceedings of the 16th biennial conference of the Australian Association of Mathematics Teachers* (pp. 47-51). Adelaide: Australian Association of Mathematics Teachers.

Bell, A., Costello, J. & Kuchemann, D. (1983). *A review of research on mathematical education: Part A: Learning and teaching*. London: NFER Nelson.

Bell, J. (1987). *Doing your research project.* Milton Keynes: Open University Press.

Berger, M. (1998). Graphic calculators: An interpretive framework. For the Learning of Mathematics, 18 (2), 13-20. (Abstract from ERIC Document Reproduction Service No. EJ 590 355).

Bergeron, J. C. & Herscovics, N. (1990). The kindergarteners' knowledge of numerals. In G. Booker, P. Cobb & T. N. de Mendicuti (Eds.), *Proceedings of the 14th Psychology in Mathematics Education (PME) conference* (pp. 191-198). Mexico: PME.

Berlak, H. (1992a). The need for a new science of assessment. In H. Berlak, F. Newmann, E. Adams, D. Archbald, T. Burgess, J. Raven & T. Romberg (Eds.), *Toward a new science of educational testing and assessment* (pp. 1-22). Albany, US: State University of New York Press.

Berlak, H. (1992b). Toward the development of a new science of educational testing and assessment. In H. Berlak, F. Newmann, E. Adams, D. Archbald, T. Burgess, J. Raven & T. Romberg (Eds.), *Toward a new science of educational testing and assessment* (pp. 181-206). Albany, US: State University of New York Press.

Bickmore-Brand J. & Gawned, S. (1990). Scaffolding for improved mathematical understanding. In J. Bickmore-Brand (Ed.), *Language in Mathematics* (pp. 43-58). Carlton South, Vic.: Australian Reading Association.

Bidell, T. & Fischer, K. (1992). Beyond the stage debate: Action, structure and variability in Piagetian theory and research. In R. J. Sternberg & C. A. Berg (Eds.), Intellectual development (pp. 100-140). New York: Cambridge University Press.

Biggs, J. B. & Collis, K. F. (1982). *Evaluating the quality of learning: The SOLO Taxonomy (Structure of the Observed Learning Outcome).* New York: Academic Press.

Birenbaum, M. (1996). Assessment 2000: Towards a pluralistic approach to assessment. In M. Birenbaum & F. Dochy (Eds.), *Alternatives in assessment of achievements, learning processes and prior knowledge* (pp. 3-29). Mass.: Kluwer Academic.

Birenbaum, M. & Dochy, F. (Eds.) (1996). *Alternatives in assessment of achievements, learning processes and prior knowledge*. Mass.: Kluwer Academic.

Bishop, A. J., Clements, K., Keitel, C., Kilpatrick, J. & Laborde, C. (Eds.) (1996). *International handbook of mathematics education.* Netherlands: Kluwer Academic.

Björkqvist, O. (1997). Some psychological issues in the assessment of mathematical performance. In E. Pehkonen (Ed.), *Proceedings of the 21st conference of the*

international group for the Psychology of Mathematics Education (PME), 1, (pp. 3-17). Lahti, Finland: PME.

Board of Studies N.S.W. (1994). *English K-6: Syllabus and support document.* North Sydney: Author.

Board of Studies N.S.W. (1998). *Mathematics K-6: Outcomes and indicators.* Sydney: Author.

Bobis, J. (1996). Visualisation and the development of number sense with kindergarten children. In J. Mulligan & M. Mitchelmore (Eds.), *Children's number learning: A research monograph of Mathematics Education Research Group of Australasia and the Australian Association of Mathematics Teachers* (pp. 17-33). Adelaide, South Australia: Mathematics Education Research Group of Australasia/Australian Association of Mathematics Teachers.

Bobis, J. & Gould, P. (1998). The impact of an early number project on the professional development of teachers. In C. Kanes, M. Goos & E. Warren (Eds.) *Teaching mathematics in new times: Proceedings of the twenty-first annual conference of the Mathematics Education Research Group of Australasia (pp. 106-113).* Brisbane, Australia: Griffith University.

Boulton-Lewis, G. (1993). An analysis of the relation between sequence counting and knowledge of place value in the early years of school. *Mathematics Education Research Journal, 5 (2),* 94-106.

Boulton-Lewis, G. (1996). Representations of place value knowledge and implications for teaching addition and subtraction. In J. Mulligan & M. Mitchelmore (Eds.), *Children's number learning: A research monograph of Mathematics Education Research Group of Australasia and the Australian Association of Mathematics Teachers* (pp. 75-88). Adelaide, South Australia: Mathematics Education Research Group of Australasia/Australian Association of Mathematics Teachers.

Boulton-Lewis, G. & Halford, G. (1991). *Analysis of the processing demand of counting and the counting sequence as a predictor of knowledge of place value in the early years of school.* Unpublished paper presented at the Australian Association for Research in Education annual conference, Surfers Paradise: AARE.

Brainard, M. (1997). Assessment as a way of seeing. In A. L. Goodwin, (Ed.), *Assessment for equity and inclusion: Embracing all our children* (pp. 163-179). New York: Routledge.

Bransford, J. Delclos, V., Vye, N., Burns, S. & Hasselbring, T. (1987). Sate of the art and future directions. In C. S. Lidz (Ed.), *Dynamic assessment: An interactional approach to evaluating learning potential* (pp. 479-496). New York: Guilford.

Broadfoot, P. (1996). Assessment and learning: Power or partnership? In H. Goldstein & T. Lewis (Eds.), *Assessment: Problems, developments and statistical issues* (pp. 21-40). West Sussex, England: Wiley.

Brown, A. L., Campione, J. C., Webber, L. S. & McGilly, K (1992) Interactive Learning Environments: A New Look at Assessment and Instruction. In B. R. Gifford & M. C. O'Connor (Eds.), *Changing assessments: Alternative views of aptitude, achievement and instruction* (pp. 121-212). Mass.: Kluwer Academic.

Brozo, W. (1990). Learning how at-risk readers learn best: A case for interactive assessment. *Journal of Reading, April,* 522-527.

Budoff, M. (1987). The validity of learning potential assessment. In C. S. Lidz (Ed.), *Dynamic assessment: An interactional approach to evaluating learning potential* (pp. 52-81). New York: Guilford.

Burton, L. (1996). Assessment of mathematics: What is the agenda? In M. Birenbaum & F. Dochy (Eds.), *Alternatives in assessment of achievements, learning processes and prior knowledge* (pp. 31-61). Mass.: Kluwer Academic.

Butler, J. (1997). *Episodes of meaning making in qualitative method.* Conference paper from the Australian Association of Research in Education. www.swin.edu.au/aare

Cameron, J. & Pierce, W. D. (1994). Reinforcement, reward and intrinsic motivation: A meta-analysis. *Review of Educational Research, 64 (3),* 363-423.

Campbell, C. & Carlson, J. S. (1995). The dynamic assessment of mental abilities. In J. S. Carlson (Ed.), *Advances in cognition and educational practice: European contributions to dynamic assessment, 3,* (pp. 1-31). Connecticut: JAI Press.

Campione, J. C. & Brown, A. L. (1987). Linking dynamic assessment with school achievement. In C. S. Lidz (Ed.), *Dynamic assessment: An interactional approach to evaluating learning potential* (pp 82-115). New York: Guilford.

Campione, J. C., Brown, A. L., Ferrara, R. & Bryant, C. (1984). The zone of proximal development: Implications for individual differences and learning. *New Directions for Child Development, 23,* 77-91.

Carlson, J. S. & Wiedl, K. (1992). The dynamic assessment of intelligence. In H. Haywood & D. Tzuriel (Eds.), *Interactive assessment* (pp. 167-186). New York: Springer.

Carney, J. J. & Cioffi, G. (1992). The dynamic assessment of reading abilities. *International Journal of Disability, Development and Education, 39 (2),* 107-114.

Carpenter, T. P., Fennema, E. & Romberg, T. A. (Eds.) (1993). *Rational numbers: An integration of research.* Hillsdale, NJ: Lawrence Erlbaum.

Carr, K. (1994). Assessment and evaluation in primary Mathematics. In J. Neyland (Ed.), *Mathematics education: A handbook for teachers, 1,* (pp. 202-214). Karori, Wellington NZ: The Wellington College of Education.

Carr, K. (1998). "Why are we assessed in mathematics?": The views of students. In C. Kanes, M. Goos & E. Warren (Eds.) *Teaching mathematics in new times: Proceedings of the twenty-first annual conference of the Mathematics Education Research Group of Australasia (pp. 129-136).* Brisbane, Australia: Griffith University.

Carraher, T. N. & Schliemann, A. D. (1990). Knowledge of the numeration system among pre-schoolers. In L. P. Steffe. & T. Wood, *Transforming children's mathematics education: International perspectives* (pp.135-141). New Jersey: Lawrence Erlbaum.

Casey, D.P. (1978). Failing students: A strategy of error analysis. In P. Costello (Ed.), *Aspects of motivation* (pp. 295-306). Melbourne: Mathematical Association of Victoria.

Chaffey, G. (in progress). The role of dynamic testing in identifying high academic potential in Australian Aboriginal children. PhD research and thesis in progress. Armidale: University of New England.

Chambers, D. (1993). Integrating assessment and instruction. In N. Webb & A. Coxford (Eds.), *Assessment in the mathematics classroom* (pp. 17-25). Reston: National Council of Teachers of Mathematics.

Clarke, D. (1992). The role of assessment in determining mathematics performance. In G. Leder (Ed.), *Assessment and learning of mathematics* (pp. 145-168). Hawthorn, Vic.: Australian Council for Educational Research.

Clarke, D. (1987). A rationale for assessment alternatives in mathematics. *The Australian Mathematics Teacher, 43 (3),* 8-10.

Clarke, D. (1996). Assessment. In A. J. Bishop, K. Clements, C. Keitel, J. Kilpatrick & C. Laborde. (Eds.), *International handbook of mathematics education* (pp. 327-370). Netherlands: Kluwer Academic.

Clarke, D., Clarke, D. & Lovitt, C. (1990). Changes in mathematics teaching: Call for assessment alternatives. In T. Cooney, & C. Hirsch (Eds.), *Teaching and learning mathematics in the 1990s: 1990 Yearbook.* (pp. 118-129). Reston: National Council of Teachers of Mathematics.

Clarke, D., Stephens, M. & Wallbridge, M. (1993). The instructional impact of changes in assessment. In B. Atweh, C. Kanes, M. Carss, & G. Booker (Eds.), *Proceedings of the 16th annual conference of the Mathematics Education Research Group of Australasia* (pp. 177-182). Brisbane: Mathematics Education Research Group of Australasia.

Clarke, D., Sullivan, P., Cheeseman, J. & Clarke, B. (2000). The early numeracy research project: Developing a framework for desceribing early numeracy learning. In J. Bana & A. Chapman (Eds.) *Mathematics education beyond 2000. Proceedings of the 23rd annual conference of the Mathematics Education Research Group of Australasia* (pp.180-187). Fremantle: Mathematics Education Research Group of Australasia.

Clay, M. & Cazden, C. B. (1999). A Vygotskian interpretation of Reading Recovery. In P. Lloyd & C. Fernyhough (Eds.) Lev Vygotsky: Critical assessments: The zone of proximal development, Vol III, (pp. 353-370). Florence, KY: Taylor & Francis/Routledge. (Abstract from ERIC Document Reproduction Service No. 1998-06799-018).

Clements, K. (1980). Analyzing children's errors on written mathematical tasks. *Educational Studies in Mathematics, 11,* 1-21.

Clements, M. A. & Ellerton, N. F. (1995). Short answer and multiple-choice pencil-and-paper tests: Still useful for school mathematics in the 21st century? *Journal of Science and Mathematics Education in Southeast Asia, 18 (2),* 10-23.

Cobb, P. & Steffe, L. (1983). The constructivist researcher as teacher and model builder. *Journal for Research in Mathematics Education, 14 (12),* 83-94.

Cobb, P. & Wheatley, G. (1988). Children's initial understandings of ten. *Focus on Learning Problems in Mathematics, 10 (3),* 1-28.

Cockcroft, W. H. (1982). *Mathematics counts: Report of the committee of inquiry into the teaching of Mathematics in schools.* London: Her Majesty's Stationery Office.

Collins, A., Brown, J. S. & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.), *Knowing, learning, instruction: Essays in honor of Robert Glaser* (pp. 453-494). Hillsdale, NJ: Lawrence Erlbaum.

Collis. K. & Romberg, T. (1991). Assessment of mathematical performance: An analysis of open-ended test items. In M. C. Wittrock & E. L. Baker (Eds.), *Testing and cognition* (pp. 82-130). Englewood Cliffs, NJ: Prentice-Hall.

Commonwealth of Australia (2000). *Numeracy, A priority for all: Challenges for Australian schools.* Canberra: Department of Education, Training and Youth Affairs.

Connolly, A. J. (1988). *KeyMath: A diagnostic inventory of essential mathematics (Rev. ed.).* Circle Pines, Minnesota: American Guidance Service.

Cooney, T., Badger, E. & Wilson, M. (1993). Assessment, understanding Mathematics and distinguishing visions from mirages. In N. Webb & A. Coxford (Eds.), *Assessment in the Mathematics classroom,* (pp. 239-247). Reston: National Council of Teachers of Mathematics.

Cordeiro, P. (1999). Vygotsky in the classroom: An interactionist literacy framework in mathematics. In P. Lloyd & C. Fernyhough (Eds.) Lev Vygotsky: Critical assessments: The zone of proximal development, Vol III, (pp. 353-370). Florence, KY: Taylor & Francis/Routledge. (Abstract from ERIC Document Reproduction Service No. 1998-06799-020).

Das, J. & Conway, R. (1992). Reflections on remediation and transfer: A Vygotskian perspective. In H. Haywood & D. Tzuriel (Eds.), *Interactive assessment* (pp. 94-115). New York: Springer-Verlag.

Day, J. D. (1983). The zone of proximal development. In M. Pressley & J. R. Levin (Eds.), *Cognitive strategy research: Psychological foundations* (pp. 155-175). New York: Springer-Verlag.

Day, J. D. & Cordón, L. A. (1993). Static and dynamic measures of ability: An experimental comparison. *Journal of Educational Psychology, 85 (1).* American Psychological Association.

Day, J. D., Engelhardt, J. L., Maxwell, S. E. & Bolig, E. E. (1997). Comparison of static and dynamic assessment procedures and their relation to independent performance. *Journal of Educational Psychology, 89 (2),* 358-368.

Dehaene, S. (1997). *The number sense: How the mind creates mathematics.* London: Penguin.

Delclos, V., Vye, N., Burns, S., Bransford, J. & Hasselbring, T. (1992). Improving the quality of instruction: Roles for dynamic assessment. In H. Haywood & D. Tzuriel (Eds.), *Interactive assessment* (pp. 317-331). New York: Springer-Verlag.

Denvir, B. & Brown, M. (1986a). Understanding of number concepts in low attaining 7-9 year olds: Part I. Development of descriptive framework and diagnostic instrument. *Educational Studies in Mathematics, 17*,15-36.

Denvir, B. & Brown, M. (1986b). Understanding of number concepts in low attaining 7-9 year olds: Part II. The teaching studies. *Educational Studies in Mathematics, 17,* 143-164.

Department of Education and Science and the Welsh Office (1989). *Mathematics in the national curriculum.* London: Her Majesty's Stationery Office.

Dickson, L., Brown, M. & Gibson, O. (1984). *Children learning mathematics: A teacher's guide to recent research.* Eastbourne, UK: Holt Rinehart & Winston for the Schools Council.

Dienes, Z. P. (1966). *Mathematics in the primary school.* London: Macmillan.

Doig, B. (1994). *Curriculum-embedded assessment in Mathematics.* Hawthorn, Vic.: Australian Council for Educational Research.

Doig, B. (1995a). Mapping conceptual understanding. In I. Livingstone, (Guest Ed.), *Best of Set Assessment. Number Two, Item 3,* Hawthorn, Vic.: New Zealand Council for Educational Research & Australian Council for Educational Research.

Doig, B. (1995b). Analysing qualitative data: Simple steps to stunning results. In S. Groves & R. Tytler (Eds.), *Contemporary approaches to research in mathematics and science education: Conference and symposium proceedings 1* (pp. 96-104). Geelong, Vic.: Deakin University, Centre for Studies in Mathematics, Science and Environmental Education.

Doig B. & G. Masters (1992). Through children's eyes: A constructivist approach to assessing mathematics learning. In Leder, G. (Ed.), *Assessment and learning of mathematics*, Hawthorn, Vic.: Australian Council for Educational Research

Dupree, G. N. (1999). *Mathematical empowerment: A case study of relational classroom learning.* Dissertation Abstracts International Section A: Humanities and Social Sciences, 60 (4-A); 1055. ERIC Document Reproduction Service No. 1999-95019-077.

Durell, C.V. (1936). *General arithmetic for schools.* London: Bell.

Egan, G. (1998). *The skilled helper: A problem-management approach to helping (6th ed).* Pacific Grove, CA: Brooks/Cole.

Ellerton, N. & Clements M. (1997). Pencil-and-paper mathematics tests under the microscope. In F. Biddulph, & K. Carr (Eds.), *People in mathematics education: Proceedings of the 20th annual conference of the Mathematics Education Group of Australasia, 1.* (pp. 155-162). Waikato: Mathematics Education Research Group of Australasia.

Ellerton, N. F. & Clarkson, P.C. (1996). Language factors in mathematics teaching and learning. In A. J. Bishop, K. Clements, C. Keitel, J. Kilpatrick & C. Laborde. (Eds.), *International handbook of mathematics education* (pp. 987-1033). Netherlands: Kluwer Academic.

Embretson, S. E. (1987). Toward development of a psychometric approach. In C. S. Lidz (Ed.), *Dynamic assessment: An interactional approach to evaluating learning potential* (pp. 141-170). New York: Guilford.

Ernest, P. (Ed.). 1989, *Mathematics teaching: The state of the art.* Lewes, East Sussex: Falmer.

Fennema, E. & Franke, M. L. (1992). Teachers' knowledge and its impact. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics* (pp. 575-596). New York: Macmillan.

Feuerstein, R. (1980). *Instrumental enrichment: An intervention program for cognitive development.* Baltimore: University Park Press.

Feuerstein, R., Feuerstein, R. & Gross, S. (1997). The Learning Potential Assessment Device. In D. P. Flanagan, J. L. Genshaft & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests and issues* (pp. 297-313). New York: Guilford.

Feuerstein, R., Rand, Y. & Rynders, J. (1988). *Don't accept me as I am: Helping 'Retarded' people to excel.* New York: Plenum Press.

Feuerstein, R., Miller, R., Rand, Y. & Jensen, M. R. (1981). Can evolving techniques better measure cognitive change? *The Journal of Special Education, 15 (2),* 201-219.

Feuerstein, R., Rand, Y., Jensen, M. R., Kaniel, S. & Tzuriel, D. (1987). Prerequisites for assessment of learning potential: The LPAD model. In C. S. Lidz, *Dynamic assessment : An interactional approach to evaluating learning potential,* (pp. 35-51). New York: Guilford.

Fischer, F. (1990). A part-whole curriculum for teaching number in the kindergarten. *Journal for Research in Mathematical Education, 21 (3),* 207-215.

Fleischner, J. (1994). Diagnosis and assessment of Mathematics learning disabilities. In G. Lyon (Ed.), *Frames of reference for the assessment of learning disabilities: New views of measurement issues* (pp. 441-458). Baltimore, MD: Paul H. Brookes.

Fuson, K. (1990a). Issues in place value and multidigit addition and subtraction learning and teaching. *Journal for Research in Mathematical Education, 21, (4),* 273-280.

Fuson, K. (1990b). Conceptual structures for multiunit numbers: Implications for learning and teaching multidigit addition, subtraction and place value. *Cognition and Instruction, 7,* 343-403.

Fuson, K. (1992). Research on whole number addition and subtraction. In D. A. Grouws (Ed.), *Handbook of Mathematics teaching and learning* (pp. 243-275). New York: Macmillan.

Fuson, K., Wearne, D., Hiebert, J., Murray, H., Human, P., Olivier, A., Carpenter, T. & Fennema, E. (1997). Children's conceptual structures for multidigit numbers and methods of multidigit addition and subtraction. *Journal of Research in Mathematical Education, 28 (2),* 130-162.

Fuson, K., Smith, S. T., & Lo Cicero, A. M. (1997). Supporting Latino first graders' ten-structured thinking in urban classrooms. *Journal for Research in Mathematics Education, 28 (6),* 738-766.

Galbraith, P. (1993). Paradigms, problems and assessment: Some ideological implications. In M. Niss, (Ed.), *Investigations into assessment in mathematics education: An ICMI Study* (pp. 73-86). Dordrecht, Netherlands: Kluwer Academic.

Gall, M. D. & Artero-Boname, M. T. (1995). Questioning. In L. Anderson (Ed.), *International encyclopedia of teaching and teacher education (2nd ed.)* (pp. 242-248). New York: Pergamon.

Gay, S. & Thomas, M. (1993). Just because they got it right, does it mean they know it? In N. Webb & A. Coxford (Eds.), *Assessment in the mathematics classroom* (pp. 130-134). Reston: National Council of Teachers of Mathematics.

Gerber, M., Semmel, D. & Semmel, M. (1994). Computer-based dynamic assessment of multidigit multiplication. *Exceptional Children, 61 (2),* 114-125.

Gerber, R., Williams, M. & Biilmann, O. (1995). Conceptualising qualitative research in curriculum studies: an international study. *Curriculum Studies, 3 (3),* 283-297.

Gettinger, M. (1984). Measuring time needed for learning to predict learning outcomes. *Exceptional Children, 51 (3),* 244-248.

Gifford, B. R. & O'Connor, M. C. (Eds.), (1992). *Changing assessments: Alternative views of aptitude, achievement and instruction.* Mass.: Kluwer Academic.

Gillam, R. B., Pena, E. D. & Miller, L. (1999). Dynamic assessment of narrative and expository discourse. *Topics in Language Disorders, 20 (1),* 33-47.

Ginsburg, H. (1977). *Children's arithmetic: The learning process.* New York: D. Van Nostrand.

Ginsburg, H. P., Jacobs, S. F. & Lopez, L. S. (1993). Assessing mathematical thinking and learning potential in primary grade children. In M. Niss (Ed.), *Investigations into assessment in Mathematics education,* (pp. 157-167). Netherlands: Kluwer Academic.

Gipps, C. (1999). Socio-cultural aspects of assessment. In A. Iran-Nejad & P. D. Pearson (Eds.), *Review of research in education 24,* (pp. 355-392). Washington: American Educational Research Association.

Goldin, G. A. (1993). Observing mathematical problem solving: Perspectives on structured, task-based interviews. In B. Atweh, C. Kanes, M. Carss, & G. Booker (Eds.), *Proceedings of the 16th annual conference of the Mathematics Education Research Group of Australasia* (pp. 303-309). Brisbane: Mathematics Education Research Group of Australasia.

Graue, M. (1995). Connecting visions of authentic assessment to the realities of educational practice. In T. A. Romberg (Ed.), *Reform in school mathematics and authentic assessment* (pp. 260-275). Albany, US: State University of New York Press.

Gredler, M. E. (1997). *Learning and instruction: Theory into practice (3rd ed).* Upper Saddle River, NJ: Merrill.

Greeno, J. G. (1997). On claims that answer the wrong questions. *Educational Researcher, 26 (1),* 5-17.

Grigorenko E. & Sternberg, R. (1998). Dynamic testing. *Psychological Bulletin, 124 (1),* 75-111.

Groth-Marnat, G. (1997). *Handbook of psychological assessment (3rd ed).* New York: Wiley.

Grouws, D. A. (Ed.) (1992). *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics.* New York: Macmillan.

Guthke, J. & Wingenfeld, S. (1992). The learning test concept: Origins, state of the art, and trends (pp. 64-93). In H. Haywood & D. Tzuriel (Eds.), *Interactive assessment.* New York: Springer-Verlag.

Guthke, J., Beckmann J, & Stein, H. (1995). Recent research evidence on the validity of learning tests. In J. Carlson (Ed.), *Advances in cognition and educational practice: European contributions to dynamic assessment, 3* (pp. 117-143). Connecticut: JAI Press.

Halford, G. S. (1993). *Children's understanding: the development of mental models.* Hillsdale, NJ: Lawrence Erlbaum.

Hall, L. T. (1995) *Child cognitive development in an individual or social context? An analysis of the theories of the Troica and Piaget and the implications for education in a changing society.* Unpublished PhD thesis, University of New England, Armidale, Australia.

Hamers, J. H. M. & Sijtsma, K. (1995). Trends in learning potential assessment. In J. Carlson (Ed.), *Advances in cognition and educational practice: European contributions to dynamic assessment, 3.* (pp. 83-116). Connecticut: JAI Press.

Hamers, J. H. M., Hessels, M. G. P. & Tissink, J. (1995). Research on learning potential assessment. In J. Carlson (Ed.), *Advances in cognition and educational practice: European contributions to dynamic assessment, 3* (pp. 145-183). Connecticut: JAI Press.

Haney, M. R. & Evans, J. G. (1999). National survey of school psychologists regarding use of dynamic assessment and other nontraditional assessment techniques. *Psychology in the Schools, 36 (4),* 295-304.

Hart, K. (1981). *Children's understanding of mathematics: 11-16.* London: John Murray.

Hart, K. (1989). Place value: Subtraction. In K. Hart, D. C. Johnson, M. Brown, L. Dickson & R Clarkson (Eds.), *Children's mathematical frameworks 8-13: A study of classroom teaching* (pp. 8-45). Windsor, UK: NFER Nelson.

Harvey, F. A. & Charnitski, C. W. (1998). Improving mathematics instruction using technology: A Vygotskian perspective. In *Proceedings of selected research and development presentations at the National Conventional of the Association for Educational Communications and Technology,* St Louis, MO. ERIC Document Reproduction Service No. ED 423 837.

Harvin, V. R. (1984). *When do children understand the concept of place value?* ERIC Document Reproduction Service No. ED 244 821.

Hattie, J., Jaeger, R. M. & Bond, L. (1999). Persistent methodological questions in educational testing. *Review of Research in Education, 24,* 393-446.

Haywood, H. & Tzuriel, D. (Eds.) (1992). *Interactive assessment.* New York: Springer-Verlag.

Haywood, H. & Wingenfeld, S. (1992). Interactive assessment as a research tool. *The Journal of Special Education, 26 (3),* 253-268.

Haywood, H., Brown, A. & Wingenfeld, S. (1990). Dynamic approaches to psycho-educational assessment. *School Psychology Review, 19 (4),* 411-422.

Henning-Stout, M. (1994). *Responsive assessment: A new way of thinking about learning.* San Francisco: Jossey-Bass.

Herrington, T., Sparrow, L. Herrington, J & Oliver R. (1997). *Investigating assessment strategies in Mathematics classrooms: a CD-ROM resource enabling teachers to explore assessment teaching strategies in mathematics education.* Perth, Western Australia: Edith Cowan University.

Heuvel-Panhuizen, M. van den, & Gravemeijer, K. (1993). Tests Aren't All Bad: An attempt to change the face of written tests in primary school mathematics instruction. In Webb, N. & A. Coxford, *Assessment in the Mathematics classroom* (pp. 54-64). Reston: National Council of Teachers of Mathematics.

Hiebert, J. (Ed.) (1986). *Conceptual and procedural knowledge: The case of Mathematics.* NJ: Lawrence Erlbaum.

Hiebert, J. A. (1993). Benefits and costs of research that links teaching and learning mathematics. In T. P. Carpenter, E. Fennema & T. A. Romberg (Eds.), *Rational numbers: An integration of research* (pp. 219-238). Hillsdale, NJ: Lawrence Erlbaum.

Hiebert, J. & Carpenter, T. P. (1992). Learning and teaching with understanding. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 65-97). New York: Macmillan.

Hiebert, J. & Wearne, D. (1992). Links between teaching and learning place value with understanding in first grade. *Journal of Research in Mathematics Education, 23 (2),* 75-86.

Hoy, C. & Gregg, N. 1994). *Assessment: The special educator's role.* Pacific Grove, CA: Brooks/Cole.

Huinker, D. (1993). Interviews: A window to students' conceptual knowledge of the operations. In N. Webb & A. Coxford (Eds.), *Assessment in the Mathematics classroom* (pp. 80-86). Reston: National Council of Teachers of Mathematics.

Hunting, R. & Doig, B. (1992). Development of a clinical tool for initial assessment of a student's mathematical learning. In M. Stephens, & J. Izard (Eds.), *Reshaping assessment practices: Mathematics assessment under challenge. Proceedings from the 1st national conference on assessment in the mathematical sciences,* Geelong, Victoria, 20-24 November, (pp. 201-217). Hawthorn, Vic.: Australian Council for Educational Research.

Izard, J. (1993). Challenges to the improvement of assessment practice. In M. Niss (Ed.), *Investigations into assessment in mathematics education* (pp. 185-194). Netherlands: Kluwer Academic.

Jensen, R. J. (Ed.) (1993). *Research ideas for the classroom: Early childhood mathematics.* US: National Council of Teachers of Mathematics/ Macmillan.

Jensen, M. R. & Feuerstein, R. (1987). The learning potential assessment device: From philosophy to practice. In C. S. Lidz (Ed.), *Dynamic Assessment: An interactional approach to evaluating learning potential* (pp.379-402). New York: Guilford.

Jitendra, A. K. & Kameenui, E. J. (1993). Dynamic assessment as a compensatory assessment approach: A description and analysis. *Remedial and Special Education, 14 (5),* 6-18. Austin, TX: Pro-Ed.

Jitendra, A. K. & Kameenui, E. J. (1996). Experts' and novices' error patterns in solving part-whole mathematical word problems. *Journal of Educational Research, 90 (1),* 42-51.

Johansson, B. (1993). Diagnostic assessment in mathematics. In M. Niss (Ed.), *Investigations into assessment in mathematics education: An ICMI Study* (pp. 169-184). Netherlands: Kluwer Academic.

Jones, G. & Thornton, C. (1993). Vygotsky revisited: Nurturing young children's understanding of number. *Focus on Learning Problems in Mathematics, 15 (2 & 3),* 18-28. Centre for Teaching/Learning of Mathematics.

Jones, G., Thornton, C. & Putt, I. (1994). A model for nurturing and assessing multidigit number sense among first grade children. *Educational Studies in Mathematics, 27,* 117-143. Netherlands: Kluwer Academic.

Jones, G., Thornton, C. & Van Zoest, L. (1992). *First grade children's understanding of multi-digit numbers.* Paper prepared for the American Educational Research Association annual meeting April 20-24. San Francisco, California.

Jones, G., Thornton, C., Putt, I., Hill, K., Mogill, A., Rich, B. & Van Zoest, L. (1996). Multidigit number sense: A framework for instruction and assessment. *Journal for Research in Mathematics Education, 27 (3),* 310-336.

Kamii, C. (1986). Place value: An explanation of its difficulty and educational implications for the primary grades. *Journal of Research in Childhood Education, 1 (2),* 75-86.

Kamii, C. (1988). Teaching place value and double column addition. *Arithmetic Teacher, 35 (6),* 48-52.

Kamii, C. (1989). *Young children continue to reinvent arithmetic, 2nd grade.* New York: Teachers College Press.

Kamii, C. (1990). Constructivism and beginning arithmetic (K-2). In T. J. Cooney & C. Hirsch (Eds.), *Teaching and learning mathematics in the 1990s: 1990 Yearbook* (pp. 22-30). Reston: National Council of Teachers of Mathematics.

Kamii, C. & De Clark, G. (1985). *Young children reinvent arithmetic: Implications of Piaget's theory.* New York: Teachers College Press.

Kamii, C. & De Vries, R. (1976). *Piaget, children and number: Applying Piaget's theory to the teaching of elementary number.* Washington, DC: National Association for the Education of Young Children.

Kanes, C., Goos, M. & Warren, E. (1998). *Teaching mathematics in new times: Proceedings of the twenty-first annual conference of the Mathematics Education Research Group of Australasia.* Brisbane, Australia: Griffith University.

Karabatsos, G. (2000). A critique of Rasch residual fit statistics. *Journal of Applied Measurement, 1 (2),* 152-176.

Karpov, Y. V. & Haywood, H. C. (1998). Two ways to elaborate Vygotsky's concept of mediation: Implications for instruction. *American Psychologist, 53 (1),* 27-36. American Psychological Association.

Keane, K. J. (1987). Assessing deaf children. In C. S. Lidz (Ed.), *Dynamic assessment: An interactional approach to evaluating learning potential* (pp. 360-378). New York: Guilford.

Keeves, J. P. (1999). Overview of issues in educational research. In J. P. Keeves & G. Lakomski (Eds.), *Issues in educational research* (pp. 3-14). Oxford, UK: Pergamon.

Kilpatrick, J. (1992). A history of research in mathematics education. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 3-32). New York: Macmillan.

Kimmel, A. J. (1988). Ethics and values in applied social research. Newbury Park, CA: Sage.

Kirschenbaum, R. J. (1998). Dynamic assessment and its use with underserved gifted and talented populations. *Gifted Child Quarterly, 42 (3),* 140-147.

Klein, P. S. (1992). Assessing cognitive modifiability of infants and toddlers: Observation based on mediated learning experience. In H. Haywood & D Tzuriel (Eds.), *Interactive assessment* (pp. 233-250). New York: Springer-Verlag.

Kletzien S. & Bednar, M. (1990). Dynamic assessment for at-risk readers *Journal of Reading, 33 (7),* 528-533.

Koehler, M. S. & Grouws, D. A. (1992). Mathematics teaching practices and their effects. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 115-126). New York: Macmillan.

Kroll, D. (1989), Connections between psychological learning theories and the elementary Mathematics curriculum. In P. Trafton & A. Shutle (Eds.), *New directions for elementary school mathematics. 1989 Yearbook.* (pp. 199-211). Reston: National Council of Teachers of Mathematics.

Kulm, G. (1980). Research on mathematics attitudes. In R. J. Shumway (Ed.), *Research in Mathematics education* (pp. 356-387). Reston: National Council of Teachers of Mathematics.

Kulm, G. (1990). *Assessing higher order thinking in mathematics.* Washington: American Association for the Advancement of Science.

Labinowicz, E. (1985). *Learning from children: New beginnings for teaching numerical thinking.* California: Addison Wesley.

Lange, J. de (1995). Assessment: No change without problems. In T. Romberg, (Ed.), *Reform in school mathematics and authentic assessment* (pp. 87-172). Albany US: State University of New York Press.

Lajoie, S. (1995). A framework for authentic assessment in mathematics. In T. Romberg (Ed.), *Reform in school mathematics and authentic assessment* (pp. 19-37). Albany, US: State University of New York Press.

Lawson, M. & Rice, D. (1986). *Thinking aloud: Analysing students' mathematics performance.* Paper presented at the 11th national conference of the Australian Association of Special Education. Adelaide: Institute for the Study of Learning Difficulties, South Australian College of Advanced Education.

LeCompte, M. D. & Goetz, J. P. (1982). Problems of reliability and validity in ethnographic research. *Review of Educational Research, 52 (1)*, 31-60.

LeCompte, M. D. & Preissle, J. (1993). *Ethnography and qualitative design in educational research (2nd ed.).* San Diego: Academic Press.

Leder, G. & Forgasz, H (1997). Looking back towards the future: A case study in Mathematics. In F. Biddulph, & K. Carr (Eds.), *People in Mathematics education: Proceedings of the twentieth annual conference of the Mathematics Education Group of Australasia 1,* (pp. 302-309). Waikato: Mathematics Education Research Group of Australasia.

Lee, V. (Ed.) (1990). *Children's learning in school.* London: Hodder and Stoughton.

Lee, C. D. & Smagorinsky, P. (Eds.) (2000). *Vygotskian perspectives on literacy research: Constructing meaning through collaborative inquiry* (pp. 1-18). Cambridge, UK: Cambridge University Press.

Lidz, C. S. (Ed.) (1987). *Dynamic Assessment: An interactional approach to evaluating learning potential.* New York: Guilford.

Lidz, C. S. (1991). *Practitioner's guide to dynamic assessment.* New York: Guilford.

Lidz, C. S. (1997). Dynamic Assessment approaches. In D. P. Flanagan, J. L. Genshaft & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests and issues* (pp. 281-295). New York: Guilford.

Lidz, C. S. & Greenberg K. (1997). Criterion validity of a group dynamic assessment procedure with rural first grade regular education students. *Journal of Cognitive Education, 6 (2),* 89-99.

Lidz, C. S. & Macrine, S. L. (2001). An alternative approach to the identification of gifted and linguistically diverse learners: The contribution of dynamic assessment. *School Psychology International, 22 (1),* 74-96.

Lidz, C. S. & Thomas, C. (1987). The preschool learning assessment device: Extension of a static approach. In C. S. Lidz (Ed.) (1987). *Dynamic Assessment: An interactional approach to evaluating learning potential.* New York: Guilford.

Lieberman, M. (1981). *The development of children's understanding on numerical representation. Final Report.* ERIC Document Reproduction Service No. ED 230 410.

Linacre, J. M. (1995). *The Effect of Misfit on Measurement.* Paper presented at the annual meeting of the International Objective Measurement Workshop. Berkeley, CA.

Luria, A. R. (1987). Afterword to the Russian edition. In L. S. Vygotsky, *The collected works of L. S. Vygotsky Vol. 1 Problems of General Psychology* (pp. 359-373). R. W. Rieber & A. S Carton (Eds.) & N. Minick, (Trans.) New York: Plenum Press.

Madaus, G. & Kellaghan, T. (1993). The British experience with authentic testing. *Phi Delta Kappan, 74 (6),* 458-466.

Malone, J. & Ireland, D. (1996). Constructivist research on teaching and learning mathematics. In P. Sullivan, K. Owens & B. Atweh, (Eds.), *Research in mathematics education in Australasia 1992-1995* (pp. 119-133). Campbelltown, Australia: Mathematics Education Research Group of Australasia.

Mansfield, H., Pateman, N & Bednarz, N. (Eds.) (1996). *Mathematics for tomorrow's young children.* Netherlands: Kluwer Academic.

Martin, K. & Reynolds, S. (1993). Veteran and rookie teachers: A stereoptic vision of learning in mathematics. *Journal of Teacher Education, 44 (4),* 245-253.

Mason, J. & Waywood, A. (1996). The role of theory in mathematics education and research. In A. J. Bishop, K. Clements, C Keitel, J. Kilpatrick, & C. Laborde (Eds.), *International handbook of mathematics education* (pp. 1055-1089). Netherlands: Kluwer Academic.

Masters, G. N. & Doig, B. (1992). Understanding children's mathematics: Some assessment tools. In G. C. Leder (Ed.), *Assessment and learning of Mathematics* (pp. 249-268). Hawthorn, Vic.: Australian Council for Educational Research.

Maxwell, J. (1989). Mathephobia. In P. Ernest (Ed.), *Mathematics teaching: The state of the art* (pp. 221-228). Barcombe, UK: Falmer Press.

Maxwell, J. A. (1996). *Qualitative research design: An interactive approach.* Thousand Oaks, CA: Sage.

McKay, D. (n.d.) *Cognitive psychology and the school counsellor: The challenge of assessment.* Unpublished paper distributed to N.S.W. Department of Education school counsellors.

McLeod, D. (1992). Research on affect in mathematics education: A reconceptualization. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics* (pp. 575-596). New York: Macmillan.

Mearig, J. S. (1987). Assessing the learning potential of kindergarten and primary-age children. In C. S. Lidz (Ed.), *Dynamic assessment: An interactional approach to evaluating learning potential* (pp. 237-267). New York: Guilford.

Measor, L. (1985). Interviewing: A strategy in qualitative research. In R. G. Burgess (Ed.), *Strategies of educational research* (pp. 55-78). London: Falmer Press.

Meltzer, L. (1994). Assessment of learning disabilities: The challenge of evaluating the cognitive strategies and processes underlying learning. In G. Lyon (Ed.),

Frames of reference for the assessment of learning disabilities: New views of measurement issues (pp 571-606). Baltimore, Maryland: Paul H. Brookes.

Meyers, J. (1987). The training of dynamic assessors. In C. S. Lidz (Ed.), *Dynamic assessment: An interactional approach to evaluating learning potential* (pp. 403-425). New York: Guilford.

Minichiello, V., Axford, R., Greenwood, K. & Sullivan, G. (Eds.) (1999), *Handbook for research methods in health sciences* Frenchs Forest, Australia: Pearson Education Australia.

Minick, N. (1987a). Implications of Vygotsky's theories for dynamic assessment. In C. S. Lidz (Ed.), *Dynamic assessment: An interactional approach to evaluating learning potential* (pp. 116-140). New York: Guilford.

Minick, N. (1987b). The development of Vygotsky's thought: An introduction. In L. S. Vygotsky, *The collected works of L. S. Vygotsky Vol. 1 Problems of General Psychology* (pp. 17-36). R. W. Rieber & A. S Carton (Eds.) & N. Minick, (Trans.) New York: Plenum Press.

Mitchelmore, M. & Mulligan, J. (1996). Introduction. In J. Mulligan & M. Mitchelmore (Eds.), *Children's number learning: A research monograph of Mathematics Education Research Group of Australasia and the Australian Association of Mathematics Teachers* (pp.1-14). Adelaide, South Australia: Mathematics Education Research Group of Australasia/Australian Association of Mathematics Teachers.

Miura, I. (1987). Mathematics achievement as a function of language. *Journal of Educational Psychology, 79 (1),* 79-82.

Miura, I. & Okamoto, Y. (1989). Comparisons of U.S. and Japanese first graders' cognitive representation of number and understanding of place value. *Journal of Educational Psychology, 81 (1),* 109-113.

Miura, I., Okamoto, Y., Kim, C., Steere M. & Fayol, M. (1993). First graders' cognitive representation of number and understanding of place value: Cross national comparisons- France, Japan, Korea, Sweden, and the United States. *Journal of Educational Psychology, 85 (1),* 24-30.

Montero, I. & Huertas, J. A. (1999). *The motivational function of private speech in young children.* Poster presented at the annual meeting of the American Educational Research Association. Montreal, Canada. (ERIC Document Reproduction Service No. ED 433 137)

Morgan, C. (1996). Language and assessment issues in mathematics education. In L. Puig, & A. Gutierrez (Eds.), *Proceedings of the twentieth conference of the International Group for the Psychology of Mathematics Education, 20 (4),* 19-26. Valencia, Spain: PME.

Mulligan, J. (1991). *An analysis of children's solutions to multiplication and division word problems.* Unpublished PhD Thesis, Sydney, Macquarie University.

Mulligan, J. & Mitchelmore, M. (Eds.) (1996). *Children's number learning: A research monograph of Mathematics Education Research Group of Australasia and the Australian Association of Mathematics Teachers.* Adelaide, South Australia: Mathematics Education Research Group of Australasia/ Australian Association of Mathematics Teacher.

Mulligan, J., Bobis, J. & Francis, C. (1999). Insights into early numeracy: The Count Me In Too project. *Australian Primary Mathematics Classroom, 4 (1),* 22-26.

Mulligan, J., Mitchelmore, M., Outhred L., & Bobis, J. (1996). Children's representations and conceptual understanding of number. In P. E. Clarkson (Ed.), *Technology in mathematics education: Proceedings of the 19th annual conference of the Mathematics Education Research Group of Australasia* (pp. 406-413). Melbourne: Mathematics Education Research Group of Australasia.

Murray, H. & Olivier, A. (1989). A model of understanding two-digit numeration and computation. *Proceedings of the Psychology of Mathematics Education Conference, 13 (3),* 3-10.

National Council of Teachers of Mathematics, (N.C.T.M.) (1989). *Curriculum and evaluation standards for school mathematics.* Reston: Author.

National Council of Teachers of Mathematics, (N.C.T.M.) (2000). *Principles and standards for school mathematics.* Reston: Author.

National Project on the Quality of Teaching and Learning (1996). *National competency framework for beginning teaching.* Leichhardt, Australia: Australian Teaching Council.

National Research Council (1989). *Everybody counts.* Washington, DC: National Academy Press.

Neuman, D. (1994). Five fingers on one hand and ten on the other. In J. P. da Ponte & J. F. Matos (Eds.), *Proceedings of the 18th international conference for the Psychology of Mathematics Education, 3,* 352-359. Lisbon, Portugal: PME.

Newman, D., Griffin, P. & Cole, M. (1989). *The construction zone: Working for cognitive change in school.* Cambridge: Cambridge University Press.

Newmann, F. & Archbald, D. (1992). The nature of authentic academic achievement. In H. Berlak, F. Newmann, E. Adams, D. Archbald, T. Burgess, J. Raven & T. Romberg (Eds.), *Toward a new science of educational testing and assessment* (pp. 71-83). Albany, US: State University of New York Press.

Niss, M. (1993). *Assessment in mathematics and its effects: Investigations into assessment in mathematics education. An ICMI Study* (pp. 3-30). Netherlands: Kluwer Academic.

Norwood, K. S. & Carter, G. (1994). Journal writing: An insight into students' understanding. *Teaching Children Mathematics, 1 (3),* 146-148.

N.S.W. Department of Education (1989). *Mathematics K-6.* Sydney: Author.

N.S.W. Department of Education and Training (1999). *Count me in too: Professional development package.* Ryde, Australia: Curriculum Support Directorate.

N.S.W. Department of School Education (1996). *Principles for assessment and reporting in N.S.W. government schools.* Ryde, Sydney: Assessment and Reporting Directorate.

O'Connor, M. C. (1992). Overview: Rethinking aptitude, achievement and instruction: Cognitive science research and the framing of assessment policy. In B. R. Gifford & M. C. O'Connor (Eds.), *Changing assessments: Alternative views of aptitude, achievement and instruction* (pp. 9-36). Mass:, Kluwer Academic.

Payne, J. N. & Huinker, D. M. (1993). Early number and numeration. In R. J. Jensen, *Early childhood research ideas for the classroom* (pp. 43-70). Reston: National Council of Teachers of Mathematics/Macmillan.

Pegg, J. & Davey, G. (1998). Interpreting student understanding in geometry: A synthesis of two models. In R. Lehrer & D. Chazan (Eds.), *Designing learning environments for developing understanding of geometry and space* (pp. 109-135). Mahwah, NJ: Lawrence Erlbaum.

Pellegrino, J. (1992). Commentary: Understanding what we measure and measuring what we understand. In B. Gifford & M. O'Connor (Eds.), *Changing assessments: Alternative views of aptitude, achievement and instruction*, (pp. 275-300). Mass.: Kluwer Academic.

Pellegrino, J. W., Baxter, G. P. & Glaser, R. (1999). Addressing the "Two Disciplines" problem: Linking theories of cognition and learning with assessment and instructional practice. *Review of Research in Education, 24*, 307-353.

Pengelly, H. (1990). Mathematical learning beyond the activity. In L. P. Steffe & T. Wood (Eds.), *Transforming children's mathematics education: International perspectives* (pp. 357-376). Hillsdale NJ: Lawrence Erlbaum.

Perry, R., Mulligan, J. & Wright, R. (1992). Research on early childhood mathematical development. In B. Atweh, & J. Watson (Eds.), *Research in mathematics education in Australasia 1988-1991* (pp.180-207). Brisbane: Mathematics Education Research Group of Australasia.

Peters, S. (1997). The relationship between the place value understanding of seven-year-old children and the strategies that they use to solve written addition problems. In F. Biddulph, & K. Carr (Eds.), *Proceedings of the 20th annual conference of the Mathematics Education Research Group of Australasia* (pp. 397-405). Aotearoa, NZ: Mathematics Education Research Group of Australasia.

Piaget, J. (1952). *The child's conception of number* (Translation of 1941 French version). London: Routledge and Kegan Paul.

Pimm, D. (1996). *Symbols and meanings in school mathematics.* London: Routledge

Pirie, S. (1989). Classroom-based assessment. In P. Ernest (Ed.), *Mathematics teaching: The state of the art* (pp. 47-55). Lewes, East Sussex: Falmer.

Price, P. (1997). The potential of computer manipulatives for overcoming place value misconceptions. In F. Biddulph, & K. Carr (Eds.), *Proceedings of the 20th annual conference of the Mathematics Education Research Group of Australasia* (pp. 414-421). Aotearoa, NZ: Mathematics Education Research Group of Australasia.

Price, P. (1998). Year 3 students' place-value misconceptions: Another look at MAB. In C. Kanes, M. Goos & E. Warren (Eds.) *Teaching mathematics in new times: Proceedings of the 21st annual conference of the Mathematics Education Research Group of Australasia* (pp. 452-459). Brisbane, Australia: Griffith University.

Punch, K. F. (1998). *Introduction to social research: Quantitative and qualitative approaches.* London: Sage.

Ransley, W. (1980). Distinctive aspects of diagnosis and prescription in mathematics for children with special needs. *Australian Journal of Special Education, 4 (2),* 34-39.

Raven, J. (1992). A model of competence, motivation, and behaviour, and a paradigm for assessment. In H. Berlak, F. Newmann, E. Adams, D. Archbald, T. Burgess, J. Raven & T. Romberg (Eds.) *Toward a new science of educational testing and assessment* (pp. 85-116). Albany, US: State University of New York Press.

Redden, E. (1995). *A longitudinal investigation into children's understanding of number patterns and the consequent emergence of algebraic concepts.* Unpublished PhD thesis, University of New England, Armidale, Australia.

Reddy, E. J. (1996). *Mathematics lessons: A smorgasbord of emotions.* Unpublished Masters thesis, University of New England, Armidale, Australia.

Reisman, F. (1982). *A guide to the diagnostic teaching of arithmetic (3rd ed).* Columbus, Ohio: Charles Merrill.

Renshaw, P. (1996). A sociocultural view of the mathematics education of young children. In H. Mansfield, N. Pateman & N. Bednarz (Eds.), *Mathematics for tomorrow's young children* (pp. 59-77). Netherlands: Kluwer Academic.

Resnick, L. (1983). A developmental theory of number understanding. In H. Ginsburg (Ed.), *The development of mathematical thinking.* (pp. 109-151). New York: Academic Press.

Resnick, L. B. (1984). Beyond error analysis: The role of understanding in elementary school arithmetic. In H. N. Cheek (Ed.), *Diagnostic and prescriptive mathematics: Issues, ideas and insights* (pp. 2-14). Kent, OH: Research Council for Diagnostic and Prescriptive Mathematics.

Resnick, L. B. (Ed.) (1989). *Knowing, learning, and instruction.* Hillsdale, NJ: Lawrence Erlbaum.

Resnick, L. & Resnick, D. (1992). Assessing the thinking curriculum: New tools for educational reform. In B. Gifford & M. O'Connor (Eds.), *Changing assessments: Alternative views of aptitude, achievement and instruction* (pp. 37-76). Mass.: Kluwer Academic.

Reys, R. E., Lindquist, M. M., Lambdin, D. V., Smith, N. L. & Suydam, M. N. (2001). *Helping children learn mathematics (6th ed.).* New York: Wiley.

Ridgway, J. & Passey, D. (1993). An international view of mathematics assessment. In M. Niss (Ed.), *Investigations into assessment in mathematics education* (pp. 57-72). Netherlands: Kluwer Academic.

Rogoff, B. (1990). The joint socialisation of development by young children and adults. In V. Lee (Ed.), *Children's learning in school* (pp. 41-58). London: Hodder and Stoughton.

Rogoff, B & Wertsch, J. V. (Eds.) (1984). *Children's learning in the "Zone of Proximal Development"* New Directions for Child Development Series. San Francisco: Jossey-Bass.

Romberg, T. (1993). How one comes to know: Models and theories of the learning of mathematics. In M. Niss (Ed.), *Investigations into assessment in mathematics education* (pp. 108-109). Netherlands: Kluwer Academic.

Romberg, T. (Ed.) (1995). *Reform in school mathematics and authentic assessment.* Albany, US: State University of New York Press.

Romberg, T. & Wilson L. (1995). Issues related to the development of an authentic assessment system for school mathematics. In T. A. Romberg. (Ed.), *Reform in school mathematics and authentic assessment* (pp. 1-18). Albany US: State University of New York Press.

Romberg, T., Zarinnia, E. & Collis, K. (1990). A new world view of assessment in mathematics. In G. Kulm (Ed.), *Assessing higher order thinking in mathematics* (pp. 21-38). Washington: American Association for the Advancement of Science.

Ross, S. H. (1986). *The development of children's place-value numeration concepts in grades two through five.* Paper presented at the annual meeting of the American Educational Research Association. San Francisco.

Ross, S. H. (1989). Parts, wholes and place value: A developmental view. *Arithmetic Teacher, 36 (6),* 47-51.

Ross, S. H. (1990). Children's acquisition of place value numeration concepts: The roles of cognitive development and instruction. *Focus on Learning Problems in Mathematics, 12 (1),* 1-17. US: Centre for Teaching/Learning of Mathematics.

Rowntree, D. (1987). *Assessing students: How shall we know them?* London: Kogan Page.

Rubin, A. & Russell, S. J. (1992). Children's developing concepts of landmarks in the number system. In W. Geeslin & K. Graham (Eds.), *Proceedings of the 16th Psychology of Mathematics Education Conference, III,* 136. Durham, NH, University of New Hampshire: PME.

Samuels, M., Lamb, C. & Oberholtzer, L. (1992). Dynamic assessment of adults with learning difficulties. In H. Haywood & D. Tzuriel (Eds.), *Interactive assessment* (pp. 275-299). New York: Springer-Verlag.

Sattler, J. (1992). *Assessment of children (3rd ed.).* San Diego: Author.

Schleiger, H. E. (1993). *Diagnostic mathematical tasks (Rev. ed. by J. Gough).* Geelong Australia: Deakin University Press.

Scott, P. (1998). Teacher talk and meaning making in science classrooms: A Vygotskian analysis and review. Studies in Science education, 32, 45-80. (Abstract from ERIC Document Reproduction Service No. EJ 584 561)

Seng, S. (2000). *Teaching and learning primary mathematics in Singapore.* Paper presented at the annual international conference and exhibition of the Association for Childhood Education international. Baltimore, MD. ERIC Document Reproduction Service No. ED 439 812.

Sewell, T. E. (1987). Dynamic assessment as a nondiscriminatory procedure. In C. S. Lidz (Ed.), *Dynamic assessment: An interactional approach to evaluating learning potential* (pp. 426-443). New York: Guilford.

Shavelson, R. J., Gao, X., & Baxter, G. P. (1996). On the content validity of performance assessments: Centrality of domain specification. In M. Birenbaum

& F. Dochy (Eds.), *Alternatives in assessment of achievements, learning processes and prior knowledge* (pp. 131-141). Mass: Kluwer Academic.

Shepard, L. (1989). Why we need better assessments, *Educational Leadership, 46 (7)*, 4-9.

Shepard, L. (2000). The role of assessment in a learning culture. *Educational Researcher, [online] 29 (7), October.* Available http://www.aera.net/pubs/er/arts/29-07/shep07.htm

Shepardson, D. P. (1999). Learning science in a first grade science activity: A Vygotskian perspective. *Science Education, 83 (5)*, 621-638.

Shurin, R. (1999). *Concurrent and discriminant validity of a dynamic assessment procedure with special needs and typical preschool children.* ERIC Document Reproduction Service No. 435 681.

Sierink, T. (1989). *Place value in the primary school.* Unpublished B.Ed (Hons) thesis. University of Tasmania, Australia.

Sierink, T. & Watson, J. M. (1991), Children's understanding of place value. *Australian Journal of Early Childhood, 16 (4)*, 33-42.

Silver, E. & Kenney, P. (1995). Sources of assessment information for instructional guidance in mathematics. In T. Romberg (Ed.), *Reform in school mathematics and authentic assessment* (pp. 38-86). Albany, US: State University of New York Press.

Sinclair, A. & Scheuer, N. (1993). Understanding the written number system: 6 Year-olds in Argentina and Switzerland. *Educational Studies in Mathematics, 24*, 199-221. Netherlands: Kluwer Academic.

Sinclair, A., Garin, A. & Tieche-Christinat, C. (1992). Constructing and understanding place value in numerical notation. *European Journal of Psychology of Education, 7 (3)*, 191-207.

Skuy, M. (1997). Cross cultural and interdimensional implications of Feuerstein's construct of mediated learning experience. *School Psychology International, 18*, 119-135.

Snyder, S. & Sheehan, R. (1992). Research methods: The Rasch measurement model: An introduction. *Journal of Early Intervention, 16 (1)*, 87-95.

Southwell, B. (1997). Learning from learners: Sources of assessment. In N. Scott & H. Hollingsworth (Eds.), *Mathematics: Creating the future: Proceedings of the 16th biennial conference of the Australian Association of Mathematics Teachers.* Adelaide: Australian Association of Mathematics Teachers.

Spector, J. (1992). Predicting progress in beginning reading: Dynamic assessment of phonemic awareness. *Journal of Educational Psychology, 84 (3)*, 353-363.

Stake, R. (1995), The invalidity of standardized testing for measuring mathematics achievement. In T. Romberg (Ed.), *Reform in school Mathematics and authentic assessment* (pp. 173-235). Albany: State University of New York Press.

Steffe, L. (1991). The constructivist teaching experiment: Illustrations and implications. In E. von Glasersfeld (Ed.), *Radical constructivism in mathematics education.* Boston: Kluwer Academic.

Steffe, L. (1994). Children's multiplying schemes. In G. Harel. & J. Confrey (Eds.) *The development of multiplicative reasoning in the learning of mathematics* (pp. 3-39). Albany, NY: State University of New York.

Steffe, L. (1996). Social-cultural approaches in early childhood mathematics education: A discussion. In H. Mansfield, N. Pateman & N. Bednarz (Eds.), *Mathematics for tomorrow's young children* (pp. 79-99). Netherlands: Kluwer Academic.

Steffe, L. & Cobb, P. (1988). *Construction of arithmetical meanings and strategies.* New York: Springer-Verlag.

Steffe, L. & Wood, T. (Eds.) (1990). *Transforming children's mathematics education: International perspectives.* NJ: Lawrence Erlbaum.

Steffe, L., von Glasersfeld, E. Richards, J. & Cobb, P. (1983). *Children's counting types: Philosophy, theory and application.* New York: Springer-Verlag.

Stenmark, J. K. (1989). *Assessment alternatives in Mathematics: An overview of assessment techniques that promote learning.* Berkeley, CA: EQUALS and Assessment Committee of the California Mathematics Council.

Stephens, M. (1997). Performance assessment in mathematics. In N. Scott & H. Hollingsworth (Eds.), *Mathematics: Creating the future: Proceedings of the 16th biennial conference of the Australian Association of Mathematics Teachers,* (pp. 43-46). Adelaide: Australian Association of Mathematics Teachers.

Sternberg, R. J. (Editor in Chief) (1994). *Encyclopaedia of Human Intelligence.* New York: Macmillan.

Sternberg, R. J. & Horvath, J. A. (1995). A prototype view of expert teaching. *Educational Researcher, 24 (6),* 9-17.

Sullivan, P. (1997). Mixing open-ended and closed questions to enrich assessment. In N. Scott & H. Hollingsworth (Eds.), *Mathematics: Creating the future: Proceedings of the 16th biennial conference of the Australian Association of Mathematics Teachers* (pp. 39-42). Adelaide: Australian Association of Mathematics Teachers.

Sullivan, P., Owens, K. & Atweh, B. (Eds.) (1996). *Research in mathematics education in Australasia: 1992-1995.* Campbelltown, Australia: Mathematics Education Research Group of Australasia.

Sullivan, P., Cheeseman, J., Clarke, B., Gervasoni, A., Gronn, D., Horne, M., McDonough, A. & Montgomery, P. (2000). Using learning growth points to help structure numeracy teaching. *Australian primary mathematics Classroom, 5 (1), 4-8.*

Swan, M. (1993). Improving the design and balance of mathematical assessment. In Niss, M. (Ed.), *Investigations into Assessment in Mathematics Education* (pp. 195-216). Netherlands: Kluwer Academic.

Tanner, H. & Jones, S. (1998). Dynamic scaffolding and reflective discourse: Successful teaching styles observed within a project to teach mathematical

thinking skills. In C. Kanes, M. Goos & E. Warren (Eds.) *Teaching mathematics in new times: Proceedings of the twenty-first annual conference of the Mathematics Education Research Group of Australasia (pp. 596-604).* Brisbane, Australia: Griffith University.

The Psychological Corporation (2001). *Testing materials for psychologists.* Marrickville, Australia: Harcourt Brace. http://www.psychcorp.com.au/catalog.html

Thomas, N. (1992). An analysis of children's understanding of numeration. In *Space. The First and Final Frontier. Proceedings of the 15th annual conference of the Mathematics Education Research Group of Australasia*, (pp. 521-540). Nepean, Sydney: University of Western Sydney.

Thomas, N. (1996). Understanding the number system. In J. Mulligan & M. Mitchelmore (Eds.), *Children's number learning: A research monograph of Mathematics Education Research Group of Australasia and Australian Association of Mathematics Teachers* (pp. 89-106). Adelaide: Australian Association of Mathematics Teachers.

Thomas, N. (1997) Enhancing numeration sense through imagery. In N. Scott & H. Hollingsworth (Eds.), *Mathematics: Creating the future: Proceedings of the 16th biennial conference of the Australian Association of Mathematics Teachers* (pp. 302-309). Adelaide: Australian Association of Mathematics Teachers.

Thomas, N. (1998). *Children's understanding of the number system.* Unpublished PhD thesis. Macquarie University, Sydney.

Thomas, N. & Donaldson, P. (1995). Year 7 mathematics recovery program. In A. Richards (Ed.), *Forging links and integrating resources: Proceedings of the fifteenth biennial conference of the Australian Association of Mathematics Teachers.* Adelaide: Australian Association of Mathematics Teachers.

Thomas, N., Mulligan, J. & Goldin, G. A. (1994). Children's representation of the counting sequence 1-100: Study and theoretical interpretation. In J. P. da Ponte & J. F. Matos (Eds.), *Proceedings of the 18th international conference for the Psychology of Mathematics Education, 3,* (pp. 3-8). Lisbon, Portugal: PME.

Thomas, N., Mulligan, J. & Goldin, G. A. (1996). Children's representation of the counting sequence 1-100: Cognitive structural development. In L. Puig & A. Gutierrez (Eds.), *Proceedings of the twentieth conference of the International Group for the Psychology of Mathematics Education 4,* (pp. 307-314). Valencia Spain: PME.

Thompson, C. S. (1993). Number sense and numeration in grades K-8. In T. E. Rowan & L. J. Morrow (Eds.), *Implementing the K-8 curriculum and evaluation standards: Readings from the 'Arithmetic Teacher'* (pp. 31-33). Reston: National Council of Teachers of Mathematics.

Thorndike, R. L., Hagen, E. & Sattler, J. M. (1986). *The Stanford-Binet intelligence scale (4th ed).* Chicago, IL: Riverside.

Torrance, H. (Ed.) (1995). *Evaluating authentic assessment: Problems and possibilities in new approaches to assessment.* Buckingham: Open University Press.

Tracey, D., Perry, B. & Howard, P. (1998). Teacher beliefs about the learning and teaching of mathematics : Some comparisons. In C. Kanes, M. Goos & E. Warren (Eds.) *Teaching mathematics in new times: Proceedings of the 21st*

annual conference of the Mathematics Education Research Group of Australasia (pp. 613-620). Brisbane: Griffith University.

Tuckman, B. (1988). *Conducting educational research (3rd ed.)*. San Diego: Harcourt Brace Jovanovich.

Tzuriel, D. (1992). The dynamic assessment approach: A reply to Frisby and Braden. *The Journal of Special Education, 26 (3)*, 302-324.

Underhill, B., Uprichard, E. & Heddens, J. (1980). *Diagnosing mathematical difficulties*. Columbus, OH: Merrill.

Van-Oers, B. (2000). The appropriation of mathematical symbols: A psychosemiotic approach to mathematics learning. In P. Cobb, E. Yackel et al. (Eds.), *Symbolizing and communicating in mathematics classrooms: Perspectives on discourse, tools and instructional design* (pp. 133-176). Mahwah, NJ: Lawrence Erlbaum. (Abstract from ERIC Document Reproduction Service No. 2000-07261-003).

Vaughn, S. & Wilson, C. (1994). Mathematics assessment for students with learning disabilities. In G. R. Lyon (Ed.), *Frames of reference for the assessment of learning disabilities: New views of measurement issues* (pp. 459-472). Baltimore, Maryland: Brookes.

Veer, R. van der & Valsiner, J. (1991). *Understanding Vygotsky: A quest for synthesis.* Oxford, UK: Blackwell.

Vizcarro, C., Bermejo, I., del Castillo, M. & Aragonés, C. (1996). Development of an inventory to measure learning strategies. In M. Birenbaum & F. Dochy (Eds.), *Alternatives in assessment of achievements, learning processes and prior knowledge* (pp. 341-364) Mass.: Kluwer Academic.

Vye, N. J., Burns, S., Delclos, V. R. & Bransford, J. D. (1987). A comprehensive approach to assessing intellectually handicapped children. In C. S. Lidz (Ed.), *Dynamic assessment: An interactional approach to evaluating learning potential* (pp. 327-359). New York: Guilford.

Vygotsky L. S. (1962). *Thought and language.* E. Hanfmann & G. Vakar (Eds. & Trans.) Mass: Massachusetts Institute of Technology/Wiley.

Vygotsky, L. S. (1978). *Mind in Society: The development of higher psychological processes.* M. Cole, V. John-Steiner, S. Scribner & E. Souberman (Eds.). Cambridge MA: Harvard University Press

Vygotsky L. S. (1987). *The collected works of L. S. Vygotsky Vol. 1 Problems of General Psychology.* R. W. Rieber & A. S Carton (Eds.) & N. Minick, (Trans.) New York: Plenum Press.

Vygotsky, L. S. (1997). *Educational psychology.* R. Silverman (Trans.) Boca Raton, FL: St. Lucie Press.

Vygotsky, L. S. (1999). The collected works of L. S. Vygotsky, Vol. 6: Scientific legacy. R. W. Reiber (Ed.) M. J. Hall (Trans.) New York: Kluwer Academic/Plenum (Abstract from ERIC Document Reproduction Service No 1999-02979-000).

Webb, N. (1992). Assessment of students' knowledge of mathematics: Steps toward a theory. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 661-683). New York: Macmillan.

Webb, N. (1993). Visualizing a theory of the assessment of students' knowledge of mathematics. In Niss, M. (Ed.), *Investigations into assessment in mathematics education* (pp. 253-263). Netherlands: Kluwer Academic.

Webb, N. & Coxford, A. (Eds.) (1993). *Assessment in the mathematics classroom.* Reston: National Council of Teachers of Mathematics.

Wertsch, J. V. (1985). *Vygotsky and the social formation of mind.* Cambridge, Mass.: Harvard University Press.

Westwood, P. (2000). *Numeracy and learning difficulties: Approaches to teaching and assessment.* Camberwell, Vic.: Australian Council for Educational Research.

Wheeler, D. (1993). Epistemological issues and challenges to assessment: What is mathematical knowledge? In M. Niss (Ed.), *Investigations into assessment in mathematics education. An ICMI Study* (pp. 87-95). Netherlands: Kluwer Academic.

Wiedl, K., Guthke, J. & Wingenfeld, S. (1995). Dynamic assessment in Europe: Historical perspectives. In J. Carlson (Ed.), *Advances in cognition and educational practice: European contributions to dynamic assessment* (pp. 33-82). Connecticut, US: JAI Press.

Wiersma, W. (1991). *Research methods in education: An introduction.* Boston: Allyn and Bacon.

Willis, S. (1994). Student outcome statements: What's it all about? *Cross Section, 6 (1)*, 2-7.

Wilson, M. (1995). Assessment nets: An alternative approach to assessment in mathematics achievement. In T. A. Romberg (Ed.), *Reform in school mathematics and authentic assessment* (pp. 236-259). Albany, US: State University of New York Press.

Wingenfeld, S. A. (1991). *Dynamic and neuropsychological assessment of the cognitive functioning of learning disabled and non-learning-disabled adolescents.* Unpublished PhD dissertation. Vanderbilt University, Nashville, TN.

Witt, J., Elliott, S., Daly, E., Gresham, F. & Kramer, J. (1998). *Assessment of at-risk and special needs children (2nd ed),* Boston, Mass:, McGraw-Hill.

Wright, B. D. & Linacre, J. M. (1989). Observations are always ordinal; Measurements, however, must be interval. *Archives of Physical Medicine and Rehabilitation 70,* 857-860.

Wright, R. J. (Bob) (1991a). The role of counting in the numerical development of young children. *Australian Journal of Early Childhood, 16 (2),* 43-48.

Wright, [R. J.] Bob (1991b). What number knowledge is possessed by children beginning the kindergarten years of school? *Mathematics Education Research Journal, 3 (1),* 1-16.

Wright, [R. J.] Bob (1992). Number topics in early childhood mathematics curricula: Historical background, dilemmas, and possible solutions. *Australian Journal of Education, 36 (2),* 125-142.

Wright, R. J. (1996a). Problem-centred mathematics in the first year of school. In J. Mulligan & M. Mitchelmore (Eds.), *Children's number learning: A research monograph of Mathematics Education Research Group of Australasia and the Australian Association of Mathematics Teachers*, (pp. 35-54). Adelaide, South Australia: Mathematics Education Research Group of Australasia/Australian Association of Mathematics Teachers.

Wright, R. J. (1996b). Concept development in early childhood mathematics: Teachers' theories and research. In H. Mansfield, N. Pateman & N. Bednarz (Eds.), *Mathematics for tomorrow's young children* (pp. 218-227). Netherlands: Kluwer Academic.

Wright, R. J. (1998) An overview of research-based framework for assessing and teaching early number. In C. Kanes, M. Goos & E. Warren (Eds.) *Teaching mathematics in new times: Proceedings of the 21st annual conference of the Mathematics Education Research Group of Australasia* (pp. 701-708). Brisbane: Griffith University.

Wright, [R. J.] B. & Stewart, R. (1999). Can teachers know too much? *Australian Primary Mathematics Classroom, 4 (2),* 4-7.

Yackel, E. & Cobb, P. (1996) Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal for Research in Mathematics Education, 27 (4),* 458-477.

Young-Loveridge, J. (1997). From research tool to classroom assessment device: The development of Checkout / Rapua, a shopping game to assess numeracy at school entry. In F. Biddulph, & K. Carr (Eds.), *People in mathematics education: Proceedings of the 20th annual conference of the Mathematics Education Group of Australasia, 1.* (pp. 608-615). Waikato, NZ: Mathematics Education Research Group of Australasia.

Appendix 4.1

Mathematics K-6: Outcomes related to place-value numeration

The student:

NUMERATION OUTCOMES	
N 1.1	Approximates, counts, compares, orders and represents whole numbers and groups of objects up to 100.
N 2.1	(a) Counts, compares and orders whole numbers up to 9999 and represents them in symbols and words, stating the place value of any digit. (b) Demonstrates an understanding that numbers can be represented using groupings of 10, 100, 1000.

WORKING MATHEMATICALLY OUTCOMES	
WM 1.1	asks questions about mathematics when using materials and in practical situations.
WM 1.2	answers mathematical questions using objects, pictures, imagery, actions or trial and error.
WM 1.3	explains simple mathematical situations using everyday language, actions, materials and drawing.
WM 1.4	supports answers to mathematical questions by explaining or demonstrating how the answer was obtained.
WM 1.5	recognises what worked and what did not work while answering mathematical questions.
WM 1.6	uses the available technology to explore basic mathematical concepts.
WM 2.1	poses questions or problems about mathematical situations.
WM 2.2	uses one or more strategies to solve mathematical problems.
WM 2.3	represents, interprets and explains mathematical situations using everyday language with some mathematical terminology, including simple graphs.
WM 2.4	checks, using an alternative method if necessary, whether answers to problems are correct and sensible.
WM 2.5	compares own method of solution to a problem with that of others.
WM 2.6	uses the available technology to help in the solution of mathematical problems.

VALUES AND ATTITUDES OUTCOMES	
VA 1	appreciates that mathematics involves observing, generalising and representing patterns and relationships
VA 2	demonstrates a positive response to the use of mathematics as a tool in practical situations
VA 3	shows an interest in and enjoyment of the pursuit of mathematical knowledge
VA 4	demonstrates the confidence to apply mathematics and to seek and gain knowledge
VA 5	demonstrates a willingness to work cooperatively with others and to value the contributions of others
VA 6	appreciates the importance of visualisation when solving problems
VA 7	shows willingness to take risks when working mathematically
VA 8	demonstrates a willingness to persist when solving problems and to try different methods
VA 9	uses mathematics creatively in expressing new ideas and discoveries
VA 10	recognises the economy and power of mathematical notation, terminology and convention in helping to develop and communicate mathematical ideas
VA 11	appreciates that conventions, rules about initial assumptions, precision and accuracy enable information to be communicated effectively
VA 12	appreciates that a mathematical model is a simplified image of some aspect of the social or physical environment
VA 13	realises that justification of intuitive insights is important

VA 14	appreciates how mathematics is used in a range of aspects of society
VA 15	appreciates the contribution of mathematics to our society
VA 16	recognises that mathematics has its origins in many cultures and is developed by people in response to human needs
VA 17	appreciates aspects of the historical development of mathematics
VA 18	appreciates the impact of mathematical information on daily life

Appendix 4.2

DMT: Items

Name: _____ Age: _____

Year: _____ Date: _____

Read these numbers and write them in **figures**:

seventy	thirteen	fifty-one

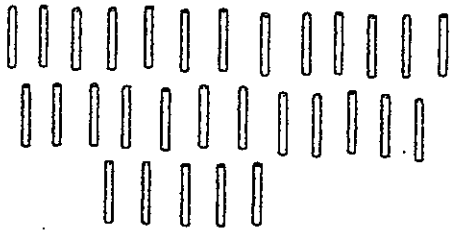
Write these numbers in **figures**:

two hundred and three _____

nine hundred and fifty _____

six hundred and nineteen _____

These rods are in **ones.** How many rods ?



_____rods

These rods are in **tens.** How many rods ?

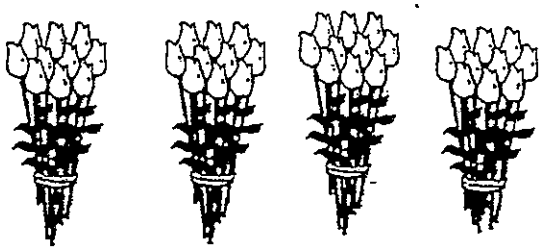
_____rods

Circle the picture about the rods that you found **easier** to count.

Say why: _____

_____

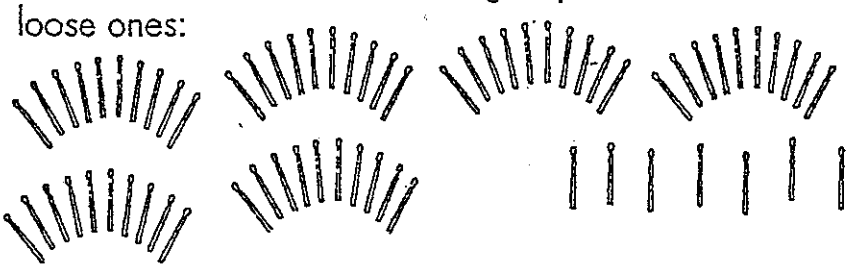
There are ten flowers in each bunch:



How many tens ? _____ tens

How many flowers altogether ? _____

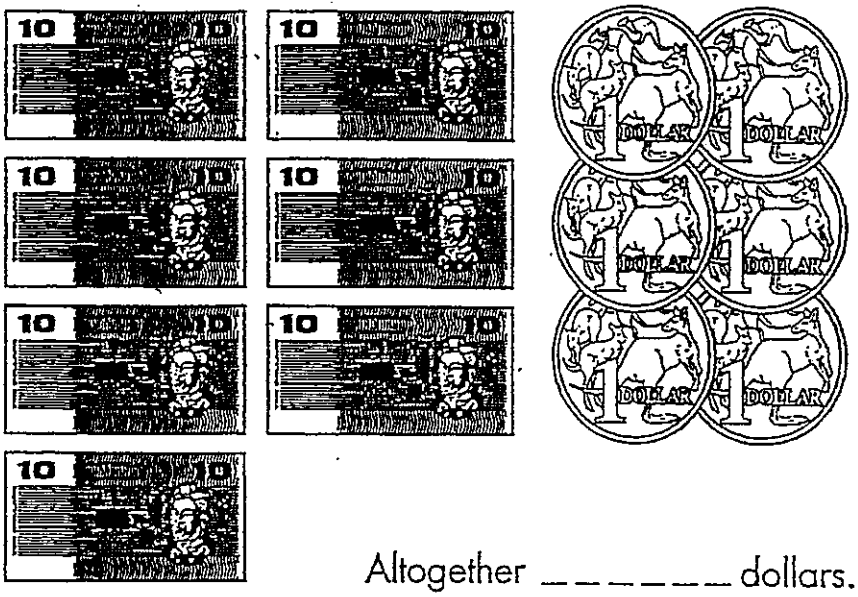
There are ten matches in each group and some loose ones:



How many tens ? _____ tens _____ones

How many matches altogether ? _____

How much money is this ?



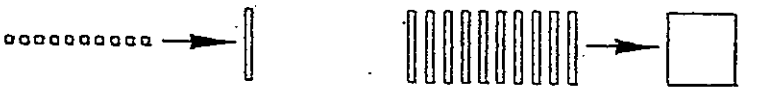
Altogether _____ dollars.

We can show a ten by (10) and a one by (1)

Draw a picture of 54 using (10) and (1)

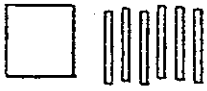
92 means _____ tens _____ ones.

We can show numbers using M.A.B. base ten pieces:



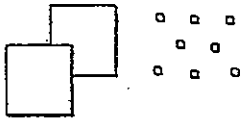
10 ones 1 ten 10 tens 1 hundred

What number is this ?



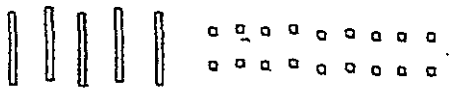
_____

What number is shown here ?



_____

Sometimes we need to re-group the base ten pieces.
What number is shown in this picture ?



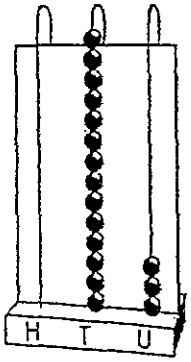
_____

What number is this ?

_____

A looped abacus is useful to show numbers of hundreds, tens, units.
Sally used the abacus to keep her score in a game.

What was Sally's score ?



_____

Put these numbers in order, starting with the **smallest**:

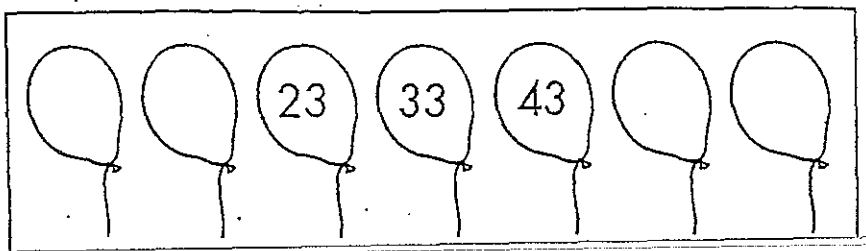
83, 16, 47, 38, 60.

_____, _____, _____, _____, _____.

Use the numbers 5, 3, 7 to make the **largest** possible number:

_____

Complete the counting pattern



Appendix 4.3

DMT: Scripted instructions

The scripted instructions for introduction of the DMT and for the first six items were taken directly from the manual (Schleiger, 1993, pp. 82 & 114).

After distributing DMT say:
'Today we are going to do some number work on these sheets. First, print your name after *Name*. Write your age in years. After *Year*, print your year level and your teacher's name. Print today's date.'

Item 1 In the first box write in figures: eighty-three.

Item 2 In the box write in figures: fifteen.

Item 3 In the box write in figures: one hundred and nine.

Item 4 In the box write in figures: two hundred and ninety.

Item 5 In the box write in figures: four hundred and nine.

Item 6 In the box write in figures: eight hundred and nineteen.

'Read the rest of the questions carefully. Do what each one asks and write your answers neatly. When you finish a question go on to the next one. If you can't read a question, raise your hand for help. If a question is too hard, leave it and go on to the next one.'

'Are there any questions? Write neatly.'

- Allow time for the children to finish the test.

- Encourage children who finish early to check their work carefully and then provide them with some quiet activities.

Appendix 4.4

KeyMath-R: Items

The twenty-four KeyMath-R items are presented here. The objectives related to each of the items, within each domain, are described with reduced reproductions of each item. The figures of each item include the scripted questions, the stimulus pictures and the correct responses from the KeyMath-R (Form A) test (Connolly, 1988).

Numbers 0-9 Items 1-6 are included in this domain which covers correspondence, rational counting, reading and sequencing numbers, and ordinal positions. The graphic stimulus for each item and the scripted questions are shown in boxes. The first two items were concerned with a picture of three sheep.

	CORRECT RESPONSE
1. How many sheep are in this picture?	3
2. Hold up as many fingers as there are sheep in this picture.	holds up three fingers

The objectives for these two items are that the student "can count objects (1-5) in a set" and "can form a set whose numbers correspond with the members of a given set (1-5)." The third and fourth items were related to three single digits shown.

4 1 8

	CORRECT RESPONSE
3. Read these numbers to me. *To obtain credit the student must correctly identify each numeral. If there is uncertainty as to which numeral is being named, point to each numeral and have the student name it.*	4, 1, 8
4. Read these numbers to me, starting with the smallest number and ending with the largest.	required order: 1, 4, 8

These items asked the student to read the numbers, and then to read them in order from smallest to largest. The defined objectives for these items are that the student "can read one digit numerals (0-9)" and "can order a set of one digit numbers."

The fifth and sixth items referred to a picture of people lined up at a ticket booth.

	CORRECT RESPONSE
5. How many people are in this picture?	8
6. The first person in line is buying a ticket. Which is the fifth person in line?	fifth person

The student was asked how many people were in the line and who was the fifth person in the line. From these items it was determined whether the student "can count objects (0-9) in a set" and "name the ordinal position of each object in a row of up to nine objects."

Items 1 to 6, as described above, represent the domain of single-digit numbers in the Numeration subtest of the KeyMath-R. They involved counting, ordering and reading of numbers.

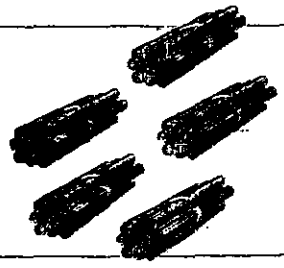
Numbers 0-99 The second domain within the Numeration subtest covers place value (tens and ones), reading, comparing, sequencing, renaming numbers, and skip counting, related to two-digit numbers. The items in this domain are 7, 8, 9, 10, 12 and 17. The stimulus graphics and the scripted questions are shown.

		CORRECT RESPONSE
___ 19 ___	7. When counting, what numbers come just before and just after this number? *To obtain credit, the student must give both numbers.*	18, 20

The seventh item tests whether the student "can determine the numbers immediately preceding and following a given two-digit number."

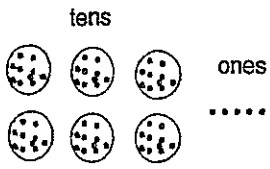
		CORRECT RESPONSE
46 15 80 43	8. Read these numbers to me, starting with the smallest number and ending with the largest. *To obtain credit, the student must correctly identify each number in the proper order.*	required order: 15, 43, 46, 80

Item 8 asked the student to read four two-digit numbers out loud, in order from smallest to largest. The defined objective was that the student could "order a set of two-digit numbers."



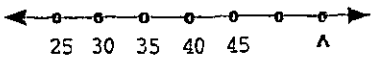
	CORRECT RESPONSE
9. There are ten rods in each bundle. How many rods are there in all?	50

Item nine presented a picture of five bundles of ten rods, and asked the student how many rods were in the picture altogether. The outcome is a determination whether the student "can count sets of tens."



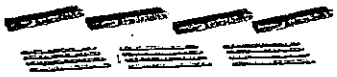
	CORRECT RESPONSE
10. *Point to the circles containing dots and then to all the dots as you say:* Each circle has ten dots. In all, how many dots are on this page? *If the student responds "sixty" motion to the entire set and ask:* How many dots in all?	65

The tenth item grouped dots into circles of tens, with five dots separate. The student is asked to say how many dots are on the page altogether. The defined objective for this item is that a student "can determine the two-digit number depicted in a given representation of tens and ones."



	CORRECT RESPONSE
12 Each dot on this line should have a number. What number should the blue dot have?	55

Item 12 refers to a number line with dots at intervals of five. The question seeks to know what number should be at the blue dot (the second un-labelled dot which is represented in this figure by the pointer). The objective for this item is that a student "can determine the two-digit number associated with a given point on a number line."



	CORRECT RESPONSE
17. There are ten pencils in each box. *Motion across the boxes and the loose pencils.* How many pencils are there in all?	52

This last item in the domain of two-digit numbers uses another representation of groups of ten pencils, along with more-than ten ungrouped pencils. The item is designed to see whether a "student can determine the two-digit number depicted in a given representation of tens and ones that requires regrouping."

The six items that tested a student's knowledge and skills with two-digit numbers were spread from item 7 to 17, and covered several aspects of place value defined in the literature. These aspects included counting by ones, tens, and fives, reading and ordering two-digit numbers, interpreting representations of groupings of tens, with and without extra ones, and regrouping of the ones into tens.

Numbers 0-999 The domain of Numbers 0-999 includes items 11, 13, 15, 16, 21,

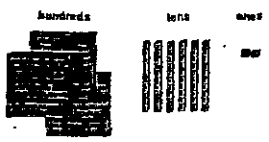
and 22. This domain is focused on three-digit numbers and has an emphasis on place value, representing, comparing, sequencing and renaming numbers, and initial concepts in rounding numbers.

		CORRECT RESPONSE
473 429 205 479	11. Read these numbers to me, starting with the smallest number and ending with the largest. *To obtain credit the student must correctly identify each number in the proper order.*	required order: 205, 429, 473, 479

The first item in this domain, item 11, asks the student to read three-digit numbers in order from smallest to largest. Only one of the numbers differs in the hundreds value, so the student has to discriminate between the tens values in the other numbers. The item objective is that the student "can order a set of three digit numbers."

		CORRECT RESPONSE
927 937 947 ____ ____	13. What are the next two numbers in this sequence? *To obtain credit, the student must give both numbers.*	957, 967

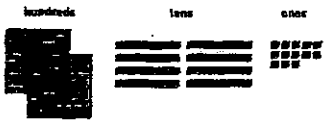
The second item, item 13, presents a sequence of three-digit numbers that are increasing by tens. Again the student has to focus on the tens value in order to respond correctly to the question. The item aims to see whether the student "can determine the next two numbers in a sequence of three-digit numbers in equal increments."

		CORRECT RESPONSE
	15. How many small blocks are in this picture? *If the student appears to focus only on the ones, motion to the entire set and ask:* How many small blocks in all?	362

Item 15 requires the student to interpret a picture of base-ten blocks, with hundreds, tens and ones. The question refers to the number of "small blocks" that make up all the blocks in the representation. The item aims to see whether the student "can determine the three-digit number depicted in a given representation of hundreds, tens, and ones."

		CORRECT RESPONSE
583 570 648	16. When rounded to the nearest hundred, these numbers are the same. What is the rounded number?	600

This item, 16, refers to the 'rounding' of numbers to the nearest hundred. The objective states that the student scoring correctly for this item "can determine the nearest hundred to which a given set of three-digit numbers all round."

		CORRECT RESPONSE
	21. How many small blocks are in this picture? *If the student appears to focus only on the ones, motion to the entire set and ask:* How many small blocks in all?	293

Item 21 is the second item that uses the base-ten block representation of three-digit numbers, this time regrouping is required. It investigates the student's skill to "determine the three-digit number depicted in a given representation of hundreds, tens, and ones that requires regrouping."

		CORRECT RESPONSE
4 hundreds 17 tens 2 ones = ____	22. Four hundreds, seventeen tens, two ones equal what three-digit number?	572

Item 22 is the last item in the domain of three-digit numbers. It aims to see whether the student "can rename a three-digit number" that is described with more than ten tens.

The six items that are included in the domain numbers 0-999 were spread from item 11 to 22, and covered aspects of place value defined in the literature. The items involve interpreting representations of groupings of tens and hundreds; comparing, sequencing and renaming numbers; and the concept of rounding numbers.

Multi-digit numbers and advanced numeration topics The last domain in the subtest focuses on larger numbers and advanced numeration topics. This domain includes comparing, sequencing and rounding of multi-digit numbers, initial understanding of exponents and powers of ten, as well as positive and negative integers. These items are illustrated.

		CORRECT RESPONSE
4,837 | 4,759 | 4,832	14. Read these three numbers to me starting with the smallest number and ending with the largest.	required order: 4,759, 4,832, 4,837

The first item in this domain was placed at 14 in the 24 items. It required the student to read four-digit numbers in order from smallest to largest. The four-digit numbers all had the same thousands digit and so had to be ordered on the hundreds and tens values. The objective for this item was that the student "can order a set of four-digit numbers."

		CORRECT RESPONSE
5 0 7 2	18. What is the greatest four-digit number that can be formed using these digits? *If the student reads "seven-five-two-oh," say:* Yes but what is that as a four-digit number?	7,520

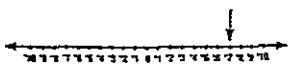
Item 18 involved the combining of four digits to make the largest possible four-digit number. From this item it could be seen whether the student "can determine the greatest four-digit number that can be formed from a given set of four single digits."

		CORRECT RESPONSE
2,017,509	19. Read this number to me.	two million, seventeen thousand, five hundred [and] nine

This item required the student to read a millions number that included two zeros as place-holders. The defined objective for the item is that the student "can read a large multi-digit number involving millions."

		CORRECT RESPONSE
3,589 3,599 3,609	20. For this sequence, what number goes in the blue box?	3,619

Item 20 presented three four-digit numbers in a sequence that increased by tens. The student had to provide the next number in the sequence. The result indicates whether the student "can determine the next number in a sequence of four-digit numbers in equal increments."

		CORRECT RESPONSE
	23. What number is ten less than a positive seven? *To obtain credit, the student must indicate that the answer is a negative three.*	-3

Item 23 involved a number line with positive and negative numbers. The student was asked to say what number is "ten less than a positive seven." This item involved

counting backwards by tens into negative numbers. The number line was available for use by the student. The defined objective for the item is that the student "can give the value of a point on a number line involving positive and negative integers."

		CORRECT RESPONSE
10^5	24. What number does this represent?	100,000

The last item in the test, involved the notation for powers of ten. It asked the student to say what number was represented by this notation. The objective was defined as the ability to "determine the value of 10 raised to a given power."

The six items in the last domain, of multi-digit numbers and advanced numeration topics, ranged from 14 to 24, and were interspersed with items from the previous two domains. Several of the items followed a similar structure to items in the previous domains, for example, the sequencing items. The items involved reading large numbers, ordering large numbers, and making large numbers. The last two items introduced advanced topics of numeration, negative numbers and the notation for powers of ten.

Appendix 4.5

KeyMath-R: Record form (part)

1 NUMERATION

		Numbers 0–9	Numbers 0–99	Numbers 0–999	Multi-digit numbers
K,1 ▸	1. how many sheep				
	2. as many fingers				
	3. read 4; 1, 8				
	4. read in order 4, 1, 8				
	5. how many people				
2,3 ▸	6. fifth person				
	7. ____ 19 ____				
	8. read in order 46 15 80 43				
	9. how many rods				
4 ▸	10. how many dots				
	11. order 473 429 205 479				
5-7 ▸	12. blue dot				
	13. 927 937 947 ____ ____				
	14. order 4,837 4,759 4,832				
	15. how many small cubes				
8,9 ▸	16. round to nearest hundred				
	17. how many pencils				
	18. four-digit number				
	19. read 2,017,509				
	20. number in blue box				
	21. how many small cubes				
	22. three-digit number				
	23. less than positive seven				
	24. what does 10^5 represent				
____	CEILING ITEM DOMAIN SCORES				

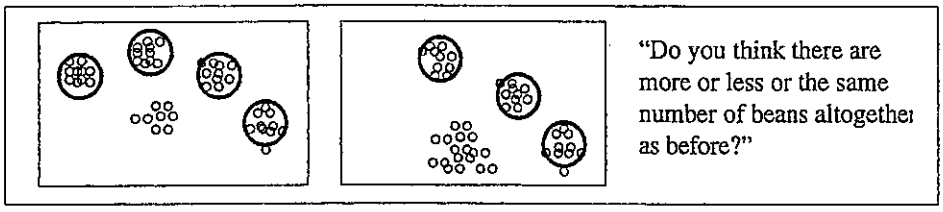
SUBTEST RAW SCORE
(Sum of domain scores)

Appendix 4.6

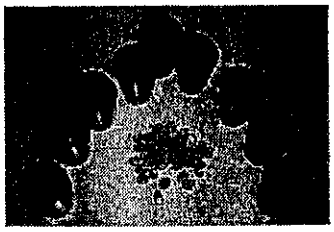
STOPV: Tasks and levels of response

In this appendix, the seven tasks used in the alternative assessment are described. The aspects of place-value numeration relevant to each task are defined, the administration procedures, materials, and methods of recording results are described and the levels of response are defined.

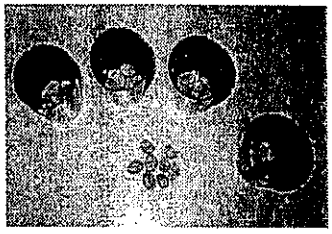
Task 1 *Conservation of number (Ross, 1986)*



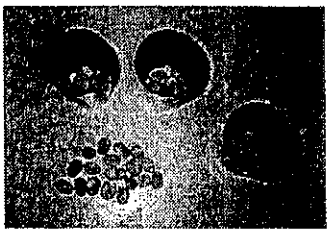
This task was designed to assess skills of counting and conservation of quantity (Ross, 1986). The question also involved the language terms of 'more-than' and 'less-than' relevant to number relationships (Jones, Thornton & Putt, 1994). The following three photographs show the materials related to the task.



Photograph A.1



Photograph A.2



Photograph A.3

The student was given 48 beans, in a pile on the table with nine cups arranged around them (Photograph A.1). The examiner stated: *"Here we have 48 beans. Put 10 beans in each cup."* The researcher then put five cups aside (Photograph A.2) and asked: *"How many beans are there?"* Upon confirmation that there were 48 beans the examiner tipped one cup of beans onto the table (Photograph A.3) and asked: *"Do you think there are more or less or the same number of beans*

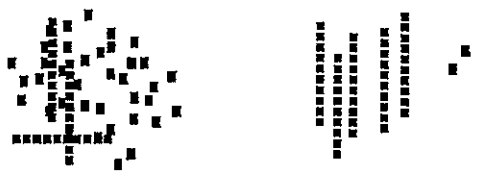
altogether as before?" After this response the student was asked to explain and justify the answer: *"Why?"*

A problem with the wording of the question became apparent during the second administration, as the students interpreted: *"Do you think there are more or less or the same number of beans as before?"* to mean "... as in the previous session?" The researcher altered the wording to state " ... *as we had a minute ago?"* to remove the misinterpretation in the question, and these words were used for all students.

Three levels of response were provided by Ross (1986). At the lower level the student was unable to conserve at all. The second level involved counting of the beans to confirm that there were the same number. Students who responded appropriately, without counting the number of beans remaining, represented the highest level.

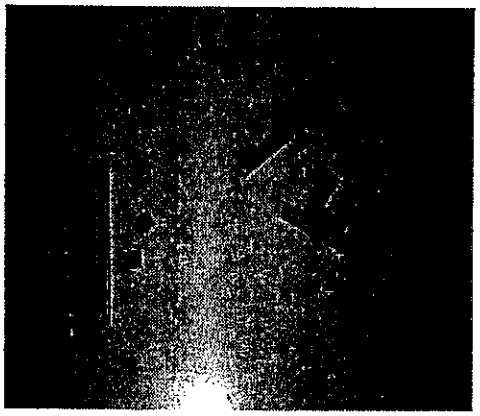
Task 2 Standard partitioning and digit correspondence (Ross, 1986)

"Use these counting blocks to build 52." "How do you know that is 52?"



This task was designed to assess a student's skills with standard partitioning using Dienes' base-ten blocks. The student was given 40 units (shorts) and 8 tens (longs) and instructed to: *"Use these counting blocks to build 52."* On construction of the number the student was asked: *"How do you know that is 52?"* The number of unit blocks available did not allow construction using ones alone, so the student had to use groups of tens. The photographs show the blocks as presented and then as used to build 52.

Photograph A.4



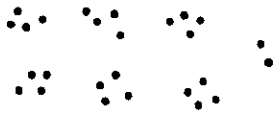
Photograph A.5

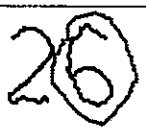
The question allowed a student to provide a response which indicated an understanding of tens and ones. A student's level of understanding was inferred from terms used and the form of explanation. Four levels of response were defined by Ross (1986) and Sierink (1989). At the lowest level the student was unable to build 52 using the blocks. The second level involved an unsuccessful attempted use of unit blocks to make 52, before using the tens blocks. Construction of 52 using the blocks, but without explanation was level 3. Routine performance of the task, using 5 tens and 2 ones, and an explanation of the tens and ones composition of the number represented the highest level.

Task 3 Non-standard partitioning and digit correspondence (Ross, 1989)

"Count these and write down how many."

"Sort the counters into groups of 4."



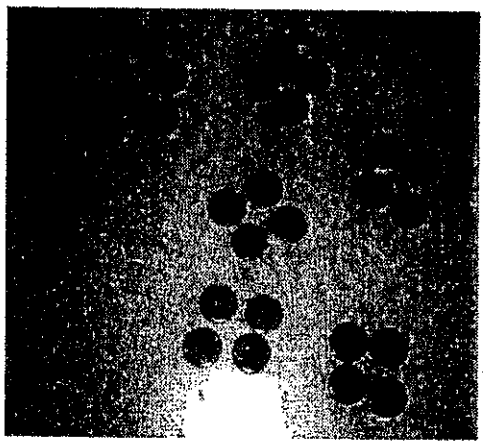


"Does this part of your 26 have anything to do with how many counters you have?"

This task was designed to see if a student was using face-value meaning for the digits in a two-digit number. The task was designed to test the stability of a student's references to tens and ones, by introducing a lower level distracter, the non-standard groupings of the counters. The task involved a visual grouping on which the student could rely if they were still functioning at the visual level. The student was given 26 counters (Photograph A.6), pencil and paper, and instructed to: "*Count these and write down how many.*" Following this part of the task, the student was asked to: "*Sort the counters into groups of 4.*" This action resulted in

six groups of four counters, with two left over (Photograph A.7). Referring to the numeral written by the student, the researcher then circled the '2' and asked: *"Does this part of your 26 have anything to do with how many counters you have?"* The question was repeated referring to the digit '6.' These questions were similar to the questions in the previous task, and focused on asking the student what the individual digits in the two-digit number meant.

Photograph A.6



Photograph A.7

Four levels of performance were provided from previous studies for this task. At the lowest level students wrote the numeral incorrectly, stated that they did not know what the digits meant, or made a general statement that the digits "make it 26." The second level of performance included responses that related the digit '2' to two objects and '6' to six groups, or invented some other meaning for the digits. When students stated that '2' was twenty and '6' was six, they were at the third level. The highest (fourth) level required the student to indicate that '2' was interpreted as two tens and '6' was six ones.

Task 4 Counting a large number of objects (Kamii, 1986)

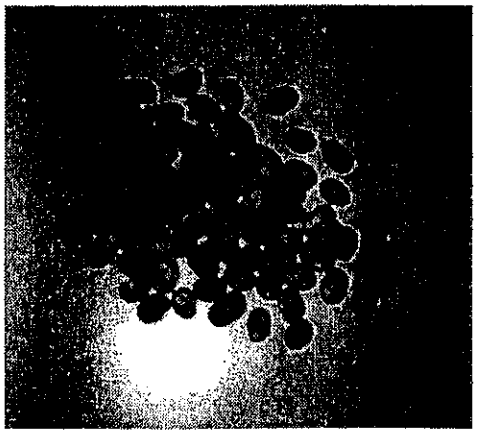
"How many beans do you think there are?"

"Count them."

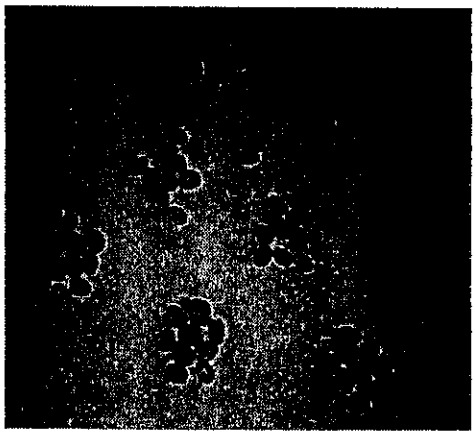
"Count them again by tens"

This task involved counting a large number of objects. Ninety-seven (97) broad beans were tipped on the table in front of the student. The exact number was altered for the second (89) and final (92 Photograph A.8) assessments to reduce

direct memory support for the task. The student was asked to estimate or guess: "*How many beans do you think there are?*" Those students who were hesitant were encouraged to provide some response. Following this estimate, the student was asked to: "*Count them.*" Strategies for counting this large number were noted. If the student used ones or groupings other than tens, they were then asked to: "*Count them again by tens.*" This often resulted in the arrangement shown in Photograph A.9.



Photograph A.8



Photograph A.9

The responses to this task were classified at one of four levels. At the lowest level the student showed no idea, or counted each bean as ten. The second level involved counting the beans into groups of ten without conservation of the whole, i.e., when asked how many beans there were, the student's answer referred to the number of piles, rather than the number of beans. Students at the third level grouped each ten but "in reality counted by ones" despite the groupings (Sierink & Watson, 1991, p.36). The highest level involved counting groups of ten with conservation of the total number of beans. This was counting using the tens and ones systems simultaneously.

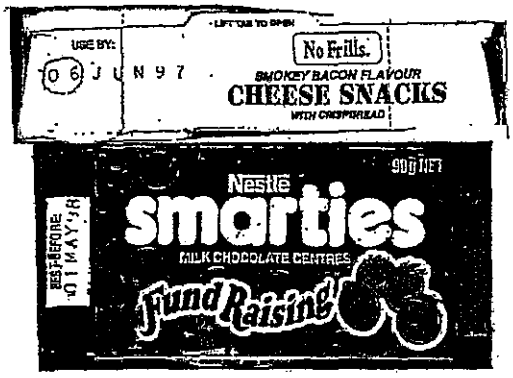
Task 5 Interpretation of the whole numeral '06' (Sierink & Watson, 1991)

USE BY: 0 6 J U N	"What number is this?" "Why?"

This task was devised by Sierink (1989), using a common form of two-digit numbers, the use-by-dates on food items, to investigate a student's understanding of the role of '0' in numbers. The item originated from a classroom comment by a

student who asked why the milk container said "use by the fiftieth of June when there wasn't such a thing" (Sierink & Watson, 1991, p.39). The two-digit form of a number less than ten was chosen so that only a student with a clear understanding of the role of zero as a placeholder was able to respond appropriately to the task.

The student was presented with a biscuit packet with 'USE BY 06 Apr' printed on it. The stimulus package was replaced with a biscuit pack with a use-by date of '06 Jun' for the second assessment, and a lollies pack with a date of '01 May' for the third assessment, to reduce the students' direct memory of the unusual task. Two of these use-by dates are shown.



Photograph A.10 Task 5 use-by dates

The student was directed to the '06' and asked: *"What number is this?"* Further questions were asked to determine the student's reasons for the response: *"Why?"* and *"What does the nought do?"* This task was designed to investigate a student's perception of the place value of the digits, and the use of zero as a place-holder. Three levels of responses were used. The first one included students who said that '06' was 'sixty' (or '01' was 'ten'), ignoring the order of digits. At the second level, students stated that the '06' was 'not sixty' (or '01' was 'not ten'), but were unsure what it was. Students at the highest level reported that the number was 'six' (or 'one'), and that '0' was a place-holder and meant the number of tens.

Task 6 Writing multi-digit numbers (Described by Sierink & Watson, 1991)

"Write these numbers 3, 6, 19, 83, 109, 172, 1607, 3045, 6572."

The student was asked to write, as dictated, a selection of one-, two-, three- and four-digit numbers, with and without zero as a placeholder. This task has been

used by many researchers, however, the particular numbers used in this study were those used by Sierink (1989). The instructions were to: "*Write these numbers 3, 6, 19, 83, 109, 172, 1607, 3045, 6572.*" The numbers were read separately and sufficient time was provided for the student to write each number. Numbers were repeated if requested.

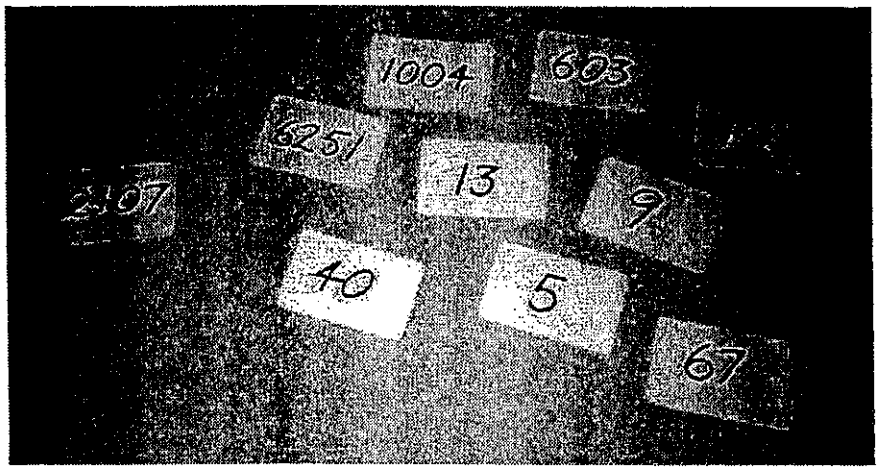
Classification of performance was related directly to the number of digits that the student could write correctly. The lowest level of performance was writing correctly single-digit numbers, the second level was two-digit numbers, the third level was three-digit numbers, and the highest level involved four-digit numbers.

Task 7 Reading multi-digit numbers (Described by Sierink & Watson, 1991)

"Tell me what these numbers are."

5 9 13 40 67 158 603 1004 2407 6251

For this task the student was presented with a series of cards, one-by-one, on which single-digit to four-digit numbers (5, 9, 13, 67, 40, 158, 603, 1004, 2407, 6251) were written. The student was asked to name each number. All the cards are shown in Photograph A.11.



Photograph A.11 Task 7 cards

The level of performance was again related directly to the size of the numbers read successfully.

Appendix 4.7

STOPV-DA: Record form

Name _____ Date(s) (1) _____
(2) _____
(3) _____

Task 1 48 beans 9 cups

Here we have 48 beans.
Put 10 beans in each cup. (put five cups aside)

How many beans are there?

(1)	(2)	(3)

(Spill one cup)***Do you think there are more or less or the same number of beans altogether as before? Why?***

	(1)	(2)	(3)
Unable to conserve			
counted			
Same number, no counting			

Task 2 40 unit blocks 8 tens

Use these counting blocks to build 52.

	(1)	(2)	(3)
Unsuccessful			
Successful but only after unsuccessful attempt using unit blocks			
Performed routinely without explanation			
Performed routinely with explanation			

How do you know that is 52?

Task 3 26 counters pencil and paper

Count these and write down how many.
Sort the counters into groups of 4.

Circle each digit.

(6) ***Does this part of your 26 have anything to do with how many you have?***

(2)***Does this part of your 26 have anything to do with how many you have?***

	(1)	(2)	(3)
DK / wrote number incorrectly / 'to make it twenty six'			
2 is two objects 6 is six groups			
2 is twenty and 6 is six			
2 is two tens and 6 is six ones			

Task 4 80-100 beans

How many beans do you think there are?

(1)	(2)	(3)

Count them.

	(1)	(2)	(3)
by ones			
by tens			
by others			

Count them again by tens.

	(1)	(2)	(3)
No idea/counted each object as ten			
Groups of ten without conservation of the whole			
Counted each ten but joined then in process			
Groups of ten with conservation of whole			

Task 5 Present a container with USE BY 01 Apr 98

What number is this? Why?

	(1)	(2)	(3)
is ten (60)			
not ten (60) but unsure			
is one (six), 0 is placeholder			

What does the nought do?

	(1)	(2)	(3)
no meaning given to 0			
meaning number of tens			

Task 6 Dictate

Write these numbers.

	(1)	(2)	(3)
3, 6			
19, 83			
109, 172			
1607, 3045, 6572			

Task 7 Cards with numbers

Read these numbers.

	(1)	(2)	(3)
5, 9			
13, 67, 40			
158, 603			
1004, 2407, 6251			

Stage of understanding

	(1)	(2)	(3)
emergent			
construction			
understanding			

Appendix 4.8

DMT: Data analysis

The student responses to the DMT on each of the three assessment occasions were analysed as prescribed by the manual (Schleiger, 1993). The forms of analysis included a coded checklist, percentage scores, pattern of mastery and item analysis, identification of students for follow-up, and individual interpretation.

Checklist

A coded checklist format was provided by the manual (Schleiger, 1993). This was adapted to include only the thirty items used in the study. The responses of the students were coded to indicate whether they were incorrect ■, partly correct ◪ or not-attempted [N] , and whether errors involved spelling [S] , reversal of digit or numerals [R] , or omission of symbols or units [O] . The pattern of correct / partly correct / incorrect was analysed as was the frequency of each of the errors. This analysis occurred for each student, providing a description of the types of errors made.

Percentage scores

The design of the DMT provided for totalling the raw scores and calculating percentages for any subgroup of items (Schleiger, 1993, p.4). As the study had selected thirty items this was an important aspect of the design of the instrument that was considered. For each student a raw score, out of a possible total of 30, was calculated and converted to a percentage. Each student was then determined to be above or below the 75% level of mastery. Mastery was set at 75%, however, caution was recommended in accepting the scores alone without some further analysis of the scatter and type of errors (p.4), which could be done using the checklist.

A graphic representation of the class percentage scores was provided through construction of a frequency of performance graph using the percentage scores. Interpretation of the graph was done through observation of the position of the "bulge" of the graph. This was used to determine whether the domain was "reasonably well known", and whether there existed a "need for more difficult

work, or for new topics and extension of earlier topics" or "a need to continue consolidating, clarifying and practising the work covered in the DMT" (Schleiger, 1993, p.6).

Pattern of mastery and item analysis

The checklist and the percentage scores were also used for the item analysis, to provide a pattern of mastery. If an item was answered by 75% of the class, the question was seen to have been mastered by the class overall (Schleiger, 1993, p.5). Items not achieving this level of response were considered to need further instruction, and the types of errors occurring on these items were analysed. As a result of the error analysis, areas of difficulty for the class in terms of items not yet mastered were determined.

Identification of students for follow-up

The manual suggested use of the performance of frequency graph to help identify students who were in need of "enrichment and extension" as well as those who were struggling and required further diagnostic investigation (Schleiger, 1993, p.7). This was done by identifying each student by initial on the graph. Those students who stood out "at either end of the frequency performance graph", were considered to "need special attention" and "follow-up" (p.6). This includes students "struggling to cope with the ordinary classroom curriculum", as well as those requiring "enrichment and extension" (p.6).

Individual interpretation

Individual analysis for each of the students identified "in need of follow-up" was carried out. This included the analysis of each student's checklist and paper. The students identified as above were marked on the checklist and their pattern of errors was analysed from the coding on the checklist, with further reference to each students' paper. Information about areas and particular items causing difficulty, as well as types of errors were compiled for each of these students.

In summary, this data analysis for the DMT was as prescribed by the manual. This produced coded checklists, percentage score, patterns of mastery and item analysis, identification of students for follow-up and individual interpretation.

Appendix 4.9
KeyMath-R: Data analysis

The gathering of results of the KeyMath-R, and their analysis, was carried out as prescribed in the manual (Connolly, 1988) for each of the three administrations of the KeyMath-R in this study. The manual provided for scaled scores for the subtest, domain raw scores and item analysis. Individual analysis was carried out using raw and scaled scores, and individual profiles based on defined objectives for the items.

Scaled scores

The raw score, out of twenty-four, was used to derive scaled scores with a mean of 10 and standard deviation of 3. The scaled scores were designed to approximate a normal distribution with 68% of the scores being within one standard deviation of the mean (Connolly, 1988, p.26). A scaled score derived from an age group as well as one derived from a grade group (US sample) were possible. For this study the age group was used as the comparison group, since the grade equivalents between US and Australian schools produce some discrepancy. Two levels of confidence were available for the scaled score, 68% and 90% (Connolly, 1988, p.24). For this study the 90% confidence level was used to determine the range or interval within which the true score was likely to fall, to increase the meaning of the results. This resulted in a range of ±1.8 for each score for all relevant ages. The raw score was determined for each student as the total score achieved once the ceiling of three consecutive incorrect items was achieved. This score included any items below the established basal. This raw score was converted, according to the age norm tables, to a scaled score (Connolly, 1988, p.120). The scores then allowed for an interpretation that indicated the performance of the class as a whole in terms of total scores, item performance across the domains, and analysis of the critical ranges across the class. Descriptors of the performance were obtained from the KeyMath-R Report to Parents (Connolly, 1988, p.42), and used to identify those who were 'markedly above average', 'above average', 'average', 'below average' and 'markedly below average'.

Domain raw scores and item analysis

Domain scores comprised four scores, each out of six. Because of the use of basals and ceilings, students did not attempt items in all domains and their performance on some items was assumed from the pattern of responses on the items that they attempted. All items that below the basal were considered to be scored correctly, and all items above the ceiling were considered to be failed. The KeyMath-R provides for the analysis of domain raw scores in comparison to grade norms, resulting in a description of a student's performance as weak, average or strong. Because of the difficulties in applying US grade norms to Australian samples, this was not carried out. However, comparison of the results within the group and in relation to the stated objectives within each domain was carried out to provide a description of the class performance within each domain.

Individual raw and scaled scores

The individual performance of each student is presented in terms of raw scores, scaled scores based on age norms, and individual profiles of skills in terms of the objectives for each of the items. Analysis of performance on the items and within each domain was also carried out. Individual item analysis was done using the defined objectives (Connolly, 1988, p.86) providing a profile of skills and concept knowledge for each student.

Individual profiles

Individual performance is described through the scores and item analysis. The design of this study involved administration of one of the thirteen strands within the KeyMath-R. Scores available therefore included the Numeration subtest raw and scaled scores, descriptor of relative performance in reference to the norm sample and individual profile of skills and knowledge in reference to the objectives defined for each item in the subtest. The objectives were included in an individual profile form, that allowed recording of correct items on each of the three assessment occasions. A part of the profile form is shown in Table A.1.

Table A.1 KeyMath-R Profile (part)

Item	Objective	(1)	(2)	(3)
1	The student can count objects (1-5) in a set.	√	√	√
2	The student can form a set whose numbers correspond with the members of a given set (1-5).	√	√	√
3	The student can read one digit numerals (0-9).	√	√	√
4	The student can order a set of one digit numbers.	√	√	√
5	The student can count objects (0-9) in a set.	√	√	√
6	The student can name the ordinal position of each object in a row of up to nine objects.	√	√	√
7	The student can determine the numbers immediately preceding and following a given two-digit number.	√	√	√
8	The student can order a set of two-digit numbers.	√	√	√
9	The student can count sets of tens.	√	√	

The profile includes the item number, the relevant objective defined in the manual, and a column for each of the three administrations. Tick marks in the columns indicate the item was scored correctly. Analysis of performance on specific items with respect to the objectives of the items also augmented the interpretation (Connolly, 1988, p.2). This profile and the students' record form assisted such interpretation.

In summary, the data analysis of the KeyMath-R was as prescribed in the manual. This provided scaled scores based on age norms, domain raw scores and item analysis across the class. Information provided about each individual student was in the form of raw and scaled scores, with associated descriptors of relative performance, as well as individual profiles of skills and knowledge.

Appendix 4.10

STOPV: Stages of understanding

Students who could not read and write two-digit numbers, or count to about thirty were considered to have conceptual understanding prior to the five stages defined here. It was considered unlikely that any students in this study would not be able to be classified into the stages. The stages of development of place-value numeration of two-digit numbers are defined here and the type of indicators generated by the STOPV are presented.

Stage III, Stage of Understanding

Understanding, was defined by Ross (1986) to include students who know:

> that the individual digits in a two-digit numeral represent a partitioning of the whole quantity into a tens part and a ones part. The quantity of objects corresponding to each digit can be determined even for collections which have been non-canonically partitioned.
>
> (Ross, 1986, p.39)

Stage II: The Construction stage

It is defined by Ross (1986) to include students who know:

> the left digit in a two-digit numeral represents sets of ten objects and that the right digit represents the remaining single objects but this knowledge is tentative and characterized by unreliable task performances.
>
> (Ross, 1986, p.37)

Stage I: The Emergent stage

This first stage of development of understanding of place-value numeration incorporates the first three of Ross' stages. Therefore students within this stage may include

- those who are:

> able to read and write two-digit numerals and associate the whole numeral with the number it represents. The child assigns no meaning, however, to the individual digits which comprise the two-digit numeral.
>
> (Ross, 1986, p.33)

- as well as those who know:

> that in a two-digit numeral the digit on the right is in the "ones place" and the digit on the left is in the "tens place."
>
> (Ross, 1986, p.34)

These students can identify and label the tens and ones columns in a two-digit number, with some reversal errors, however, they do not identify the quantities represented by the individual digits.

- and those who interpret:

> each digit as representing the number indicated by its face value; the set of objects represented by the tens digit, however, are different objects than the objects represented by the ones digit.
>
> (Ross, 1986, p.35)

The value represented by the digits need not combine to form the total quantity of the number, they do not represent a part-whole relationship. Task 3 was designed specifically to identify students who were using this type of conceptualisation. It includes a grouping of counters that supports a face-value interpretation of a two-digit number.

Appendix 4.11

STOPV-DA: Profile form

Task 1 Conservation		Level 1	Level 2	Level 3
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4
Task 3 Non-standard partitioning	Level 1	Level 2	Level 3	Level 4
Task 4 Counting by tens	Level 1	Level 2	Level 3	Level 4
Task 5 (06)		Level 1	Level 2	Level 3
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit	4 digit
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit	4 digit

Appendix 4.12

Parent information letter

(on UNE letterhead)
Dear parent,

I am carrying out some research into the assessment of children's understanding of our numeration system and would like the children in year 3 at Orange Public School to participate.

This would involve a short class test on numbers followed by individual interviews to look more closely at each child's understanding. This would later be compared with the results of the test. Part of the interview would measure the child's immediate potential for learning in numeration.

Retesting and interviewing would be used to compare the extent of growth of understanding over the months and the usefulness of the interviewing technique.

The project is being carried out as part of a Master of Education (Honours) Degree* through the University of New England. I am an experienced teacher and educational psychologist. I would ensure the experience for each student will be comfortable and that the session would contribute to their learning.

I am happy to explain the project further and to share the results at the conclusion of the project. If you wish to ask further questions please contact me on 610 169. Please complete the permission form attached, and return it to the teacher, to include your child in this project.

Jeanette Berman

.....

Parent permission for inclusion of student in research project

I give permission for my child _____to participate in the research project on assessment of number understanding, to be conducted by Ms Jeanette Berman.

I understand that there will be individual assessment interviews and that the information will be provided for the teacher following the project to assist in planning for my child.

I would like to request an interview with the examiner at the end of the project to discuss the results of the assessment of my child. Yes / No

Signed _____ Date _____

* This research began as an M.Ed (Hons) study.

Appendix 6.1

DMT: Coded checklists

DMT (1) CHECKLIST

- ◢ partly correct
- N not attempted
- sp spelling
- R reversal of digit or numerals
- O omission of symbol or unit

TOPIC	Item	OBJECTIVE	Zoe	Xavier	Wanda	Thomas	Sam	Rachael	Peta	Natalie	Maddie	Laura	Kieran	Jack	Ingrid	Hannah	Grace	Farley	Curran	Daniel	Chris	Brooke	Alex	Item %	
Numeration and Notation	1	Oral -> writes 83		R																				95	
	2	Oral -> writes 15																						100	
	3	Oral -> writes 109																						90	
	4	Oral -> writes 290																						95	
	5	Oral -> writes 409																						100	
	6	Oral -> writes 819																						86	
	7	Reads-> writes 70		O							O													67	*
	8	Reads -> writes 13																						95	
	9	Reads -> writes 51																						90	
	10	Reads -> writes 203																						86	
	11	Reads -> writes 950								R														71	*
	12	Reads -> writes 619																						76	
Place Value to 999	13	Counts by 1s -> 30							N															76	
	14	Counts by 10s -> 30							N															96	
	15	Identifies by 10s is easier						N		N														71	*
	16	Counts by 10s -> 4 tens																						71	*
	17	Recognises 4 tens = 40		N																				90	
	18	Counts -> 6 tens 7 ones																						76	
	19	Recognises 6 tens 7 ones = 67				N																		76	
	20	Counts money -> $76			N																			76	
	21	Constructs 5 tens 4 ones			N																			33	*
	22	Recognises 92 = 9 tens 2 ones				N							N											67	*
	23	MAB 10 identifies 160			O						R													43	*
	24	MAB 10 identifies 208																						76	
	25	MAB 10 renames 1s ->68																						76	
	26	MAB 10 renames 10s ->215								R		O												15	*
	27	Abacus renames 10s ->143								N	O				N									38	*
Ordering	28	Orders 5 numbers: s -> L				R												O				R		76	
	29	Writes 753 as largest			N																			76	
Counting Sequences	30	Counts Id/bk by 10s							N														N	52	*
		% Score	80	50	40	67	83	47	73	77	90	90	67	97	80	60	97	80	83	83	93	60	80		
				*	*	*		*	*				*			*						*			

* below mastery 75%

DMT (2) CHECKLIST

◢	partly correct
N	not attempted
sp	spelling
R	reversal of digit or numerals
O	omission of symbol or unit

TOPIC	Item	OBJECTIVE	Zoe	Xavier	Wanda	Thomas	Sam	Rachael	Peta	Natalie	Maddie	Laura	Kieran	Jack	Ingrid	Hannah	Grace	Hayley	Ewan	Daniel	Chris	Brooke	Alex	Hey %
Numeration and Notation	1	Oral -> writes 63																						100
	2	Oral -> writes 15								■														95
	3	Oral -> writes 109						R ◢																95
	4	Oral -> writes 280						R ◢														◢		90
	5	Oral -> writes 409																						100
	6	Oral -> writes 819						◢	◢															90
	7	Reads-> writes 70						◢			◢									◢		◢		81
	8	Reads -> writes 13				■																		96
	9	Reads -> writes 51																				◢		95
	10	Reads -> writes 203				R ◢		◢														◢		86
	11	Reads -> writes 950						◢		R ◢												N		86
	12	Reads -> writes 819		◢				◢														■		86
Place Value to 999	13	Counts by 1s -> 30					■												■	■				86
	14	Counts by 10s -> 30																						100
	15	Identifies by 10s is easier			■							■										N		86
	16	Counts by 10s -> 4 tens																■				■		90
	17	Recognises 4 tens = 40																						100
	18	Counts -> 6 tens 7 ones		◢				◢					◢	■	◢	■		■	◢			◢		57 *
	19	Recognises 6 tens 7 ones = 67		■									◢					■	◢				■	76
	20	Counts money -> $75		◢				◢																90
	21	Constructs 5 tens 4 ones		◢	N	N	■			◢		N	◢										■	62 *
	22	Recognises 92 = 9 tens 2 ones				N						N			■			■				■		76
	23	MAB 10 identifies 160				R ◢							◢		■	◢		N				◢		71 *
	24	MAB 10 identifies 208		N	■			■					◢		■					■		■	◢	62 *
	25	MAB 10 renames 1s ->68						■		◢						■		■		■				76
	26	MAB 10 renames 10s ->215		■	■			■		◢					◢			◢		◢		◢	◢	57 *
	27	Abacus renames 10s ->143			■	■		■							◢	■		■		◢		■		62 *
Ordering	28	Orders 5 numbers: s -> L																				◢		95
	29	Writes 753 as largest						■										N						90
Counting Sequences	30	Counts fd/bk by 10s	◢	■	N	N		■		N		N	◢			◢		■				■	N	43 *
		% Score	97	73	80	77	93	50	97	90	97	87	80	97	80	83	100	67	90	80	100	47	83	
				*				*										*				*		

DMT (3) CHECKLIST

partly correct
N not attempted
Sp spelling
R reversal of digit or numerals
O omission of symbol or unit

TOPIC	Item	OBJECTIVE	Zoe	Xavier	Wanda	Thomas	Sam	Rachael	Peta	Natalie	Madelei	Laura	Kieren	Jack	Ingrid	Hannah	Grace	Finlay	Ewan	Daniel	Chris	Brooke	Alex	Item %	
Numeration and Notation	1	Oral -> writes 83																						100	
	2	Oral -> writes 15																						100	
	3	Oral -> writes 109																						100	
	4	Oral -> writes 290																						100	
	5	Oral -> writes 409																						100	
	6	Oral -> writes 819																						100	
	7	Reads-> writes 70																						90	
	8	Reads -> writes 13																						95	
	9	Reads -> writes 51																						100	
	10	Reads -> writes 203																						95	
	11	Reads -> writes 950																						95	
	12	Reads -> writes 619																						90	
Place Value to 999	13	Counts by 1s -> 30																						100	
	14	Counts by 10s -> 30																						100	
	15	Identifies by 10s is easier														N								95	
	16	Counts by 10s -> 4 tens																						81	
	17	Recognises 4 tens = 40																						95	
	18	Counts -> 6 tens 7 ones																						62	*
	19	Recognises 6 tens 7 ones = 67																						86	
	20	Counts money -> $76																						90	
	21	Constructs 5 tens 4 ones														N						N		62	*
	22	Recognises 92 = 9 tens 2 ones																						95	
	23	MAB 10 identifies 160										R				R								67	*
	24	MAB 10 identifies 208											O											81	
	25	MAB 10 renames 1s ->68																						76	
	26	MAB 10 renames 10s ->215																						67	*
	27	Abacus renames 10s ->143																						81	
Ordering	28	Orders 5 numbers: s -> L																						90	
	29	Writes 753 as largest																					N	76	
Counting Sequences	30	Counts fd/bk by 10s				N																		71	*
		% Score	87	73	87	90	100	63	100	100	100	97	83	93	90	93	97	60	97	90	100	73	87		
				*				*										*				*			

Appendix 6.2

STOPV-DA: Individual student assessment data

Twenty-one individual profiles and collated data from the STOPV-DA assessment.

STOPV-DA individual data — Alex

Task 1 Conservation		Level 1 (1)	Level 2	Level 3 (2) (3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1	Level 2	Level 3 (1) (2)	Level 4 (3)
Task 4 Counting by tens	Level 1	Level 2	Level 3 (1) (2)	Level 4 (3)
Task 5 (06)		Level 1	Level 2 (1) (2) (3)	Level 3
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit (1) (2) (3)	4 digit
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit (1)	4 digit (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	13	16	10
No. interactions	18	20	12
No. tasks	6	4	2
No. task-steps	7	4	2

	(1)	(2)	(3)
Effective mediation strategies	Clarification of meaning of the question Seek meaning from presentation Explanation of link to previous work	Guiding link with previous work Seeking evaluation, guiding evaluations	Seeking evaluation
Ineffective mediation strategies	Seeking alternative meaning Guided link to previous concepts	Seeking explanations	
Aspects of functioning	Very slow, deliberate when counting, stops at times to consider Sought clarification, comments showed he was trying to make sense of the task e.g.,	Needed encouragement at times Challenged idea of the question "It's not a number"	Challenged ides of the questions" You can't." Needed to check often, still made mistakes, needed ordered groups Participated in discussion

	"I didn't count them I just put them in piles" Keen to learn, but anxious		

STOPV-DA individual data Brooke

Task 1 Conservation	Level 1 Level 2 Level 3 (1) (2) (3)
Task 2 Standard place value partitioning	Level 1 Level 2 Level 3 Level 4 ***
Task 3 Non-standard partitioning	Level 1 Level 2 Level 3 Level 4 (1) ~~(2) (3)~~
Task 4 Counting by tens	Level 1 Level 2 Level 3 Level 4 (1) ~~(2) (3)~~
Task 5 (06)	Level 1 Level 2 Level 3 (1) ~~(2) (3)~~
Task 6 Writing multi-digit numbers	1 digit 2 digit 3 digit 4 digit (1) ~~(2) (3)~~
Task 7 Reading multi-digit numbers	1 digit 2 digit 3 digit 4 digit (1) ~~(2) (3)~~

	(1)	(2)	(3)
Length of session (minutes)	36	19	29
No. interactions	96	37	73
No. tasks	6	6	5
No. task-steps	9	7	5

	(1)	(2)	(3)
Effective mediation strategies	Very explicit explanations using small focus Familiar base-ten representation, with links made explicit recalling previous concepts, needed guided linking Explanation of makeup of the base-ten blocks, columns in line with the blocks	familiar representation, guided explanation of grouping explicit explanation, modelled self-talk, integration of visual, language and action immediate evaluation, to reduce her going off in wrong direction	guided and provided links combined guided and provided explanations, combination of visual, action and description / explanation assistance with visualisation and reference to the blocks
Ineffective mediation strategies	Less focused strategies reliance on assumed memory following Brooke's ideas, usually well off the track	Regrouping with requestioning (no meaning)	regrouping with requestioning, still stuck on the other groupings (face value) seeking evaluation or explanation making assumptions about "knowns"

Aspects of functioning	confused explanations - >expressive language difficulties participates, volunteers and tries, is engaged but finds it very difficult memory? confused reasoning needed reassurance, sought clarification at times	Memory? doesn't trust her memory, has no shortcuts, goes back to the beginning a lot receptive language difficulties Uses self-talk Will have a go	participates in discussion effectively needs lots of consolidation and practice no shortcuts, every step is hard work contributes, takes turns effectively, but needs appropriate steps to make it meaningful

STOPV-DA individual data Christopher

Task 1 Conservation		Level 1 -1	Level 2	Level 3 (2) (3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 4 Counting by tens	Level 1 (1) (2)	Level 2	Level 3	Level 4 (3)
Task 5 (06)		Level 1	Level 2 (1)	Level 3 (2) (3)
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1) (2) (3)
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1) (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	12	8	5
No. interactions	6	11	0
No. tasks	3	1	0
No. task-steps	5	2	0

	(1)	(2)	(3)
Effective mediation strategies	focus on all beans, paraphrasing question explanation of counting by tens	seeking and guiding of explanation	No mediation
Ineffective mediation strategies			
Aspects of functioning	misinterpretation of question, not making sense of it acceptance of concepts that make little sense,		precise efficient responses / explanations

	not questioning, does not seek information, clarification not engaging fully in learning or in the relationship, does not initiate learning very quiet, not prepared to have a go, won't explore unknown, needed encouragement to respond ponders issues on his own, but then accepts misconceptions had to repeat the numbers for writing, memory? tentative responses gets put off when not really sure		

STOPV-DA individual data Daniel

Task 1 Conservation		Level 1	Level 2	Level 3 (1) (2) (3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1 (1)	Level 2	Level 3 (2)	Level 4 (3)
Task 4 Counting by tens	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 5 (06)		Level 1	Level 2 (1) (2)	Level 3 (3)
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1) (2) (3)
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1) (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	14	12	10
No. interactions	16	11	0
No. tasks	2	2	0
No. task-steps	3	2	0

	(1)	(2)	(3)
Effective mediation strategies	familiar representation, seek explanation to level 3 guide explanation to level 2, seek visual representation of counters and explanation guided explanation	using block representation, and organisation of blocks in columns, with guided explanation	
Ineffective mediation strategies	seeking generation of alternative ideas	discussion of block representation	
Aspects of functioning	self-driven and wanting to please embarrassed that could not answer, anxious, likes to know what to expect looked to researcher for clues as to whether on the right track no risk taking	sought clarification when did not clearly understand the question doubts self at times, easily loses confidence, needs reassurance and encouragement no risk taking	in a rush, agitated, anxious considered responses and self-corrected twice

STOPV-DA individual data Ewan

Task 1 Conservation		Level 1	Level 2	Level 3 (1) (2) (3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1 (2)	Level 2	Level 3	Level 4 (1)→(3)
Task 4 Counting by tens	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 5 (06)		Level 1	Level 2 (1)	Level 3 (2) (3)
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1) (2) (3)
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1) (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	17	14	7
No. interactions	9	8	1
No. tasks	1	1	0
No. task-steps	1	2	0

	(1)	(2)	(3)
Effective mediation	reflect previous ideas (made immediate link	reflections with focus, assisting the direction	seek evaluation

strategies	and applied it) provide explanation (he wanted to know why)	of explanation	
Ineffective mediation strategies	seeking explanation		
Aspects of functioning	distractable, loses attention, active, socially confident, excellent language made immediate links diverts attention when "doesn't know" the answer, went on to tell about his computer	can give elaborated explanations but not always focused on the point of the question	

STOPV-DA individual data Farley

Task 1 Conservation		Level 1 (1) (2)	Level 2	Level 3 -3
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1 (1)	Level 2	Level 3 (2)	Level 4 (3)
Task 4 Counting by tens	Level 1 (1) (2) (3)	Level 2	Level 3	Level 4
Task 5 (06)		Level 1	Level 2 (1) (2)	Level 3 (3)
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit (1) (2) (3)	4 digit
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit (1)	4 digit (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	20	22	14
No. interactions	61	41	5
No. tasks	6	5	2
No. task-steps	9	7	2

	(1)	(2)	(3)
Effective mediation strategies	sequence of guided explanation of very small bits of information familiar representation, provide the language, guide the links modelling, labelling, repeating information	providing description of action, recalling number of beans, then asking question again emphasise the meaning made from his explanations, provide immediate feedback on misconceptions	explanation that counting by tens means grouping reflect the correct aspects of success, focus on pertinent aspects on the question link reading and writing

	and ideas (structured training) providing evaluations	familiar representation, guide the links explanation, describe process for base-ten block counting	
Ineffective mediation strategies	seeking explanations (he made little or no response to many of these) frustration of the researcher is evident leading to selection of modelling strategies and direct explanations seeking evaluations	seeking description and explanation reflecting on previous ideas seeking links	
Aspects of functioning	unmotivated, not interested, needs urging, distrusts own ability, gives up easily, distractable minimal expressive language made it hard to know what he was thinking some eagerness to please, the only aspect that could be used to keep the session going imprecise language, hard to determine thinking, confusing	doubts ability, needed reassurance and feedback of success uses visual structure, made beans into rows for counting by tens	memory? minimal expressive language made it hard to know what he was thinking happy to accept the immediate face meaning, doesn't search for meaning

STOPV-DA individual data Grace

Task 1 Conservation		Level 1	Level 2	Level 3 (1)(2)(3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1)(2)(3)
Task 3 Non-standard partitioning	Level 1	Level 2 (1)(2)	Level 3	Level 4 (3)
Task 4 Counting by tens	Level 1	Level 2	Level 3	Level 4 (1)(2)(3)
Task 5 (06)		Level 1	Level 2 (1)	Level 3 (2)(3)
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit (1)(2)	4 digit (3)
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1)(2)(3)

	(1)	(2)	(3)
Length of session (minutes)	17	9	6
No. interactions	28	12	0
No. tasks	3	2	0
No. task-steps	3	2	0

	(1)	(2)	(3)
Effective mediation strategies	expectation of success, reversing roles, seeking alternative task, extension to five-digit number familiar representation, link with previous ideas seeking link with familiar representation guided explanation	reflection of spontaneous counting, grouping by tens, seeking links seeking evaluation, with reference to correctly read number	No mediation
Ineffective mediation strategies	regrouping	regrouping	
Aspects of functioning	eager to please, wanting to learn, good interpersonal skills absorbed by task, comfortable in adult company, persistent, needed minimum commendation excellent receptive and expressive language confident, challenged by hard tasks	makes links, provides meaningful explanations eager to please, wanting to learn, good interpersonal skills absorbed by task, comfortable in adult company, persistent, needed minimum commendation excellent receptive and expressive language	

STOPV-DA individual data Hannah

Task 1 Conservation		Level 1	Level 2	Level 3 (1) (2) (3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1	Level 2 (1) (2) ~~(3)~~	Level 3	Level 4
Task 4 Counting by tens	Level 1 -1	Level 2	Level 3 (2) ~~(3)~~	Level 4
Task 5 (06)		Level 1	Level 2 (1) (2) ~~(3)~~	Level 3
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit (1) (2) ~~(3)~~	4 digit
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit (1) (3)	4 digit (2)

	(1)	(2)	(3)
Length of session (minutes)	27	23	13
No. interactions	76	35	20
No. tasks	5	4	5
No. task-steps	6	4	5

	(1)	(2)	(3)
Effective mediation strategies	familiar representation, procedural understanding obvious reflection then guided explanation, needed modelling of counting by tens seeking reflection and evaluation, but needed to be safely done, as she was very low in confidence reflection and evaluation during the tasks to keep her going, could evaluate effectively and move on	seeking links with familiar representations supported exploration of ideas, validating her thinking, seeking generation of ideas, taken up well reflection for evaluation, restating the question statement of the generalisation about two-digit numbers, applied effectively	seeking alternative grouping to make sense of the two digits familiar representation, linked the grouping idea to the counters with no assistance reflection and seeking evaluation
Ineffective mediation strategies	ungrouping, with focusing explanation of counting by tens		
Aspects of functioning	good receptive and expressive language, full sentence responses, making sense needs praise, encouragement, and reassurance often distrusts own ability to an extent, some anxiety, when flustered mumbles	introduced and verbalised exploration of ideas, explained ideas clearly enjoyed the exploration of how to join the counters into groups of tens	provides alternative ideas for consideration rushing, made errors reading (lack of practice?)

STOPV-DA individual data Ingrid

Task 1 Conservation		Level 1	Level 2	Level 3 (1) (2) (3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1	Level 2 (1) (2)	Level 3 (3)	Level 4
Task 4 Counting by tens	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 5 (06)		Level 1	Level 2 (1) (2) (3)	Level 3
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit	4 digit (3)
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1) (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	18	17	12
No. interactions	29	25	9
No. tasks	3	3	2
No. task-steps	3	3	2

	(1)	(2)	(3)
Effective mediation strategies	familiar representation with guided explanation guided link with previous ideas reflection on written numbers, with reference to correctly read numbers of similar structure seeking reflection of actions, providing explanations in feedback, and encouragement	regrouping with requestioning, supported exploring of idea to see whether it helped make sense reflection of previous ideas guided evaluation, specific feedback, acknowledgment of success relating to the representation to consolidate and explore ideas	seeking more explicit explanation seeking evaluation and rechecking reflection of previous ideas
Ineffective mediation strategies	regrouping with requestioning seeking explanation of number of digits		
Aspects of functioning	quiet, reserved, limited contribution excellent receptive and expressive language, asked clarifying questions "I'm not very good at these." needed	some tentativeness, needed exploring and consolidating of ideas can identify links and make sense of them uses guided explanations effectively	making sense of hints given, used guided explanations effectively

	reassurance and then reflection of success		

STOPV-DA individual data Jack

Task 1 Conservation		Level 1	Level 2	Level 3 (1) (2) (3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 4 Counting by tens	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 5 (06)		Level 1	Level 2	Level 3 (1) (2) (3)
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1) (2) (3)
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1) (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	6	7	6
No. interactions	0	0	0
No. tasks	0	0	0
No. task-steps	0	0	0

	(1)	(2)	(3)
Effective mediation strategies			
Ineffective mediation strategies			
Aspects of functioning	excellent receptive and expressive language wanting to make sense of things uses language appropriately, e.g., "represents"		

STOPV-DA individual data Kieren

Task 1 Conservation		Level 1	Level 2	Level 3 (1) (2) (3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1	Level 2 (1) (2) (3)	Level 3	Level 4
Task 4 Counting by tens	Level 1 (1) (2)	Level 2	Level 3 (3)	Level 4
Task 5 (06)		Level 1	Level 2 (1) (2)	Level 3 (3)
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit (1)	4 digit (2) (3)
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit (1) (2) (3)	4 digit (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	23	20	9
No. interactions	47	31	8
No. tasks	5	3	2
No. task-steps	6	4	3

	(1)	(2)	(3)
Effective mediation strategies	familiar representation as reference while seeking explanation and regrouping counters explanation of counting by tens, reflection through link with reading and writing, then guided evaluation linking with previous ideas, recall and guided explanation, modelled use of specific language link with procedure of making numbers using base-ten blocks	familiar representations to recall previous ideas, but needed explicit linking to task 3 guided exploration of application to real problem (counting children in playground) reflect on previous ideas -> guided explanation	familiar representations to recall previous ideas with direct link illustrated through groupings
Ineffective mediation strategies	altering grouping and requestioning	removing groupings -> whole numeral response familiar representations without explanations seeking explanations	familiar representations without explanations
Aspects of functioning	when introduced to counting by tens, very slow, attention and focus is low, keeps losing it needed to go over	offering more comprehensive responses and explanations needed consolidation, showed some ongoing	increasing efficiency but needed practice counting by tens

	things several times, assisted exploration of ideas	confusion	

STOPV-DA individual data Laura

Task 1 Conservation		Level 1	Level 2	Level 3 (1) (2) (3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1 (2) (3)	Level 2 (1)	Level 3	Level 4
Task 4 Counting by tens	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 5 (06)		Level 1	Level 2 (1) (2) (3)	Level 3
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit (1) (2)	4 digit (3)
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit (1)	4 digit (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	20	12	12
No. interactions	28	22	12
No. tasks	4	3	2
No. task-steps	4	4	3

	(1)	(2)	(3)
Effective mediation strategies	explicit explanations, guided links with previous ideas familiar representations with explanation transfer to other tasks to build confidence and give practice opportunities to apply ideas presented, with support through guiding and reflection of success	guided explanation, guided links with previous work familiar representations with guided explanation and seeking evaluation explicit explanations and descriptions	reflection with elaboration for next guided question explicit reflection of Laura's short responses relating to previous work directly
Ineffective mediation strategies	seeking generation of alternative ideas	seeking explanations and links with previous work	indirect links, seeking links
Aspects of functioning	needed opportunities to see herself as learning and have it reflected to her needed intervention when unsure, to	guided evaluation to share responsibility of evaluation on to Laura not confident enough to explore ideas	not exploring ideas, gives short responses

	encourage continuation low confidence		

STOPV-DA individual data Maddie

Task 1 Conservation		Level 1	Level 2	Level 3 (1) (2) (3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1	Level 2 (1) (3)	Level 3	Level 4 (2)
Task 4 Counting by tens	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 5 (06)		Level 1	Level 2 (1)	Level 3 (2) (3)
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit (1)	4 digit (2) (3)
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1) (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	10	7	8
No. interactions	14	2	6
No. tasks	3	0	1
No. task-steps	3	0	1

	(1)	(2)	(3)
Effective mediation strategies	guiding evaluation and reflection, embedded feedback, not blatant, balance of intrusiveness familiar base-ten blocks seeking generation of alternative ideas seeking and guiding explanations (through focus)	seeking explanation	familiar base-ten blocks
Ineffective mediation strategies			removing the groupings and requestioning generate alternative ideas
Aspects of functioning	engaged with the teaching, made meaningful contributions, trying to make sense intrinsically motivated	Highly engaged in the session	had been away for two days sick, was very flat in the session, and slow to respond, not as had been in other sessions

STOPV-DA individual data — Natalie

Task 1 Conservation		Level 1 (1)	Level 2	Level 3 (2) (3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1	Level 2 (1) (2) (3)	Level 3	Level 4
Task 4 Counting by tens	Level 1 (1)	Level 2	Level 3 (2)	Level 4 (3)
Task 5 (06)		Level 1	Level 2 (1) (2) (3)	Level 3
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit (1)	4 digit (2) (3)
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit (1) (2)	4 digit (3)

	(1)	(2)	(3)
Length of session (minutes)	19	11	10
No. interactions	62	18	19
No. tasks	6	4	2
No. task-steps	8	4	2

	(1)	(2)	(3)
Effective mediation strategies	clarify question through emphasis, focus on total number familiar representations and 'look like' explain counting by tens seek generation of ideas seek link with previous ideas guided explanation	ungrouping, seek explanation (with time) familiar representation, compare groupings explanation, reflection and requestion	familiar representation, compare groupings 'look like' familiar representation, and guided explanation
Ineffective mediation strategies	repeat task question regrouping reflection, challenge number of beans	familiar previous idea, seek link	seek explanation
Aspects of functioning	needs direction, doesn't generate learning direction	tentative guess, needs safe environment and support for risk taking	lack confidence, needs reassuring interactions

STOPV-DA individual data Peta

Task 1 Conservation		Level 1	Level 2	Level 3 (1) (2) (3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1	Level 2	Level 3	Level 4 (3)
Task 4 Counting by tens	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 5 (06)		Level 1	Level 2	Level 3 (2) (3)
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit	4 digit (2)
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1) (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	16	12	11
No. interactions	20	6	2
No. tasks	3	1	1
No. task-steps	3	2	1

	(1)	(2)	(3)
Effective mediation strategies	representation (base-ten blocks) guiding explanations guiding reflection	alter visual arrangement guiding explanation	reflection of emotional response, gave her permission to self-evaluate
Ineffective mediation strategies	regrouping and seek explanation generalisation about grouping verbal interpretations		
Aspects of functioning	not highly engaged, waits to be told neutral emotional poor expressive language		more engaged

STOPV-DA individual data Rachael

Task 1 Conservation		Level 1	Level 2	Level 3
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4
Task 3 Non-standard partitioning	Level 1	Level 2	Level 3	Level 4
Task 4 Counting by tens	Level 1	Level 2	Level 3	Level 4
Task 5 (06)		Level 1	Level 2	Level 3
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit	4 digit
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit	4 digit

	(1)	(2)	(3)
Length of session (minutes)	27	29	18
No. interactions	80	45	18
No. tasks	6	5	3
No. task-steps	9	7	3

	(1)	(2)	(3)
Effective mediation strategies	familiar representations, with explicit description guided explanation and explicit, detailed explanation previous ideas with guided explanation boxes, structure for positional property, with explanations	requestion with emphasis (don't always accept DK as a response) familiar representation, with explicit comparison, requestion familiar previous idea, seek explanation explanation of number digits and positions, familiar representations, guide reflection practice manipulating base ten blocks with modelled explanations and reflections of actions	regrouping into familiar groupings expect success , guide explanation guided explanation, focus on number of digits, moving digits to different places (no blocks used)
Ineffective mediation strategies	seek link		seeking explanation
Aspects of functioning	needed reassurance, time and encouragement needed explicit direction for learning	does not expect success needed ongoing encouragement, especially as the teaching needs to be so intense	needs to have direct reflections of her learning teaching of writing and reading large numbers using symbols only, no blocks used

STOPV-DA individual data Sam

Task 1 Conservation		Level 1	Level 2 (3)	Level 3 (1) (2)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1	Level 2 (1) (2) (3)	Level 3	Level 4
Task 4 Counting by tens	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 5 (06)		Level 1	Level 2 (1) (2) (3)	Level 3
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1) (2) (3)
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit	4 digit (1) (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	16	11	11
No. interactions	14	11	10
No. tasks	2	2	3
No. task-steps	2	2	2

	(1)	(2)	(3)
Effective mediation strategies	familiar representations, seek explanation, guide explanation previous ideas with guided explanation provide explanation	familiar representations with requestion familiar previous idea, seek link	refocus on all 26 counters and requestion seek explanation
Ineffective mediation strategies	ungrouping (stuck on previous groupings)	regrouping and seeking explanation	regrouping and seeking explanation
Aspects of functioning	participates in the teaching / learning interaction effectively	can catch on to links, with minimal assistance	

STOPV-DA individual data Thomas

Task 1 Conservation		Level 1	Level 2	Level 3 (1) (2) (3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1	Level 2 (2)	Level 3 (1) (3)	Level 4
Task 4 Counting by tens	Level 1	Level 2	Level 3 (3)	Level 4 (1) (2)
Task 5 (06)		Level 1 (1)	Level 2 (2) (3)	Level 3
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit (1) (2) (3)	4 digit
Task 7 Reading multi-digit numbers	1 digit	2 digit (1)	3 digit	4 digit (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	33	20	19
No. interactions	82	8	17
No. tasks	4	3	4
No. task-steps	6	3	4

	(1)	(2)	(3)
Effective mediation strategies	familiar representation with guided explanation familiar representation with guided explanation guided explanation (focus on number of digits), memory support guided practice and transfer, guided reflection, familiar representations, guided use	ungrouping and requestion previous ideas, with some guidance reflection of type of error	guided reflection guided explanation
Ineffective mediation strategies	seek explanation previous idea and requestion		seek explanation
Aspects of functioning	needed recognition of success memory recall inconsistent began to question and challenge ideas needed explicit directed teaching		confusion, and does not reflect on what he has said, it can be quite wrong low confidence

STOPV-DA individual data Wanda

Task 1 Conservation	Level 1 Level 2 Level 3 (1) (2) (3)
Task 2 Standard place value partitioning	Level 1 Level 2 Level 3 Level 4 (1) (2) (3)
Task 3 Non-standard partitioning	Level 1 Level 2 Level 3 Level 4 (1) (2) (3)
Task 4 Counting by tens	Level 1 Level 2 Level 3 Level 4 (1) (3) (2)
Task 5 (06)	Level 1 Level 2 Level 3 (1) (2) (3)
Task 6 Writing multi-digit numbers	1 digit 2 digit 3 digit 4 digit (1) (2) (3)
Task 7 Reading multi-digit numbers	1 digit 2 digit 3 digit 4 digit (1) (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	34	24	17
No. interactions	99	64	35
No. tasks	6	6	6
No. task-steps	9	7	8

	(1)	(2)	(3)
Effective mediation strategies	very explicit guided explanations explicit reflections of actions and responses, modelled actions familiar representations with guided explanation direct explanation and guided reflection cover part of stimulus, direct explanations, box structure, build up of small steps	requestioning, with focus familiar representation with guided explanation modelled counting with explanation familiar previous idea guided reflection practice with manipulating base ten blocks with guided explanations, box structure	explanation with focus familiar representation, seek explanation and link explanation of counting by tens guide explanation reflect error and requestion, guided reflection
Ineffective mediation strategies	ungrouping and seek explanation explanation	ungrouping and requestion	ungrouping and seek explanation
Aspects of functioning	waits to be told, needs support, set expectation of response and success low confidence, prefers easy tasks, needs memory support tries very hard, to succeed and to please, need to build on success small steps, one concept or idea at a time	encouragement and recognition of success and effort	encouragement and recognition of success and effort

STOPV-DA individual data Xavier

Task 1 Conservation		Level 1	Level 2	Level 3
		(1) (2)		(3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4
				(1) (2) (3)
Task 3 Non-standard partitioning	Level 1	Level 2	Level 3	Level 4
		(1) (2) (3)		
Task 4 Counting by tens	Level 1	Level 2	Level 3	Level 4
		(1) (2) (3)		
Task 5 (06)		Level 1	Level 2	Level 3
		(1)	(2) (3)	
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit	4 digit
			(1) (2) (3)	
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit	4 digit
		(1) (2)		(3)

	(1)	(2)	(3)
Length of session (minutes)	26	22	15
No. interactions	54	49	20
No. tasks	5	6	3
No. task-steps	9	7	4

	(1)	(2)	(3)
Effective mediation strategies	seeking recall, interpretation and reflection combined to ensure he saw things as they were before moving on relating to previous work familiar representation, seeking explanation and parallel representation with counters seeking evaluation strategies	seek recall, to emphasise number, and requestion familiar representation, seek explanation familiar previous idea guided evaluation	familiar representation, seek explanation familiar previous idea guided reflection
Ineffective mediation strategies	regrouping	ungrouping and seek explanation	ungrouping and seek explanation
Aspects of functioning	misconceptions are not challenged, do not assume anything poor receptive language, needs constant praise and encouragement some anxiety, waits to be told, urging needed		

	at times clear expressive language		

STOPV-DA individual data Zoe

Task 1 Conservation		Level 1	Level 2	Level 3
		(1) (2)		(3)
Task 2 Standard place value partitioning	Level 1	Level 2	Level 3	Level 4
				(1) (2) (3)
Task 3 Non-standard partitioning	Level 1	Level 2	Level 3	Level 4
		(1) (2) (3)		
Task 4 Counting by tens	Level 1	Level 2	Level 3	Level 4
			(1)	(2) (3)
Task 5 (06)		Level 1	Level 2	Level 3
			(1) (2)	(3)
Task 6 Writing multi-digit numbers	1 digit	2 digit	3 digit	4 digit
			(1) (2)	(3)
Task 7 Reading multi-digit numbers	1 digit	2 digit	3 digit	4 digit
				(1) (2) (3)

	(1)	(2)	(3)
Length of session (minutes)	20	13	8
No. interactions	55	36	7
No. tasks	5	4	1
No. task-steps	6	5	1

	(1)	(2)	(3)
Effective mediation strategies	paraphrase question seeking explanation from familiar representation, guided reflection, linking reading and writing recalling previous meanings using boxes, seeking explanations	familiar representation boxes and reading, for evaluation, needed guidance	familiar representation, seeking explanation
Ineffective mediation strategies	seeking alternative meaning	remove groupings seek evaluation	remove groupings
Aspects of functioning	needed urging, waits to be told, anxious, distrusts own ability, gives up, prefers only easy tasks explores ideas, seeks clarification	clear precise explanations makes connections gets flustered when unsure, mumbles, needs reassurance needed encouragement, withdraws when unsure, won't risk, not confident	

Appendix 6.3

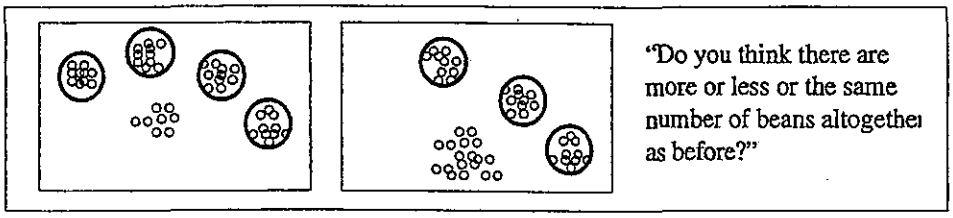
STOPV-DA: Number of Interactions

Student	No. Interactions (1)	No. Interactions (2)	No. Interactions (3)
Zoe	55	36	1
Xavier	54	48	20
Wanda	99	64	35
Thomas	82	8	17
Sam	14	11	10
Rachael	80	45	18
Peta	20	6	2
Natalie	62	18	19
Maddie	14	2	6
Laura	28	22	12
Kieren	47	31	8
Jack	0	0	0
Ingrid	29	25	9
Hannah	76	35	20
Grace	28	12	0
Farley	61	41	5
Ewan	9	8	1
Daniel	16	11	0
Christopher	6	0	0
Brooke	96	37	73
Alex	18	20	12

Appendix 6.4

Patterns of mediation

Task 1 Conservation of number



The initial strategy was to direct the focus onto the total number of beans, by more specific language and inclusive gestures. Once the total number of beans was re-established, the action of regrouping, by tipping some beans out of a cup and removing the cup was repeated. More specific language describing the action was used to emphasise the removal of a cup, not the beans. The description of the amount of beans being the 'same' was also reinforced. The action of tipping out the beans and removing another cup was repeated to finally establish that the student's conservation response was reliable.

A transcript of a typical mediation session for Task 1 is presented below. The bold writing identifies the scripted instructions and questions that were the same for all students. Res. indicates the contribution of the mediator, while the name of the student identifies their responses. Actions are included in brackets.

Res.	**(Put 48 beans and 9 cups on the table) Here we have 48 beans. Put ten beans in each cup.**
Natalie	(put all cups out, counted by ones into a cup at a time)
Res.	**How many beans are there?**
Natalie	...48
Res.	**Do you think there are more or less or the same number of beans altogether as before?**
Natalie	Less
Res.	**Why?**
Natalie	This one's got eight an these are all ten.
Res.	OK, so how many beans have you got altogether?
Natalie	48
Res.	48, so have we got the same or more or less than we had before?

Natalie Umm

Res. Altogether?
Natalie The same.

Res. The same, so we've got all the same. OK (tipped out another cup) If I take that cup away, have we got more, or less, or the same number of beans altogether now as before?
Natalie The same.

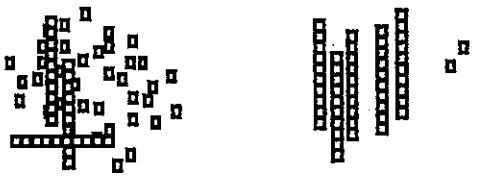
Res. The same. Why?
Natalie These two are ten and these were joined up to be ten and that's eight so it's 48.

Res. Ok so it's still the same?
Natalie Yep

Res. And if I do this (tip out a cup), what's happened now?
Natalie It's still the same.

Task 2 Standard place value partitioning and digit correspondence

"Use these counting blocks to build 52." "How do you know that is 52?"



Only one student received mediation on this task as all others provided highest level responses on the pre-test on all three assessments. Rachael gave no response to this question on the second assessment. The researcher paraphrased the question to reflect the procedure that Rachael used, and then reassured Rachael that she did know the answer.

Res. Use these counting blocks to build 52.
Rachael (routine)

Res. How do you know that is 52?
Rachael (no response)

Res. Why did you pick those instead of taking some more or less of these? Why have you got those?
Rachael umm

Res. Come on you know, tell me.
Rachael Because there's five. Fifty there and two.

Res. Yes. There's five. What's here?
Rachael Tens

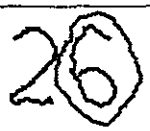
Res. So you do know! Did you think you'd get it wrong? Did you?
Rachael mmm

Res. Well you didn't, you got it right. There are five tens here and that makes fifty and you've got two ones, haven't you.

Task 3 Non standard partitioning of twenty-six

"Count these and write down how many."

"Sort the counters into groups of 4. "



"Does this part of your 26 have anything to do with how many counters you have?"

Xavier's session is presented to illustrate the type of mediation which typically occurred.

Res. **TASK 3 (26 counters on the table) Count these and write down how many.**
Xavier (by ones) ... 26

Res. **Sort the counters into groups of four.**
Xavier There's not enough.

Res. **(Circle 2) Does this part of your 26 have anything to do with how many counters you have?**
Xavier That there's two left over.

Res. **Circle 6 Does this part of your 26 have anything to do with how many counters you have?**
Xavier (no response)

Res. Any idea?
Xavier No

Res. Just think about this number, what number is it?
Xavier 26

Res. Now if we didn't group them (the counters), what does this 2 tell you about how many you've got?
Xavier (no response)

Res. What about this one (6)?
Xavier (no response)

Res. Tell you what, let's do it with this. Make 26 with these (base-ten blocks).
Xavier (no response)

Res. You've got 26. Now think about the question again. What does this (2) tell you about the number 26
Xavier That there's two tens.

Res. OK and that's what you've got with that, isn't it. What does this one tell you?

Xavier	Six little blocks
Res.	Six little blocks, six ones. All right, can you make that (counters), which is the same number as that (base-ten blocks), look a bit like that (base-ten blocks).
Xavier	(into rows)
Res.	OK. So what have we got?
Xavier	Two of these
Res.	Yes, what are they?
Xavier	Two tens and six ones

This transcript from the session with Xavier illustrates the typical pattern of mediation that occurred for Task 3.

Task 4 Counting by tens

"How many beans do you think there are?"

"Count them."

"Count them again by tens"

Hannah's session was more explicit than many of the sessions, however, it illustrated the general pattern of teaching which occurred.

Res.	**(Given 97 broad beans) How many beans do you think there are?**
Hannah	90
Res.	**Count them**
Hannah	(very erratic counting, no pattern and no rhythm) ... 97
Res.	**Count them again by tens.**
Hannah	(by twos giving value of ten to each two) 10, 20, ...100, 101, 102, 103, ...108, 200, 201, ...300, 303, 304, ...
Res.	So how many does that make altogether?
Hannah	A hundred and ... I mean 709.
Res.	Are there 709 there?
Hannah	Yep, ... no.
Res.	How many ?
Hannah	97
Res.	So how did we get 709?
Hannah	I was counting wrong...I think.
Res.	When you count by ones, 1, 2, 3, 4, 5. When you count by twos you go ... 2, 4, 6, 8 (together)
Hannah	2, 4, 6, 8. (together)

Res. If you count by tens, what do you do? Can you count by tens in your head?
Hannah Yes

Res. OK, got it? How do we do that with these?
Hannah Go 10, 20, 30 ... (for each bean)

Res. Got to put them in tens. (mediator modelled) You do it now.
Hannah (Counted ten, ... ten) 50.

Res. Hang on, you haven't got fifty beans there though have you? How many have you got there?
Hannah 20

Res. 20. Good girl, 10, 20, ... Keep going.
Hannah (Continued counting tens)

Res. How many are we putting in each group?
Hannah 10. ... 40, ... 50, ... 60, ... 90

Res. How many left over?
Hannah 90, ... 1, 2, 3, 4, 5, 6, 7.

Res. So how many?
Hannah 97

Res. Which is what you got when you counted by ones, and now you can count by tens too. Which is easier, counting by ones or tens?
Hannah Tens

Res. Yes, and you can check it more easily can't you.

Task 5 Interpretation of the whole numeral '06'

USE BY: 0 6 A P R	"What number is this?" "Why?"

The following transcript illustrates the typical mediation pattern.

Res. **(Present packet with USE BY 06 Apr) What number is this?**
Natalie 6 0 or 0 6

Res. 0 6
Natalie no response

Res. **What does the nought do?**
Natalie ...

Res. Why is the nought there? What's the 0 there for?
Natalie ...

Res. Any ideas?
Natalie No

Res. You know how you told me here that this (2 in 26), told you...

Natalie Two tens

Res. ... and that (6), told you..
Natalie Six ones

Res. Six ones. Now look at this (06). What does this (0) tell you?
Natalie No tens and six ones.

Res. Well done. That's exactly right. If we had it round the other way and it was 6 0 what would that tell you?
Natalie Six tens and no ones.

Res. And it would be sixty wouldn't it?
Natalie Yea

Res. Cause it's that way, it's no tens and six ones. Do you know what the nought's doing there?
Natalie ...

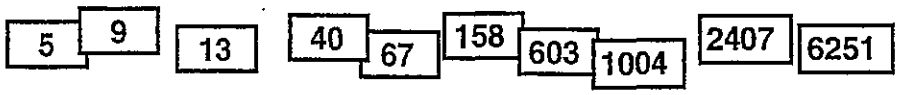
Res. It's holding the place, for if there are going to be any tens. When there are some here, like here you've got two tens, the nought goes away and the two sits here instead. So it holds the place for the tens.

Task 6 Writing multi-digit numbers

"Write these numbers 3, 6, 19, 83, 109, 172, 1607, 3045, 6572."

Task 7 Reading multi-digit numbers

"Tell me what these numbers are."



The two tasks, 6 and 7 were mediated together. Parts of a typical mediation session are presented.

Res. **Write these numbers. Three, six, nineteen, eighty three, one hundred and nine, one hundred and seventy two, one thousand six hundred and seven, three thousand and forty five, six thousand five hundred and seventy two.**
Wanda (3 digit correct, 100607, 30045, 6005072)

Res. **Read these numbers. (5, 9, 13, 67, 40, 158, 603, 1004, 2407, 6251 on cards)**
Wanda (3 digit correct) one hundred and four. 2 hundred and 4, 6 hundred and 51.

Res. (covered 62 in 6251) What's this?
Wanda 51

Res. (uncovered 2 in 251)
Wanda 251

Res. So if it's got three digits it's a hundreds number. What is it when it's got four digits?
Wanda (non-response)

Res. They're much bigger, they're thousands. You know when we have the blocks, the shorts -ones, the longs -tens, the flats -hundreds and the big cubes - thousands. So this is 6,251. (drew boxes, ones, 10s, 100s, 1000s) let's make some more thousands numbers by putting numbers in these boxes (wrote 6,391). Let's read it. Six thousand, three hundred and ninety one. Read this one. (3453)

Wanda Three thousand, four hundred and fifty three (slowly and tentatively).

Res. Well done, Wanda. You can read any thousand number now. Now we're going to get a bit tricky because we're going to use nought (wrote 2406). What number have I written?

Wanda Two thousand, four hundred and ...

Res. And six. The nought shows that there are no tens, so you just go on to the ones. Now try this one (1053).

Wanda One thousand and fifty three.

Res. Very good, and because the nought was there it told you...

Wanda No hundreds

... (Session continued)

Res. Make up a number for me to write Wanda.

Wanda One thousand and two.

Res. Alright I've got to remember that One thousand and two. It has a one for the thousands and two ones. It must have two noughts in between to hold the places for the hundreds and tens. Right?

Wanda Yes

Res. Alright look at these numbers. You said this was a hundred and four. It's not a hundred and four is it? What is it?

Wanda One thousand and four.

Res. One thousand and four, good girl. What's this one?

Wanda Six thousand, two..

Res. hundred

Wanda and fifty one.

Res. Good now I want you to write down three thousand and forty five.

Wanda (wrote 3,045)

Res. Excellent. OK, one more. ... (Session continued)

These transcript excerpts have illustrated the type of mediation that occurred for the tasks.

Appendix 6.5
Mediation strategies defined

The mediation strategies used in the dynamic assessment are defined. This complements the Table 6.6 in which they are summarised and illustrated.

Strategy 1 Explanation, Description, Interpretation, or Summary

The first strategy is the explanation, description, interpretation or summary of information, actions, or concepts. The lowest degree of intrusiveness for this strategy would be to seek an explanation, description , interpretation or summary from a student. A moderate degree of intrusiveness would be the researcher guiding an explanation, description or summary from a student, and the most intrusive form of this strategy would be for the researcher to provide an explanation, summary, interpretation, or description.

Strategy 2 Task question

The repetition of a task question was considered a separate strategy. This occurred for different reasons. The task questions were reintroduced following some teaching, as probes, or were applied to parallel tasks. The researcher repeated a question directly, paraphrased it, or elaborated the meaning, providing additional meaning to the question.

Strategy 3 Recall

Another strategy that was used was the recall of information, concepts, and actions from within the tasks or from earlier parts of the session. This included the information provided within the task question and other details of teaching. There were three degrees of intrusiveness within this strategy. The researcher could seek recall from the student, could guide recall, or provide the recall. Other supports such as having information available for reference on paper, by note-taking, or in other forms were also included in this strategy.

Strategy 4 Focus

The strategy of focusing learning was also used. The three degrees of intrusiveness were seeking the focus from the student, guiding the focus, and providing the focus explicitly. This strategy occurred through verbalisations, gestures or a combination of both.

Strategy 5 Alternative

The teaching included the introduction of information, concepts, and procedures that were alternative to those being used by a student. This was also done across the three different levels of intrusiveness. The researcher could ask the student for other ways of doing or thinking about the task, could guide this generation and exploration of alternatives, or could provide an alternative. If the student was following an alternative pathway, generated during the session, the researcher could accept the exploration, guide it or model it.

Strategy 6 Connection

A useful teaching strategy was to link the teaching to previous aspects of the session or to other aspects of place-value numeration, i.e., to make connections between information, concepts and actions. The researcher could seek a link from a student, could guide a link, or could provide a direct link. The link could be to ideas and concepts dealt with previously during the session, to earlier tasks, or the links could be between different aspects of numeration.

Strategy 7 Representation

The use of concrete and visual representations of numbers during the teaching was considered a separate teaching strategy. The representations available for use included the material representations such as the base-ten blocks, the counters, beans, etc. used in the tasks, as well as paper and pencil for graphic representations. The researcher could provide access to materials, and invite the student to use the representations. This was the least intrusive approach. The next degree of intrusiveness would be for the researcher to guide the student in the use of materials, suggesting an appropriate representation and possible use, and the most intrusive form of the strategy would be for the researcher to model the use of the materials.

Strategy 8 Reflection

Reflection was used as a teaching strategy during the sessions. This occurred in three different ways. The reflection of verbalisations from a student occurred, and was directly repeated, paraphrased (same meaning different words) or was reflected with elaboration. The actions of the student were also reflected, and this became a description (strategy 1) or an interpretation of an action (strategy 2). Reflection was also provided of the learning strategies, and participation and responses of a student. This strategy involved the repeating of self-reflections made by a student, the paraphrasing of such comments, or the elaboration of them. It also involved the identification and acknowledgment of learning effort and strategies, the seeking of such reflections, the guiding of reflections or the description and interpretation of the student's learning by the student.

Strategy 9 Evaluation

Evaluation of the responses of the student were either sought, guided or provided by the researcher. These involved direct yes/no evaluations, evaluations with some focus, or evaluations with explanations of why a response was incorrect or correct.

Strategy 10 Transfer

At times the transfer of learning to parallel tasks was used. This was used to allow the practice of concepts learnt during the session, development of confidence with a concept, the exploration of concepts derived from the task, or investigation of the student's grasp of concepts by the researcher.

Strategy 11 Emotional focus

Teaching strategies that verbalised emotional support were also used. These were in conjunction with non-verbal strategies that were used to optimise the relationship. The verbalised strategies involved differing degrees of intrusiveness. The strategies focused on expectation, acknowledgment, collaboration, confidence, reassurance, encouragement, or a combination. The non-verbal strategies were considered to be least intrusive of the emotional strategies while the verbal strategies were either moderately or most intrusive.

In summary, the researcher used counselling and interviewing skills to establish an optimum teaching-learning relationship with each student. Within that relationship, teaching strategies were selected, during the session, in response to the individual learning needs of each student. The selection of teaching strategies was guided by the structure of the tasks, and the materials available. It was also considered within the researcher's perception of each relationship and of the particular cognitive, social and emotional functioning of the student.

Appendix 6.6

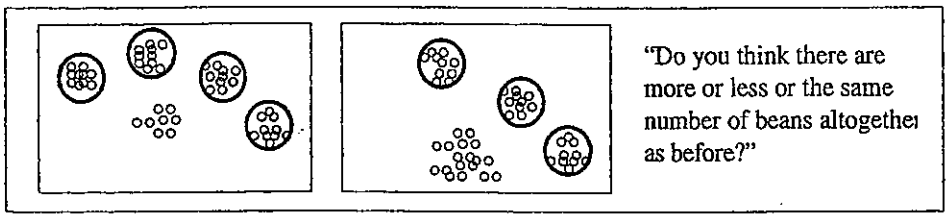
STOPV-DA (1): Mediation analysis

This appendix contains the narrative and analysis of the mediation that was carried out on the first assessment occasion to illustrate the analysis. It is ordered according to the tasks as they were administered.

STOPV-DA (1)

The mediation used across the class for each task was developed from the structure and materials of the tasks, the aspects of place-value numeration underlying the seven tasks and the defined levels of performance. The strategies were defined in Appendix 6.5 and described across the dimension of degree of intrusiveness. The patterns of mediation employed during the study were adapted to meet specific needs of each student. The strategies used across the class for each task are described, with the resulting outcomes for the students.

Task 1. Conservation of number



Eight students did not demonstrate conservation of quantity on the administration of this task, and therefore required mediation. Student comments referring to the table, or the cups, suggested that the students had not interpreted the task question to include all the beans, as intended, and that the meaning of the task question needed to be clarified. The initial mediation strategy employed was to direct focus on to the total number of beans, by paraphrasing the task question and incorporating gestures. This strategy is illustrated through an excerpt from Chris' mediation. The words and actions that were contributed by the student are labelled by name and those contributed by the researcher are marked Res. These pairs of contributions, that make up one interaction are grouped. Descriptions of actions are included within square brackets.

Res.	Look at these altogether, including those and these [gestured to beans in cups and on table]. Are there the same number, more, or less than we had?
Chris	Same.

Res. Why?
Chris Because you didn't take any away.

For four of the eight students who received mediation on task 1, the verbal and gestured inclusion of all the beans with a paraphrased question was enough to support their demonstration of conservation. These students needed between one and nine interactions (Chris-one, Alex-two, Natalie-seven, Zoe-nine). These outcomes supported the impression of the researcher that the format and language of the task confused some students and contributed to them providing a lower level response than they may have been otherwise able to. For four students, more intensive mediation, involving memory support, repeated task with explanation, as well as another similar, less complicated conservation task, occurred. These four students had fifteen (Xavier), sixteen (Farley), twenty-nine (Wanda) and thirty-one interactions (Brooke).

The strategy of the inclusion of beans and the paraphrasing of the question was not enough for four students who needed more intrusive strategies. Farley needed more intensive and intrusive mediation, although it was still directed at the clarification of the meaning of the task. His responses indicated that he was focusing on the beans in the cups only, and he needed several interactions from the researcher to establish for him that the question was referring to all the beans. Then he provided a conservation response.

Xavier, Brooke and Wanda needed mediation that was aimed at other aspects of their learning. They needed mediation focusing on conservation; they required more challenging of their ideas that the number of beans had changed. Brooke remembered how many beans there were but still said that there were different numbers.

Res. How many beans are here?
Brooke Forty eight.

Res. How many did we have before?
Brooke We had forty eight.

Res. We had forty eight and now we have forty eight. Have we got the same number of beans?
Brooke No.

This series of interactions suggested some problems with Brooke's understanding of the language being used. The researcher followed this issue up by seeking an

explanation from Brooke, who said "Well you had forty eight and then you tipped ten more in there." This explanation suggested that the grouping was the difficulty so the researcher reinforced the inclusion of all the beans in the cups and on the table, and explicitly described the action of tipping out beans from a cup on to the table.

Res. Where did the ten come from?
Brooke [No response]

Res. From here didn't it? So how many beans have we got here now, altogether?
Brooke Eighteen.

Res. Altogether.
Brooke [Counted again by tens and ones] Forty eight.

Res. Forty eight, and that's how many we started with and we've still got forty eight, so is that the same?
Brooke Yep.

Res. It is, we've got the same number. [Tipped out another cup] Think carefully. Are there the same number or are there more or less beans than we had a minute ago?
Brooke They're not the same number any more.

Res. Why not?
Brooke Because you just put out a ten.

Res. Did I take some beans away?
Brooke No.

Res. Did I bring some new beans here?
Brooke No.

Res. So how can we have any different from what we had a minute ago?
Brooke Because if you put some tens in the cups and I just count them all and then you put some more tens out and I have to figure out more or less.

Brooke's explanations were confused. She ignored the concrete numbers. The researcher repeated the action of tipping out beans on to the table and described it as it happened, emphasising that no new beans were added to the group and no beans were taken away. This pattern of mediation occurred three times before Brooke responded that the number of beans was still the same. Brooke's understanding of the task question seemed to do with "same" or "different" being a reference to arrangement rather than to number.

Xavier stated that he had seen beans removed from the table, so the researcher asked Xavier to count the beans. When asked whether this was the same number as before he could not remember how many beans were there at the beginning. The researcher then used four interactions to reinforce the number of beans, through

description and re-counting. Wanda also needed some support to retain the number of beans in her memory, before it could be used in the comparison.

Res. Altogether how many did we have?
Wanda [no response]

Res. You tell me. How many beans did I tip out on the table first?
Wanda Ten.

Res. Forty eight.
Wanda Forty eight.

Wanda's mediation involved other arrangements and groupings of the beans. This was done to reinforce the idea that there was still the same number although they looked different.

Res. So it doesn't matter what grouping I put them in there's still forty-eight. Let me try a different one. [put all beans in one group] How many now?
Wanda Forty-eight.

Res. [spread out the beans] How many now?
Wanda Forty eight.

Res. Why?
Wanda 'Cause they're still all here.

Res. You're right. They're still all here and even though they're spread out more and take up more space, still only forty eight isn't there?
Wanda Mmm

This visual arrangement approach was taken because Wanda explained that "It just looks like there's a larger number" in her initial response to the task. The researcher was not confident that this conception had been challenged sufficiently and so went on with another more simple conservation task that emphasised the visual space.

Res. [two rows of eight beans, one spread out] Which row has more beans in it?
Wanda First one.

Res. Why?
Wanda 'Cause they're a larger number and you can see it's more.

Res. OK, so they take up more space?
Wanda Yes.

Res. Would you like to count both the rows and see if they are the same.
Wanda [counted each eight beans] They're the same.

Res. They're the same. So even though they look like there's more in it [pointed to one row] it really hasn't has it. It's got more spaces. It's got spaces in between them. We'll squash this one up and spread this one out. Which one looks like it's got more now?

Wanda This one.

Res. It looks like it's got more. Has it?
Wanda No.

This extra conservation task was also used with Xavier and Farley for checking that they had grasped the concept of conservation during the original task. Xavier had just responded appropriately to three successive tipped out cups.

Res. Can't trick you can I. [placed a row of eight beans] How many?
Xavier [counted] Eight.

Res. Eight. [pushed row together] How many now?
Xavier Eight.

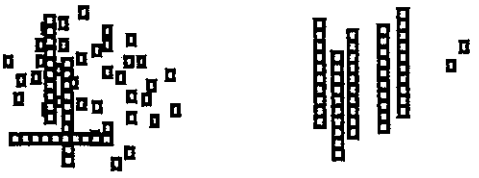
Res. But I've moved them. How come there's still eight?
Xavier Cause you haven't taken any away.

In this response Xavier demonstrated an understanding of the conservation of quantity even though the arrangement altered. Farley's response to a similar task also confirmed an understanding of conservation of quantity.

The analysis of this mediation indicated that four of the students had difficulty with the language and structure of the task, and that this was the reason for their level 1 responses. Clarification of the intention of the task question allowed them to demonstrate that they had acquired conservation. For four students this was not intrusive mediation, however, one student required more intrusive mediation with this same focus while the other three students needed more mediation to support them in demonstrating conservation.

Task 2 Standard place value partitioning

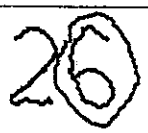
"Use these counting blocks to build 52." "How do you know that is 52?"



No mediation was provided for this task, as all the students performed at the highest level in the pre-test.

Task 3 Non standard partitioning of 26 counters

"Count these and write down how many."



"Sort the counters into groups of 4. "

"Does this part of your 26 have anything to do with how many counters you have?"

Mediation for task 3 was provided for eighteen of the twenty-one students. Two of the students stated that the '2' meant twenty and the '6' meant six, level 3 (of 4 levels) responses in the pre-test. The mediation for these students involved seeking further explanation from the students, to see if they could indicate the meaning of twenty to be two tens. Neither of the two students provided this meaning when the researcher sought further explanation. Base-ten blocks were then used to provide a concrete representation of the tens, and further explanations were sought. One student, Alex, provided the appropriate meaning after a low-level reference to the blocks.

Res.	What is the two then? Two doesn't mean twenty, so what does it mean? What are they, two whats? Two units? Two ones?
Alex	[No response.]
Res.	We've got ones here. These are our units. If these are our units or ones, what are these? [Pointed to blocks.]
Alex	Tens.

Thomas needed more explicit guidance to refer to the tens.

Res.	Two of those, which makes twenty, but it tells you that there are two what?
Thomas	[No response.]
Res.	What are these?
Thomas	Rods.
Res.	Yes. How many in each one?
Thomas	Ten.

Thirteen students gave a response in the pre-test which applied the numbers to physical objects or the groups of counters in front of the student. Ten responses referred to the groupings constructed in the task, six groups and the two left-over counters, while three responses involved other meanings such as "there's four in that [pile] and two in that which makes six." Three students gave no response or stated "No" to the questions asking what each digit had to do with the number of

counters.

The general pattern of mediation which occurred for these sixteen students began with seeking alternative meanings and further explanations to determine if there was further understanding than indicated by the initial response. An expectant and encouraging question was used with three students who had given no response to one of the questions. This strategy was not effective. Daniel's response illustrates the lack of effectiveness of the strategy.

Res.	Does this part ['6'] of your 26 have anything to do with how many counters you have?
Daniel	[No response.]
Res.	Any ideas?
Daniel	No.

Farley was referred to the number '26', as he had written it, to see if he could provide the interpretation without any further support. His garbled response, printed here, indicated a whole number understanding.

Res.	OK. How many have we got?
Farley	Twenty-six.
Res.	OK Twenty-six. Tell me what this means. What's the six [in '26'] telling you?
Farley	That there's some six and two units, that you've got two in there and got six in there equals twenty-six.
Res.	OK. Tell me more about that what do you mean you've got two in there and you've got six. What does that mean? Can you show me?
Farley	The two and you've got six there and the number equals twenty-six.

The researcher then removed the constructed groupings of fours, by placing all twenty-six counters in one pile and asked the task questions again. This strategy was used for fourteen of the students. Of these, Laura provided a level 4 response with the removal of the groupings of the counters and repetition of the question. Three other students, Daniel, Maddie, and Ingrid, provided a level 3 response, mentioning twenty in their interpretation of the digit '2'. Six students gave no meaning to the digits when referred to the combined group of counters.

Two students repeated the meanings of the digits based on the groupings of fours used in the task, and two students explored alternative meanings based on

groupings, e.g.,

Res.	What does the six tell you?
Zoe	The six tells you, well if you had six in each group it would tell you that there were six in each group.

These students were supported in exploring their grouping meanings and guided in their evaluation of the meanings once the groupings were constructed. The mediation for Zoe explored groupings of six.

Res.	OK, try that, see if that works.
Zoe	[constructed groupings of six.]
Res.	OK, so what have you got? Six in each group.
Zoe	And one left over.
Res.	And one left over. So that could tell you there were six in each group so what does this one ['2'] tell you then?
Zoe	Tells you, tells you how many are left over or something.
Res.	OK, but we've only got one left over haven't we? Alright, maybe there's another way. I tell you what we'll do, we'll use these [Blocks] and see if this helps. You make twenty-six using those and let's see if we can work out this.

The next strategy involved the use of the base-ten block representations that all students had used successfully in the previous task. The base-ten blocks were used to make twenty-six and the task questions were asked again. The students had all been able to provide this interpretation for fifty-two in base-ten blocks in an earlier task. The first response here illustrates the immediate response provided by four of the students.

Res.	Now what does this ['2'] have to do with how many you've got?
Grace	There's two tens.
Res.	Now what does this ['6'] have to do with how many you've got?
Grace	There's six ones.

Four other students took longer and needed more encouragement or guidance in making the interpretation. Natalie's transcript illustrates the nature of mediation provided.

Res.	Let's have a go with it with these. Make twenty-six with these [blocks] and we'll see if we can work out what that's all about.
Natalie	[performed routinely.]
Res.	Just think about it with what you've got there. Does this part ['6'] of your twenty-six have anything to do with how many you've got there?

Natalie	Mmm
Res.	What does the two tell you about what you've got there?
Natalie	Two tens.
Res.	What does the six tell you?
Natalie	That there's six ones.

Three students, Kieren, Maddie, and Daniel, provided level 3 responses to the base-ten blocks strategy although they had all given level 4 responses in the previous task. Kieren's transcript illustrates this type of response.

Res.	Same numbers, right? They just look a bit different. This one's already been grouped into tens and this one is all in a pile. What does this ['2'] tell you about how many you have?
Kieren	These.
Res.	What?
Kieren	These are twenty [Gestured to ten blocks].
Res.	Ah, so that tells you there's twenty, what does this ['6'] tell you?
M	There's six [Gestured to unit blocks].

Two students, Hannah and Farley, gave procedural explanations for the meanings of the two digits. Both of these students explained the tens and ones related to these blocks, when explanations were sought by the researcher, e.g.,

Res.	Now thinking about what you've just done, looking at them, you've got this many. What does this one here ['2'] tell you about what you've got there?
Hannah	Ummm That we start with two.
Res.	Two what?
Hannah	Two tens.
Res.	Oh OK. So when you were making the number you started and got two tens because this told you you had to have two tens?
Hannah	Yes.
Res.	OK, and what about this one.
Hannah	That told me I had to have six shorts.

Although the intervention for most students followed this pattern, two students were initially given the base-ten block strategy rather than the regrouping of the all counters into one pile. This was done because of the researcher's perception that they would not have been able to provide a meaningful response to the less intrusive strategy and the extra frustration and time used would not be helpful. One student, Brooke, had already received considerable mediation of 31 interactions on the first task. Rachael provided no response to each of the task questions in reference to the base-ten blocks and needed some further mediation to elicit her rationale for

constructing the number twenty-six as she did. This discussion about how she chose the blocks to make twenty-six was used to focus on the tens and ones represented in the blocks.

Res.	Let's see if we can find out what it does mean. Can you make twenty-six using these [base-ten blocks.]
Rachael	Done.
Res.	So you've got twenty-six here [blocks] and twenty-six here [counters]. Now think again, about these. Does this digit here tell you anything about what you've got here?
Rachael	[no response]
Res.	What about this one?
Rachael	[no response]
Res.	How did you know to get two of those and six of those?
Rachael	I did it by tens and ones.
Res.	You got out two longs. Why did you get two out?
Rachael	Because it's in the twenties.
Res.	Oh, because it makes twenty and that tells you...
Rachael	Twenty.
Res.	So this one here told you you had to get two of those to make twenty, is that right?
Rachael	Yes.
Res.	And what are those?
Rachael	Tens.
Res.	Two tens, and two tens make twenty. And what did this ['6'] tell you?
Rachael	To get six ones.

Brooke provided a level 2, face-value response, when asked for the digit meanings in relation to the base-ten blocks. She needed researcher use of language to clarify her meanings.

Res.	Can you make twenty-six with these [blocks] Brooke.
Brooke	There you go.
Res.	OK, now that is that many as well isn't it? So they both have twenty-six in them. Now think about my question again. Does this part ['2'] of twenty-six tell us anything about [pointed at blocks.].
Brooke	No.
Res.	Does this part ['6']?
Brooke	Yes.
Res.	What?
Brooke	It tells you that there's a six in it.
Res.	There's a six in it. Where's your six in this [the blocks]?
Brooke	There.

Res.	There, good girl. So this part tells you that there are six ones sitting there, what does this part tell you?
Brooke	It tells you these two.
Res.	Ah. There's two longs or two tens.
Brooke	And there's six small or six ones.

One student. Laura, was given the base-ten block intervention although she had provided a level four response from the whole grouping of the counters. This was done to reinforce and provide opportunity for her to link her tentative meanings for the two digits to a familiar representation, the base-ten blocks. Laura's first response "all of them" supported the researcher's perception that the tens and ones meanings provided by Laura were tentative and needed some consolidation.

Res.	OK, now show me what the six and the two mean using that.
Laura	All of them.
Res.	What does the six mean, with what you've got, what's the six?
Laura	Ones.
Res.	Six ones, so you've got six ones. OK, what does the two mean?
Laura	Tens, and I've got two tens.

Following the use of the base-ten blocks, the students were then referred again to the pile of counters and were supported in making a grouping which paralleled the base-ten representation of tens and ones. The means of making this parallel was left open to the students, usually through the request to "make these look something like the blocks."

Five students (Hannah, Grace, Daniel, Xavier, and Natalie) provided clear explanations of the groupings they constructed.

Hannah	There's ten and there's ten and then I've got six left.
Grace	Two rows of tens and six units left.
Daniel	I've made the counters into two tens and six.
Xavier	Two tens and six ones.
Natalie	You've got ten counters and then another ten to make twenty and then you've got six counters to make six and then it's twenty-six.

Five other students were given a summary of the constructed groupings by the researcher. These students had previously shown understanding and the strategy of getting them to make the groupings of the counters to represent the tens and ones had been used to consolidate or reinforce the concept. They all constructed clear

groupings of tens with six left over. The summary given to Peta is typical of the summary given to these students.

Res.	You have made it look like that haven't you, so you've made two groups of ten, two rows which is what that is, and there's six left over.

Four students, Rachael, Farley, Brooke, and Laura, provided interpretations of the groupings that referred to twenty and six. The researcher then sought and guided explanations to reach the level 4 interpretation of tens and ones. Rachael's mediation is presented here.

Res.	So what you've got is your two tells you
Rachael	Twenty.
Res.	And your six tells you
Rachael	Six.
Res.	Six left over. Over here we've got 20 but it's made into two whats?
Rachael	Two tens.

Two other students, Wanda and Zoe, required assistance constructing groupings of the counters to "look like" the blocks or to explain what twenty-six means. Wanda asked "Do I put them in to groups?" and when encouraged to try and make it "look like the number we've got there [in the blocks]" she constructed the groupings of fours as used at the beginning of the task. She was referred back to the base-ten blocks and the groupings.

Res.	You've made it into groups of four again like we did a minute ago. But these ones [the blocks] over here haven't got groups of four, what have they got groups of?
Wanda	Ten.
Res.	Tens. And you said that this tells you there are two tens. Can you make these look like you've got two tens.
Wanda	[constructed two groups of tens.]
Res.	Alright have we got two tens?
Wanda	Yes.

Zoe also needed a lot of support to construct the groupings with the counters.

Res.	OK we'll just stop a sec. Go back to these again. This two tells you there are two tens and this six tells you there are six left over. Can you make these counters look like those? So there are two tens and six left over.
Zoe	[No response.]
Res.	We can't stick them together like we stick these together can we! I suppose we could but we're not going to do that. So how can we make them look a bit like this? Two tens and six left over.

Zoe	[very slow and deliberate movement of each counter.]
Res.	Yeah, so you've got your ten.
Zoe	Yeah.
Res.	And another ten, and six left over. So twenty-six that's your twenty, two tens and six. The same as this here.
Zoe	Yep.

Further mediation occurred for Laura and Zoe as the researcher determined that their understanding was tentative. The mediation strategies used involved the introduction of similar tasks so that the students could transfer the concepts. Laura was given two other numbers from which to interpret the meaning of the two digits. '15' was written on paper and Laura was asked to make the number with blocks and then explain the meaning of the digits. She immediately provided the interpretation "one ten and five ones." She also constructed the number using the counters to show the tens and ones. Her understanding of this was tentative so another number was introduced. She was asked to interpret 23 and did so correctly, "two tens and three ones." Zoe was given one transfer task and was able to interpret the tens digit immediately but gave confused responses for the units. She used the blocks efficiently to make the number.

Task 4 Counting by tens

"How many beans do you think there are?"

"Count them."

"Count them again by tens"

Eleven students provided level 4 responses to this task, demonstrating the process of counting by tens. These students did not receive any mediation, apart from two of the students who were assisted in evaluating and self-correcting errors in counting. Errors in counting were ignored to an extent as it was the process of counting that was the focus of the task. For the ten students who provided lower level responses, mediation involved explanation and modelling of counting by tens, along with recall and focus on the number of beans. The researcher focused on the groups and the beans left over, while providing the language for reflecting on the task. Because this was a procedural task, and no new concepts were introduced, the intensity of mediation was minor.

Four students (Brooke, Alex, Zoe and Rachael) grouped the beans into tens, however, their actions and verbal self-talk indicated that they had not used the system of tens and the system of ones. Two of the students, Zoe and Rachael, were counting by ones while grouping into tens. One student, Alex, reported that he "didn't count them" he "just put them in groups of ten." The mediation employed for these students included reflection on what the students were saying as they moved the beans, and modelling of counting by the researcher. One student, Brooke, was grouping into tens and then could not deal with the one group that was less than ten and needed some support to deal with the ones as well as the tens.

Res.	Let's count it again by tens
Brooke	One, two three, four, five, six seven, eight nine ten, [repeated] and I can't make ten with that.
Res.	Ok you can't make ten with that. You've got some left over, so how many beans are there?
Brooke	Ten, twenty, thirty, forty, fifty, sixty, seventy, eighty, ninety, one hundred.
Res.	But you said you didn't make ten with one of them. So it can't be a hundred can it?
Brooke	Ten, twenty, thirty, forty, fifty, sixty, seventy, eighty, ninety,
Res.	Ninety what?
Brooke	[no response]
Res.	Ninety-one, ninety-two,
Brooke	Ninety-three, ninety-four, ninety-five, ninety-six.

Six students, when asked to count the beans by tens, counted each bean as ten. The researcher used guided evaluation of the students' responses of the number of beans when they gave values of ten to each bean or pair of beans.

Res.	So how many does that make altogether?
Hannah	A hundred and, I mean seven hundred and nine.
Res.	Are there seven hundred and nine there?
Hannah	Yep, no.
Res.	How many ?
Hannah	Ninety seven.
Res.	So how did we get seven hundred and nine?
Hannah	I was counting wrong, I think.

Hannah concluded that she had counted incorrectly, however, Chris was not concerned about having counted to nine hundred and ninety. In fact he justified the answer by saying that he had "counted by tens." For all these students, the researcher then used explanation that counting by tens involved grouping into tens, and she modelled the counting as required.

Res.	I want you to count them again and when we say by tens what I mean is that instead of counting one, two, three, four, five, you can group them into tens (counted 2 groups) How many?
Farley	Twenty.

All six students counted by tens following this form of explanation. Two students, ? and ?, were efficient in their counting, while four of the students, ?/?/, were at times slow, deliberate and made errors. They seemed to be considering the new procedure provided for them by the researcher.

The mediation employed for this task involved guided evaluation, explanation, links with counting by ones and twos, modelled process and description (self-talk).

Task 5 Interpretation of the whole numeral '06'

USE BY: 0 6 A P R	"What number is this?" "Why?"

All students received mediation on this task, except for Jack. The mediation involved relating the two-digit number '06' to '26' in the previous task, and using base-ten blocks to construct the number.

The meaning of the digits in '26', as taught in Task 3, or '60' if the student commented on the order of the digits, were used for all the students. Connections were guided. Zoe made the link quickly.

Res.	Remember how we talked about [refer to '26'] that being the number of tens and that's the number of ones?
Zoe	Units.
Res.	Yep units, so when you've got that number ['06'].
Zoe	No tens and six ones.

Sam needed more structured guidance.

Res.	It's the same isn't it? I wonder why they put that in. Let's see if we can work it out. You know how you told me that this was two tens and six
Sam	Sixes.
Res.	No not six sixes. Six
Sam	Ones.
Res.	Six ones, good boy. Here we've got a number that's got six ones ['26']. How many tens?
Sam	Zero.

Base-ten block representation of the number '06' was used for three students, in conjunction with the guided links to the previous task. This was used to reinforce the understanding of digit correspondence that seemed to be tentative for these three students.

Res.	The two told us there were two tens didn't it. So what is the nought telling us?
Thomas	[mumble] Nothing.
Res.	Nothing. No tens. No tens in that number are there?
Thomas	No.
Res.	'Cause it's number six. You make it for me using these [blocks] What will you need?
Thomas	Only need six.
Res.	You just need six, six ones, don't you.
Thomas	[takes six units.]
Res.	So you've made that number ['06'] how come you didn't get any tens out?
Thomas	There's no tens.
Res.	Good boy, there's no tens. That's telling you there's no tens. If you'd made this number how many tens would you get out?
Thomas	Two.

The other concept of this task was the role of the zero as a placeholder. This concept was taught through direct explanation for all twenty students, as no-one was able to explain this role. The form of explanation is illustrated from Daniel's transcript.

Res.	Do you know why it's there? No OK I'll tell you. It's just sitting there beside the six to hold the place for the tens. It might not be the 6th of April it might be the 26th of April and if it was the 26th there would be a two there. So it's holding the place for that, if we decide to make it a ten or twenty.

Tasks 6 & 7 Reading and writing multi-digit numbers

"Write these numbers 3, 6, 19, 83, 109, 172, 1607, 3045, 6572."

"Tell me what these numbers are."

5 9 13 40 67 158 603 1004 2407 6251

Sixteen students received mediation on one or both of these tasks. The mediation

for these two tasks was combined, as they are integrated skills. Each student's success with numbers within the task was used as the starting point for mediation.

Generally, the link between the written number and the number names was the basis of the mediation for these tasks. The numbers written by the student, or the numbers written on cards, were re-read and compared to the attempts to write large numbers, or the student was focused on the large number as read and then asked to write another similar number. The student was then referred to the attempted written numbers from the task. Seven students read larger numbers than they could write so the starting point for the mediation was with the numbers the student could successfully read. Five students read four-digit numbers but made errors writing them (Peta, Grace, Ingrid, Maddie, Zoe) and two students read three-digit numbers but made errors writing them (Rachael and Brooke). Two students wrote three-digit numbers correctly but made errors reading them (Xavier and Thomas), while eight students read and wrote the same size numbers (Brooke two-digit, Wanda, Laura, Farley, Alex, Hannah, Kieren, Natalie three-digit numbers).

The aspects of place value that were the focus of the other tasks were also important in these tasks and were highlighted as appropriate. These included the number of digits in the numbers, the names and values of the positions of the digits within the numbers, and the role of zero as a placeholder. The key strategies used in this mediation involved the evaluation of the attempted written or read numbers. For some students repeating the number that was written was enough to support their successful correction of their written number. Ingrid corrected both of her two errors after hearing her attempt read out along with the repeated task number. The mediation for Ingrid was short but after this success in evaluation through hearing the numbers, she was encouraged to read her own attempts to check they were correct.

Res.	You just read those really well. So let's go back to this one. It should be one thousand, six hundred and seven. How could you change it to be one thousand, six hundred and seven. At the moment it says one thousand, six hundred and seventy.
Ingrid	Oh! [wrote 1607.]
Res.	Why did you do that?
Ingrid	Because that means no tens just seven.
Res.	And here, [pointed to1670] how many tens did you put in it?
Ingrid	Seven
Res.	Seven tens and no units, and it had to be the other way round. OK good. Listen to this one again. Three thousand and forty-five.
Ingrid	[wrote 3045.]

Res.	OK. Read that for me.
Ingrid	Three thousand and forty-five.
Res.	Well done. Ok what's this one?
Ingrid	Three thousand four hundred and fifty.
Res.	OK and you've changed it all around. You had all the right digits didn't you, just not in the right place, and you got this one right [6572]. Now the tricks were the ones where we didn't say some tens or we didn't say some hundreds.

Ingrid expressed a perception that she was "not very good at these", and her tentativeness during the mediation reinforced that perception. The researcher decided to consolidate the success of the mediation through another practice task. Ingrid was asked to write another four-digit number with a zero in it and then to evaluate it herself. She made a mistake in the order of the digits, however, when she read it to herself she corrected it efficiently. The researcher then reflected this success

Res.	Well done Ingrid. You had the right digits again they just weren't in the right order. But when you read it back to yourself you can always check can't you. Cause you're good at reading them.

Maddie corrected her only error with little guidance, however, she was not confident about her alteration.

Res.	Now there's one there I'm worried about and you were worried about it too because you stopped. I don't think it's quite right. I'll read it to you again and see if you can work out how we can change it to make it right. Three thousand and forty-five.
Maddie	You could put a zero just there.
Res.	OK, put it in.
Maddie	[wrote 3045]
Res.	What's the zero doing in that number?
Maddie	Taking the place of, instead of a number for the hundred there's just zero.

Maddie was able to correct her only error with focus on it. She also explained the role of the zero she had put in to correct the number. For Peta guided evaluation, stating that the number needed four digits and zero was a placeholder, helped her to evaluate her number.

Res.	Now all your numbers are right except one, which one do you think mightn't be quite right.
Peta	This one?
Res.	No it's fine, six thousand, five hundred and seventy-two. Which one were you a bit worried about?

Peta	This one.
Res.	OK. I'll read it again. It's three thousand and forty five. How do you think we can change it? Remember we talked about zero being a placeholder. I think you need four digits in there to make it a thousands number..
Peta	Oh
Res.	Yes that's right. When you didn't have that what number did you have?
Peta	three hundred and forty five.

The numbers written by the student, or the numbers written on cards, were re-read and compared to the attempts to write large numbers, or the student was focused on a number as read and then asked to write another similar number. The student was then referred to the attempted written numbers from the task, and the researcher sought evaluation or guided evaluation of the written attempt.

Res.	Look at this one again. Six thousand, two hundred and fifty-one. I reckon that if it was sixty two thousand and fifty one it would be this. [62,051] They're different aren't they?
Kieren	Oh, six thousand and twenty five
Res.	Nearly.
Kieren	Six thousand.. and two hundred and fifty one.
Res.	Well done. OK, so each four digit number has a thousand, hundred, tens and ones. And they're always like that and here what we've done is we've made it tens of thousand, thousands, hundred, tens and ones. And that wasn't right was it?

Use the success with two and three digit number to explore the meanings of thousands.

Res.	[Covered 62 in 6251] What's this?
Wanda	Fifty-one.
Res.	[Uncovered 251]
Wanda	Two hundred and fifty-one.
Res.	So if it's got three digits it's a hundreds number. What is it when it's got four digits?
Wanda	[No response]
Res.	They're much bigger they're thousands. You know when we have the blocks, the shorts [are] ones, the longs [are] tens, the flats [are] hundreds and the big cubes [are] thousands. So this is six thousand two hundred and fifty-one.

Link with previous tasks.. Used the tens and ones meanings from '26' and built on those to make hundreds and thousands numbers.

Res.	You know how this was our tens and this was our one. Twenty and six ones, let's put another number in front of it. What number have I got now? [426]
Xavier	Four hundred and twenty-six.

Res.	Good. So these are our tens, these are our ones, these are our hundreds, four hundred and twenty-six. Alright what happens when I put one in here? [3426]
Xavier	[No response]

Res.	What's that number?
Xavier	Three thousand, four hundred and twenty-six.

Res.	Great. Well done. So these are thousands aren't they. Three thousand, four hundred and twenty-six.

This strategy did not work for Rachael who was then taken onto another strategy, the use of drawn boxes to provide a frame for the positions and names of the places in the numbers. This strategy was used with differing levels of intrusiveness, e.g.,

Res.	[Drew boxes, ones, 10s, 100s, 1000s] Let's make some more thousands numbers by putting numbers in these boxes. [6,391] Let's read it. Six thousand, three hundred and ninety one. read this one. [Wrote 3453]
Wanda	three thousand, four hundred and fifty three [slowly and tentatively]
Res.	Well done, Wanda. You can read any thousand number now. Now we're going to get a bit tricky because we're going to use nought. [Wrote 2406] What number have I written?

The box framework was used for seven students (Brooke, Wanda, Hannah, Farley, Natalie, Kieren, Rachael) .

The need for zero to be included as placeholder in some of the numbers, was included in many sessions. This was incorporated with evaluation of the overuse of zeros in many of the numbers. Natalie wrote 605072 for the spoken number "six thousand five hundred and seventy-two" and the researcher sought evaluation of the number through reading what was written.

Res.	What's this one supposed to be?
Natalie	Six thousand and fifty...
Res.	Mmmm, let me read that one to you the way I see it. Six hundred and five thousand and seventy two. That wasn't what we said was it?
Natalie	No.
Res.	How can we change it? It's six thousand five hundred and seventy two.
Natalie	Six thousand..five hundred and seventy two [as writing 60572]
Res.	Ok I'll read that one to you. That says sixty thousand, five hundred and seventy two
Natalie	Aah! [wrote 6572]
Res.	Oh, look at what you've done. You've taken out that nought and that nought and

kept the six thousand five hundred and seventy two. Six thousand, five hundred, seven tens and two ones. See?

This strategy of guiding the student to evaluate the use of extra zeros was very effective. Kieren was asked to explain what the zero was doing in a four-digit number he wrote.

Res.	... you've put a nought in there what's that nought doing in there?
Kieren	Taking its place for the tens.
Res.	Well done. Read that one again for me.
Kieren	Twenty-four thousand and seven.
Res.	It's not is it?
Kieren	No.
Res.	What is it?
Kieren	Two thousand, four hundred and seven.
Res.	Well done.

A bit later in his session Kieren was asked what the nought was doing in another number, '3045'. He again responded that it was "taking the place for the tens" which was incorrect. The researcher challenged this response.

Res.	No that's not the tens place.
Kieren	What was the question?
Res.	Three thousand and forty five. it's taking the place for something.
Kieren	One.
Res.	They're the ones there.
Kieren	Oh yeah.

This series of responses indicated that Kieren had some confusion over the positions of the values in the four-digit numbers and that this needed to be reinforced. The researcher introduced base-ten blocks and explored the values through these concrete representations.

Grace she was asked to evaluate and correct the written four-digit numbers from the researcher reading them, as she had correctly read all the numbers. Using this reflection she corrected the four-digit numbers and the researcher went on to explain the use of zero in the numbers.

Res.	You know how we talked about the nought on the biscuit packet was holding the place for the tens., what's this nought doing here? It's holding the place for something, not tens though cause we've got four of those to make forty so what's it holding the place for?
Grace	[No response]

Res.	Not the units, not the tens, but the ...
Grace	Hundreds.
Res.	Yes, the hundreds, and when I say that number I say three thousand and forty-five, I sort of skip over, I don't say any hundreds do I?
Grace	No.
Res.	'Cause there's none there, it's got a nought there just to mind the place for it. OK, let's try this one. One thousand, six hundred and seven .
Grace	[wrote correctly]
Res.	Oh excellent, well done. And what's the nought doing in this one?
Grace	It's holding the place for the tens.

Some students needed to be referred to the familiar materials of the base-ten blocks, which were used to construct numbers in conventional placement order, and then related to the place values in the written number. These were used for six students Kieren, Hannah, Zoe, Wanda, Brooke, and Thomas. The blocks were linked to the boxes for some students, and were used to leave gaps to emphasis where the zero should be written in a number. Thomas had difficulty retaining in his memory the number names, and showed confusion over the use of zero so the blocks were used to provide a concrete representation of the numbers and a memory support.

Res.	No listen again, three thousand and forty-five. Have another go up here in the space. Three thousand and forty-five.
Thomas	Is there meant to be two Ohs here?
Res.	No, there's not. How about we make it. You make it and then it'll be easier to write it down. Three thousand and forty five. Look at your number, thousands,
Thomas	Three thousand.
Res.	How many hundreds have we got here? How many hundreds are here?
Thomas	What's the number again?
Res.	Three thousand and forty five. No, we don't have any hundreds do we. You've got your three thousand and you've got forty-five. But what happens here where the hundreds should be. What do we put here? To hold the place for it, 'cause there's no hundreds.
Thomas	The nought.
Res.	Aahh, now think Thomas, three thousand and forty five. How are you going to write that down?
Thomas	Three thousand and nought and forty five
Res.	OK, write it down.
Thomas	[wrote 3045]
Res.	Oh well done three thousand and forty five. You've just got to remember that there's a gap in there and it's held by the nought or the zero. Alright. I'm going to give you one more tricky one like that, you ready? You all turned on ready for it?

This use of the blocks was similar for most of the students, however, Brooke

required clear explanation of the meanings of the blocks, and how they represented the numbers.

Res.	OK, let's look at these. When we do numbers, we make them with these. The first number you have there is the ones. Then you have the tens. What comes next?
Brooke	Ummm.
Res.	Ones, tens, what are the next ones? The flats. How many in a flat?
Brooke	...tens ...
Res.	What's the next biggest block you get?
Brooke	You get twen...
Res.	No you don't. You get ten of these together which makes a flat.
Brooke	That's ten, twenty, thirty, forty, fifty,
Res.	Fifty, yes,
Brooke	Sixty, seventy, eighty,
Res.	And if I stuck all those together I'd have what you call a flat, wouldn't I? How many are in a flat?
Brooke	Ten, twenty, thirty, forty, fifty, sixty, seventy, eighty, ninety, a hundred.
Res.	Hundred. Good girl, you are good at counting by tens. That's excellent. You have a hundred. So what we have is units, tens, hundreds, and then we have the big blocks, which are thousands.
Brooke	[echoed] Which are thousands.

At times the researcher reversed roles with a student and asked the student to state a number to be written by the researcher. The researcher then modelled the thinking behind the placement of digits and the use of zero, through the use of self-talk. The student evaluated the attempt from the researcher. This was done with two students, Grace and Wanda.

Res.	Good girl. Would you like to give me one and I'll have a go.
Grace	Four thousand, and one.
Res.	OK, so it's got a unit, hasn't got any hundreds and hasn't got any tens, is that right? [Wrote 4001]
Grace	Mmm.
Res.	Four thousand, and one, do you think that's right?
Grace	Yes.
Res.	Make up a number for me to write Wanda.
Wanda	One thousand and two.
Res.	Alright. I've got to remember that. One thousand and two. It has a one for the

	thousands, and two ones. It must have two noughts in between to hold the places for the hundreds and tens. Right?
Wanda	Yes.

This appendix includes the analysis of the STOPV-DA mediation, highlighting the pattern of mediation strategies and the responses of the students. The mediation on the subsequent assessments, STOPV-DA (2) and (3) was similar, however, reduced in coverage since less students received mediation.

Appendix 7.1

Ages of students at first assessment (rank by age)

Brooke	9 years 5 months
Peta	9 years 3 months
Ingrid	9 years 3 months
Natalie	9 years 3 months
Jack	9 years 2 months
Maddie	9 years 1 month
Rachael	9 years 1 month
Christopher	9 years
Thomas	8 years 11 months
Kieren	8 years 11 months
Zoe	8 years 10 months
Sam	8 years 10 months
Hannah	8 years 10 months
Wanda	8 years 9 months
Xavier	8 years 9 months
Grace	8 years 8 months
Farley	8 years 8 months
Alex	8 years 7 months
Daniel	8 years 6 months
Ewan	8 years 1 month
Laura	8 years 1 month

Appendix 8.1

Numeration outcomes and indicators

OUTCOMES AND INDICATORS		Conventional		Alternative
		DMT	KM	STOPV
N 1.1 Approximates, counts, compares, orders and represents whole numbers and groups of objects up to 100				
	Conserves number			
	Approximates near 100			
	Counts by ones			
	by fives (two-digit numbers)			
	by tens (two-digit numbers)			
	by tens and ones (two-digit numbers)			
	explains why counting by tens is easier			
	Orders single-digit numbers			
	two-digit numbers			
	Represents: Writes from oral name, single-digit numbers			
	Writes, from oral name, two-digit numbers without zero as placeholder			
	Writes, from written word name, two-digit numbers (with zero as placeholder)			
	Writes, from written word name, two-digit numbers (without zero as placeholder)			
	Reads (single-digit numbers)			
	Reads (two-digit numbers)			
	interprets graphic representation of two-digit numbers			
	interprets graphic representation of two-digit numbers (with regrouping)			
	states value of each digit in two-digit number			
	explains value of each digit in two-digit number			
	two-digit number using base-ten blocks			
	two-digit number using symbols for tens and ones			

N 2.1 (a) Counts, compares, orders whole numbers up to 9999 and represents them in symbols and words, stating the place value of any digit. (b) Demonstrates an understanding that numbers can be represented using groupings of 10, 100, 1000				
	Counts by tens (three-digit numbers)			
	by tens (four-digit numbers)			
	Orders three-digit numbers			
	four-digit numbers			
	Compares three-digit numbers			
	four-digit numbers			
	Represents: Writes, from oral name, three-digit numbers without zero as placeholder			
	Writes, from oral name, three-digit numbers with zero as placeholder			

	Writes, from written word name, three-digit numbers (with zero as placeholder)			
	Writes, from written word name, three-digit numbers (without zero as placeholder)			
	Writes, from oral name, four-digit numbers without zero as placeholder			
	Writes, from oral name, four-digit numbers (with zero as placeholder)			
	Reads three-digit number without zero as placeholder			
	Reads three-digit number with zero as placeholder			
	Reads (and renames) three-digit number			
	Reads four-digit number without zero as placeholder			
	Reads four-digit number with zero as placeholder			
	Reads (six-digit number)			
	interprets graphic representation of three-digit numbers			
	interprets graphic representation of three-digit numbers (with regrouping)			

Appendix 8.2

Numeration indicators identified (shaded) for further instruction

INDICATORS	DMT item scores				KeyMath-R item scores				STOPV pre-test task scores			
	Item no.	(1) %	(2) %	(3) %	Item no.	(1) %	(2) %	(3) %	Task no.	(1) %	(2) %	(3) %
N 1.1 Approximates, counts, compares, orders and represents whole numbers and groups of objects up to 100												
Conserves number									1	57	76	91
Approximates near 100									4	29	43	38
Counts by ones	13	76	86	100	1 2 5	100 100 95	100 100 100	100 100 100	1 3 4	100 100 100	100 100 100	100 100 100
by fives (two-digit numbers)					12	76	81	100				
by tens (two-digit numbers)	14 16 17 30	95 71 91 52	100 91 100 43	100 81 95 71	9	95	100	100				
by tens and ones (two-digit numbers)	18 19 20	76 76 76	57 76 91	62 86 91					2 4	100 52 14	95 57	100 71
explains why counting by tens is easier	15	71	86	95								
Orders single-digit numbers					4 6	100 95	100 100	100 100				
two-digit numbers	28	76	95	91	7 8	100 100	100 100	100 100				
Represents: Writes from oral name, single-digit numbers									6	100	100	100
Writes, from oral name, two-digit numbers without zero as placeholder	1 2	95 100	100 95	100 100					3 6	100 100	100 100	100 100
Writes, from written word name, two-digit numbers (with zero as placeholder)	7	67	81	91								
Writes, from written word name, two-digit numbers (without zero as placeholder)	8 9	95 91	95 95	95 100								
Reads (single-digit numbers)					3	100	100	100	7	100	100	100
Reads (two-digit numbers)									7	100	100	100
interprets graphic representation of two-digit numbers					10	95	86	95				
interprets graphic representation of two-digit numbers (with regrouping)	25	76	76	76	17	24	52	62				
states value of each digit in two-digit number	22	67	76	95								
explains value of each digit in two-digit number									2 3 5	100 14 5	95 14 29	100 38 52
two-digit number using base-ten blocks									2	100	100	100
two-digit number using symbols for tens and ones	21	33	62	62								

N 2.1 (a) Counts, compares, orders whole numbers up to 9999 and represents them in symbols and words, stating the place value of any digit. (b) Demonstrates an understanding that numbers can be represented using groupings of 10, 100, 1000												
Counts by tens (three-digit numbers)					13	48	76	100				
by tens (four-digit numbers)					20	14	14	29				
Orders three-digit numbers					11 16	76 14	81 10	100 76				
four-digit numbers					14	57	57	76				
Compares three-digit numbers	29	76	91	76								
four-digit numbers					18	19	33	33				
Represents: Writes, from oral name, three-digit numbers without zero as placeholder	6	86	91	100					6	91	100	100
Writes, from oral name, three-digit numbers with zero as placeholder	3 4 5	91 95 100	95 91 100	100 100 100					6	100	95	100
Writes, from written word name, three-digit numbers (with zero as placeholder)	12	76	86	91								
Writes, from written word name, three-digit numbers (without zero as placeholder)	10 11	86 71	86 86	95 95								
Writes, from oral name, four-digit numbers without zero as placeholder									6	48	76	86
Writes, from oral name, four-digit numbers (with zero as placeholder)									6	24	43	57
Reads three-digit number without zero as placeholder									7	100	100	100
Reads three-digit number with zero as placeholder									7	86	100	100
Reads (and renames) three-digit number					22	14	10	19				
Reads four-digit number without zero as placeholder									7	48	86	86
Reads four-digit number with zero as placeholder									7	48	71	81
Reads (six-digit number)					19	5	19	38				
interprets graphic representation of three-digit numbers	23 24	43 76	71 62	67 81	15	48	76	86				
interprets graphic representation of three-digit numbers (with regrouping)	26 27	14 38	57 62	67 81	21	19	38	38				
NOT INDICATORS FOR N 1 OR 2					23 24	5 0	14 0	24 0				

Appendix 8.3

Analysis of assessment data with respect to Working Mathematically and Values and Attitudes Outcomes

The students' results on the conventional and alternative assessment were considered in terms of the Working Mathematically and Values and Attitudes Outcomes. The summary of this analysis is contained in Table 8.7 in Chapter 8.

Conventional assessment and the Working Mathematically Outcomes

The objectives of the DMT and KeyMath-R items did not include any reference to the processes that the student used to reach the given response. The opportunities for students to produce indicators of their levels of development of the use of these processes is considered.

Questioning

WM 1.1	asks questions about mathematics when using materials and in practical situations.
WM 2.1	poses questions or problems about mathematical situations.

During the class administration of the DMT there was opportunity for the students to ask questions about the DMT, however, it was clearly specified at the outset that only questions related to reading of the items could be responded to by the supervising researcher and teacher. So there were no opportunities for the students to ask mathematical questions. When students asked any questions during the KeyMath-R administration, the researcher had to inform them that it was not possible to respond to the question. The researcher did not note the specific nature of any questions. None of the items of the DMT or KeyMath-R provided opportunities for students to pose questions or problems.

Problem Solving

WM 1.2	answers mathematical questions using objects, pictures, imagery, actions or trial and error.
WM 2.2	uses one or more strategies to solve mathematical problems.

The problems referred to in these outcomes are those appropriate for stages 1 and 2, up to years 4 in primary school. These include mathematical questions concerning the number of objects, through to more complex problems. Most of the items in the DMT required written numerals as the response, rather than the use of objects, pictures or other forms of response. The KeyMath-R items required oral responses, usually numbers. Strategies used in reaching the answer to the DMT or KeyMath-R items were not required to be evident. There was no room for the use of more than one strategy, as the items were direct response items rather than problem solving. A group of three items focused on two different counting strategies, by ones and by tens, and sought the identification of the "easier" strategy. This was a directed question rather than an opportunity to generate other strategies. However, it could be used as a preliminary indicator for this issue (WM 2.2).

Communicating

WM 1.3	explains simple mathematical situations using everyday language, actions, materials and drawing.
WM 2.3	represents, interprets and explains mathematical situations using everyday language with some mathematical terminology, including simple graphs.

There was little opportunity during the DMT and KeyMath-R for students to demonstrate explanation skills as most item responses were short answer. One DMT item, (15) sought an explanation for the answer. None of the KeyMath-R items sought any explanation. Everyday language was not required in the responses to the DMT or the KeyMath-R. The items were presented with everyday and mathematical language, and so was an opportunity to demonstrate skills in interpretation of the questions. Interpretation of some DMT items was noted to be a difficulty for a number of students. Only one item sought an explanation in everyday language (Item 15). One other item (21) sought a construction of a graphic representation, however, all the other items sought responses in numerals. This reflected the content focus of the DMT, of numeration.

Verifying

WM 1.4	supports answers to mathematical questions by explaining or demonstrating how the answer was obtained.
WM 2.4	checks, using an alternative method if necessary, whether answers to problems are correct and sensible.

DMT item 15 sought an explanation for the answer. Otherwise no items provided any opportunity for demonstration of verification strategies. Students may have checked

their responses, however, there was no requirement for any evidence of this, and it would have been incidental if the researcher or teacher noticed a student doing this. The feedback allowed during the KeyMath-R was to be non-reflective of the correctness of the response, so no checking or verification was expected, or indicated. The possibility of students checking their responses on the DMT is not able to be accessed as only the final answer, the product, is required on the paper. Similarly any working is not required on the paper, and many of the items do not have room for working as they are immediate response type items, rather than problems.

Reflecting

WM 1.5	recognises what worked and what did not work while answering mathematical questions.
WM 2.5	compares own method of solution to a problem with that of others.

There was no opportunity for any demonstration of reflection. Self-correction was possible, but was not monitored nor recorded. There was no opportunity for this strategy to be used. Comparing a method with others would have been considered 'cheating' if used during the DMT.

Using Technology

WM 1.6	uses the available technology to explore basic mathematical concepts.
WM 2.6	uses the available technology to help in the solution of mathematical problems.

There were no opportunities for any indication concerning these outcomes since the assessments were in the form of written pencil and paper test and printed stimulus within an oral interaction. No technology of the type referred to in these outcomes are necessary in these assessments.

In summary the conventional assessments used in this study did not provide much opportunity for eliciting indicators from students about these Working Mathematically outcomes. The DMT is a pencil and paper test that required short answers and no evidence of the processes or thinking that led to the answer. Although students were allowed to ask questions during the administration these were restricted to request for reading assistance and so did not provide any indication of questioning skills. The KeyMath-R interview setting provides more opportunity to identify indicators for these Working Mathematically outcomes, however, there is no focus on them in the item definitions, and no room to explore the process issues during the assessment. The items are all designed as short answer, with little need for any evidence of working.

Although the structure of the conventional assessments did not provide opportunities for indicators for Working Mathematically outcomes, some observational notes were taken at times during the KeyMath-R administration. These were not generated within the framework for the working mathematically outcomes, however, they can be interpreted within that framework. It was noted on Jack, Thomas and Natalie papers that they sought clarification of one question. It was also noted on Kieren's paper that he "explained" his response to item 16 seeking a rounding of a three-digit number. It was also noted during the KeyMath-R that Farley's language of response was not clear. No other notes were taken that provided evidence of the students' skills of Working Mathematically.

Conventional assessment and Values and Attitudes Outcomes

The Values and Attitudes Outcomes are not linked to other curriculum outcomes, but are all considered to be relevant across all stages of the curriculum. They are "different in nature from the outcomes for Working Mathematically, Space, Measurement and Number. For this reason the same values and attitudes outcomes for Mathematics K-6 apply at each stage" (Board of Studies, 1998, p.7). There are eighteen outcomes, not all of which are pertinent to this study. They are shown in the following Table A8.3i

Table A8.3i Mathematics K-6 Values and Attitudes Outcomes

VA 1	appreciates that mathematics involves observing, generalising and representing patterns and relationships	No opportunity
VA 2	demonstrates a positive response to the use of mathematics as a tool in practical situations	No opportunity
VA 3	shows an interest in and enjoyment of the pursuit of mathematical knowledge	Observation may produce subtle indicators suggesting these issues.
VA 4	demonstrates the confidence to apply mathematics and to seek and gain knowledge	Observation may produce subtle indicators suggesting these issues.
VA 5	demonstrates a willingness to work cooperatively with others and to value the contributions of others	No opportunity
VA 6	appreciates the importance of visualisation when solving problems	Nature of responses may provide indicators.
VA 7	shows willingness to take risks when working mathematically	Nature of errors, e.g., non-attempts may indicate level of risk-taking.
VA 8	demonstrates a willingness to persist when solving problems and to try different methods	Observation may produce subtle indicators suggesting these issues.
VA 9	uses mathematics creatively in expressing new ideas and discoveries	No opportunity
VA 10	recognises the economy and power of mathematical notation, terminology and convention in helping to develop and communicate mathematical ideas	These two outcomes are concerned directly with the content of the assessments, and there may be indicators.

VA 11	appreciates that conventions, rules about initial assumption, precision and accuracy enable information to be communicated effectively	
VA 12	appreciates that a mathematical model is a simplified image of some aspect of the social or physical environment	No opportunity
VA 13	realises that justification of intuitive insights is important	No opportunity
VA 14	appreciates how mathematics is used in a range of aspects of society	No opportunity
VA 15	appreciates the contribution of mathematics to our society	No opportunity
VA 16	recognises that mathematics has its origins in many cultures and is developed by people in response to human needs	No opportunity
VA 17	appreciates aspects of the historical development of mathematics	No opportunity
VA 18	appreciates the impact of mathematical information on daily life	No opportunity

The conventional assessment procedures provided a few opportunities to observe indicators of the Values and Attitudes outcomes. It was possible to observe the students showing different levels of "interest and enjoyment" during the assessments (VA 3). This was incidental and very informal during the class administration of the DMT, however, it was more possible during the KeyMath-R as the situation was an individual setting. This was similar for VA 4, 7, 8, and 11 that focused on confidence, willingness to take risks, willingness to persist, appreciation of conventions, and precision and accuracy in communicating mathematical ideas.

The researcher was not working within the framework of curriculum outcomes when observing during the class or individual administration. However, some notes were taken incidentally and provided information about these indicators for some of the students. For example, Ingrid was noted to lack confidence, and she needed encouragement as she recognised a difficult question from the previous assessment "This one got me last time." Grace was noted to be persistent, and for one item the researcher interpreted from her body language that she was not happy with her response. No follow up occurred as this is not allowed for in the standardised procedures. It was noted that the researcher found it difficult to be sure that Christopher was providing his best performance on the first assessment as he was quiet, was not seen to take risks with a guess, and seemed to have low confidence. He was also noted to have shown mild anxiety during the KeyMath-R (2). These incidental observations and notes provided information about a few of the students in terms of the above values and attitudes outcomes. However, they were incidental and only able to be taken at face value. No investigation of the suggested aspects of functioning was possible.

Alternative assessment and the Working Mathematically Outcomes

The information provided by the students' responses to the STOPV-DA was considered in reference to the Mathematics K-6 Working Mathematically Outcomes. Analysis of the dynamic assessment sessions using these outcomes clearly showed that the mediation approaches used by the researcher reflected the processes described in these outcomes. The mediation incorporated the processes for working mathematically that were defined in the Mathematics K-6 Outcomes (1998). This was not an intended aspect of the dynamic assessment design, since the outcomes were not published until after the implementation of the study. However, it reflects the processes of Working Mathematically that were defined for the curriculum.

The degree of intrusiveness of the mediation strategies reflected the fact that the mediation was working towards developing these outcomes within the students. The most intrusive strategies were used only when necessary, and less intrusive strategies were preferred until it was determined that more intrusiveness was needed.

All but two of the Working Mathematically Outcomes were found to have indicators within the STOPV-DA. These two Outcomes, WM 1.6 and 2.6 were concerned with the use of technology and so not pertinent to the nature of the STOPV-DA assessment. Otherwise, indicators for all of the other Working Mathematically Outcomes were found across the class during the STOPV-DA.

Because the dynamic assessment was not developed with the framework of outcomes in mind the analysis of the students' abilities is not comprehensive. The analysis is post-hoc, and based on notes taken by the researcher during the assessment sessions, and by later analysis of transcripts. It does not aim to be comparative, but rather to contribute to description of each student in terms of the noted behaviours and processes used by the student during the dynamic assessment. The following discussion was compiled from notes taken for individual students. Notes for each student are included in the Appendix 7F. From those notes the following descriptions have been derived.

Questioning

WM 1.1	asks questions about mathematics when using materials and in practical situations.
WM 2.1	poses questions or problems about mathematical situations.

The tasks were all structured to elicit responses from the students, and therefore included mathematical questions. The researcher also used other questioning throughout the mediation. As such she modelled questioning, and used it to direct the mediation sessions. However, there were few opportunities for the students to ask questions or to pose problems during the mediation sessions.

At times some students did ask questions, usually to seek clarification of the standardised task question or instructions, e.g., Alex's response to the questions for Task 4 contained a clarifying question.

Res. How many beans do you think there are?
Alex Is this an estimate or do you count them?

This type of clarification questioning was demonstrated by five students (Alex, Brooke, Ingrid, Xavier, and Zoe) on the first assessment, and one student (Daniel) on the second assessment. The other type of questioning that was noted was Thomas on the first assessment, and Alex on the second and third assessments, questioned or challenged the ideas presented by the tasks.

Within this focus of working mathematically, it was also noted that Christopher was not questioning at all, although it was needed. Although there were other students who did not use any questioning during the sessions, Christopher stood out as needing to develop the skill to assist in his learning. He accepted the initial conception of each task and did not attempt to make sense or match previous knowledge. He did not seek clarification or further information at any time.

Questions were not posed by other students during the assessments. This reflected the directed tasks and the task focused mediation.

Problem Solving

WM 1.2	answers mathematical questions using objects, pictures, imagery, actions or trial and error.
WM 2.2	uses one or more strategies to solve mathematical problems.

All the tasks sought responses that were answers to mathematical questions using either objects or actions. The students had access to base-ten blocks, beans, counters, pencil and paper, and were required to respond using these materials as well as orally. This allowed all the students to provide indicators of their skills in problem solving.

All the students showed their ability to respond using base-ten blocks during task 2 on all three assessments. They also all manipulated the counters in Task 3 and the beans in Task 5 as requested by the researcher. During the mediation phases these problem solving skills were also sought, guided and modelled by the researcher.

At times the researcher sought generation of alternative ideas from the student. Some students provided alternative ideas or strategies. At other times, the researcher guided or modelled this. Trial and error was used in some cases and supported by the researcher, particularly in cases where a student provided an alternative idea that needed to be investigated.

Communicating

WM 1.3	explains simple mathematical situations using everyday language, actions, materials and drawing.
WM 2.3	represents, interprets and explains mathematical situations using everyday language with some mathematical terminology, including simple graphs.

The process of communicating was used extensively during the STOPV-DA and provided many opportunities for students to demonstrate skills and difficulties. The tasks all sought explanations using everyday language, actions, and use of materials, and so elicited a rich source of indicators in this area.

The students demonstrated a wide range of skill in using everyday language. Most of the students provided clear meaningful explanations.

These ranged from adequate to excellent. Ewan, Grace, Hannah, Jack, and Ingrid were all noted to have excellent or good expressive language. They gave clear, precise, meaningful explanations as appropriate. Ewan was noted to produce elaborated explanations, however, they were not always focused on the point of the question. Xavier was noted to have clear expressive language in comparison to his poor receptive language. He had some difficulty interpreting the meaning of the researcher's language. However, there were five students who demonstrated some difficulty with expressive language. Brooke used confused explanations, in which the meaning was present but was not expressed efficiently or precisely. She showed indications of language difficulty on all assessment occasions. e.g.,

Res. How do you know that is 52?
Brooke Because if you count all them and that's five twenties and two ones.

Farley used minimal language, mostly single word responses or no responses, and when he did provide a lengthy response it was imprecise.

Res.	Does this part of your 26 have anything to do with how many counters you have?
Farley	Yes
Res.	Yes? What does that mean?
Farley	(no response)
Res.	What's it got to do with the number?
Farley	(no response)
Res.	Any idea?
Farley	No
Res.	OK. How many have we got?
Farley	Twenty-six
Res.	OK, twenty-six. Tell me what this means, what's the six telling you?
Farley	That there's some six and two units, that you've got two in there and got six in there equals twenty six.
Res.	OK. Tell me more about that what do you mean you've got two in there and you've got six. What does that mean? (pause) Can you show me?
Farley	The two and you've got six there and the number equals 26.

Kieren and Laura were also noted to use minimal language, in particular short responses.

On the second assessment it was noted that Zoe produced clear precise explanations.

The content focus of the tasks was the numeration system, which is the conventional representation of numbers. Indicators concerning this representation are defined within the Numeration Outcomes previously discussed.

Interpretation of the tasks was the focus of mediation at times. The researcher was investigating this at all times in order to validate the interpretation of the responses provided as indicating numeration understanding rather than other aspects of functioning. Evaluation of the tasks for this purpose was also kept in mind.

It was clear that interpretation of Task 1 was a source of difficulty at times. Student comments referring to the table, or the cups, suggested that the students had not interpreted the task question to include all the beans, as intended, and that the meaning of the task question needed to be clarified. The initial mediation strategy employed was to direct focus on to the total number of beans, by paraphrasing the task question and

incorporating gestures. This strategy is illustrated through an excerpt from Chris' mediation. The words and actions that were contributed by the student are labelled by name and those contributed by the researcher are marked Res. These pairs of contributions that make up one interaction, as defined earlier, are grouped. Descriptions of actions are included within the square brackets.

Res.	Look at these altogether, including those and these [gestured to beans in cups and on table]. Are there the same number, more, or less than we had?
Chris	Same.
Res.	Why?
Chris	Because you didn't take any away.

Similar mediation occurred for the other four students, in response to the researcher identifying misinterpretation as an aspect contributing to the low level of performance. For one student the misinterpretation was investigated overtly. The researcher reflected on Chris' earlier response that there were "less" beans by asking him whether he had understood the question to mean only the beans in the cups. He confirmed this interpretation.

For four students these strategies resulted in responses demonstrating conservation (Chris, Alex, Zoe, and Natalie). These outcomes supported the impression of the researcher that the format and language of the task confused some students and contributed to them providing a lower level response than they may have been otherwise able to.

The use of mathematical terminology was also elicited at times. Jack showed his familiarity with the terminology of place value using the mathematical terms appropriately and comfortably.

Res.	How do you know that is 52?
Jack	Because the longs are ten and the units represent one. So you just take five of the ten to make fifty and two of the units make two, add together to make 52.

All other students, except Brooke were seen to be beginning to use the terms of numeration, however, it was noted that Brooke was not using mathematical terminology as much as the other students. The researcher modelled the language related to the numeration concepts during the mediation, and it was noted that some students were then able to take the language and use it appropriately using the session.

Verifying

WM 1.4	supports answers to mathematical questions by explaining or demonstrating how the answer was obtained.
WM 2.4	checks, using an alternative method if necessary, whether answers to problems are correct and sensible.

The researcher sought verification from the students for their responses and used skills of verifying during the mediation. Tasks 1, 2, 3 and 5 all sought either open verification "Why?" or structured questions to investigate the students' reasoning behind their responses. This provided opportunities for the students to demonstrate their verification processes and skills.

Reflecting

WM 1.5	recognises what worked and what did not work while answering mathematical questions.
WM 2.5	compares own method of solution to a problem with that of others.

The students demonstrated a range of approaches to reflection from relying on the researcher, to being self-reflective. Daniel sought reflection from the researcher constantly, looking to the researcher for clues as to whether he was on the right track. Brooke sought reassurance, relying on the researcher as well, for reflection. Laura was also noted to need researcher reflection to reassure her. The notes for the second assessment indicated that she was beginning to self-reflect. This reliance on the researcher was also noted for Rachael, Thomas and Farley.

Several students demonstrated reflection and self-correction skills during Tasks 6 and 7. For example, Daniel considered his responses on the third assessment and made self-corrections, without looking to the researcher as he had done previously.

During Task 4 counting the large number of beans, students were observed to check their counting at times. It was noted that Alex and Christopher both stopped at times to consider their actions.

Analysis of the student contributions to the STOPV-DA sessions allowed interpretation in terms of these outcomes. These outcomes defined the processes used by the researcher in mediation as well as by the student in participating in the mediation, and reflected the social and general cognitive aspects of functioning identified within the STOPV-DA. This was not a framework which directed either the implementation of the dynamic assessment or the note taking, however, many of the notes taken during the

sessions were interpretable in terms of the Working Mathematically Outcomes. It was also clear that the mediation was carried out along the lines of the processes defined within the Working Mathematically Outcomes and that the researcher was in fact mediating these processes as well as the numeration content. They include many of the identified general cognitive and social aspects of functioning. The outcomes framework may be useful for future development of dynamic assessment procedures.

Alternative assessment and the Values and Attitudes Outcomes

Indicators for the Values and Attitudes Outcomes were also generated during the STOPV-DA. Many of these reflect the emotional aspects of functioning that were noted for the students during the STOPV-DA and which can be plotted onto this framework. The Outcomes for which indicators were not found across the class are included in the following Table A8.3ii

Table A8.3ii STOPV-DA & Mathematics K-6 Values and Attitudes Outcomes

VA 1	appreciates that mathematics involves observing, generalising and representing patterns and relationships	No opportunity
VA 2	demonstrates a positive response to the use of mathematics as a tool in practical situations	No opportunity
VA 3	shows an interest in and enjoyment of the pursuit of mathematical knowledge	
VA 4	demonstrates the confidence to apply mathematics and to seek and gain knowledge	
VA 5	demonstrates a willingness to work cooperatively with others and to value the contributions of others	
VA 6	appreciates the importance of visualisation when solving problems	
VA 7	shows willingness to take risks when working mathematically	
VA 8	demonstrates a willingness to persist when solving problems and to try different methods	
VA 9	uses mathematics creatively in expressing new ideas and discoveries	
VA 10	recognises the economy and power of mathematical notation, terminology and convention in helping to develop and communicate mathematical ideas	
VA 11	appreciates that conventions, rules about initial assumption, precision and accuracy enable information to be communicated effectively	
VA 12	appreciates that a mathematical model is a simplified image of some aspect of the social or physical environment	No opportunity
VA 13	realises that justification of intuitive insights is important	No opportunity
VA 14	appreciates how mathematics is used in a range of aspects of society	No opportunity

VA 15	appreciates the contribution of mathematics to our society	No opportunity
VA 16	recognises that mathematics has its origins in many cultures and is developed by people in response to human needs	No opportunity
VA 17	appreciates aspects of the historical development of mathematics	No opportunity
VA 18	appreciates the impact of mathematical information on daily life	[illegible]

Indicators were found for many, but not all, of the Values and Attitudes outcomes during the STOPV-DA. The first two outcomes, VA 1, 2 and outcomes VA 12 to 17, were not interpretable from the data. However, indicators were found for the other outcomes.

VA 3	shows an interest in the pursuit of mathematical knowledge

During the initial assessment, each student was also asked whether they liked Mathematics at school. Their responses were compiled in Figure 7.11.

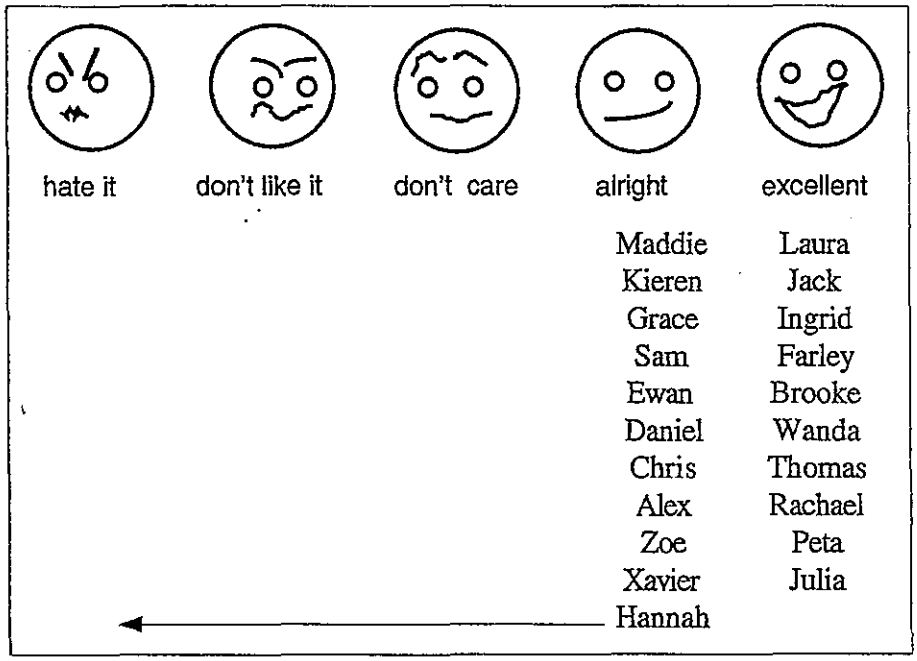


Figure A8.3i Students reported interest in school Mathematics

This figure indicates that all the students selected "alright" or "excellent" in response to the question about whether they liked Mathematics in class. One student. Hannah, circled the "alright" face and then the "hate it" face and explained that classroom Mathematics could be "boring, not much to do, hard".

An impression of whether the students were interested in and enjoyed the pursuit of mathematical knowledge was gained from the dynamic assessment interaction. Observation of the degree of engagement with the tasks, and the students' emotional states provided information about the interest and enjoyment in the context of the particular mathematical interaction. It was noted that Alex, Grace, Jack, Sam, and Maddie were keen to learn and make sense of the tasks. Natalie, Peta, and Farley were noted to be lacking interest. Other students, Brooke and Wanda were seen to be more interested in pleasing the researcher, rather than having an interest in the content of the session. Grace was also seen to be keen to please the researcher but was also interested in the tasks themselves.

VA 4	demonstrates the confidence to apply mathematics and to seek and gain knowledge

Demonstrations of degree of confidence were noted. Grace, Jack and Ewan were all seen to be confident. However, low levels of confidence, to the extent of anxiety were noted in twelve of the students (Alex, Daniel, Farley, Hannah, Ingrid, Laura, Natalie, Rachael, Thomas, Wanda, Xavier and Zoe). These were relatively consistent over the three assessments, however, changes were noted in Alex, who was less anxious on the second assessment, and Hannah who was less demonstrative about her belief that "I'm not very good at these" on the second assessment, when she was more tentative in her responses than anxious.

VA 5	demonstrates a willingness to work cooperatively with others and to value the contributions of others

All the students demonstrated a willingness to work co-operatively with the researcher during the sessions. However, there were different levels of participation and contribution. Grace was keen to contribute to the interaction and to her own learning and the researcher had a role as supportive facilitator. For students such as Grace the responsibility for the sessions was shared. The researcher had to work harder to involve some students. Christopher was hard to engage fully, and he did not initiate any of the learning interactions. Ingrid, Daniel, Wanda and Xavier also provided less participation, and the researcher was relied on to a greater extent to manage the sessions. Farley was the most difficult to work with. He was reluctant to participate, and showed little motivation for learning. It was noted that a small degree of eagerness to please the researcher was used to keep him as involved as possible, however, he never accepted responsibility for participation in the sessions.

VA 6	appreciates the importance of visualisation when solving problems

The students' appreciation of the importance of visualisation was shown by some students. In particular Farley used visual organisation of materials to assist his problem solving. No other notes relating to this outcomes were taken.

VA 7	shows willingness to take risks when working mathematically

The students' willingness to take risks during the learning sessions was noted. The researcher engineered the mediation so that the size of risks were seen to be appropriate for each student, however, it was still noted that Zoe, Farley, Daniel and Christopher were not prepared to take any risks. Natalie was seen to need a safe setting in order to take any risks. Otherwise the students took risks during the sessions.

VA 8	demonstrates a willingness to persist when solving problems and to try different methods

Persistence was noted for Grace, who wanted to achieve in each task. However, a lack of persistence was noted for Christopher, Ewan, Farley, Laura, Wanda and Zoe. They needed encouragement from the researcher to continue.

VA 18	appreciates the impact of mathematical information on daily life

The final Values and Attitudes outcome concerned the appreciation of the impact of mathematical information on daily life. This was an issue for one of the tasks, Task 5, in which a two-digit number in a use-by-date on a grocery packet was interpreted. A number of students showed that their interpretation was within the everyday context, which indicated some appreciation of the mathematical impact on daily life. The responses that indicated this appreciation included Thomas' response on the second assessment.

Res. (TASK 5 Present packet with USE BY 06 Jun 97) What number is this?
Thomas Oh six

Res. What does that mean?
Thomas It's a code number. It tells you when you have to eat it by.

Other students who provided indicators like this were Alex, Daniel, and Sam although the contexts were not exactly correct. They included the number of grams in the packet and a brand number. However, they were seeking an everyday context for the number.

On the second occasion five students (Xavier, Natalie, Kieren, Farley and Christopher) provided an indication of their contextual understanding of the numbers. On the third assessment five students (Xavier, Thomas, Natalie, Hannah, and Daniel) gave this indication.

The information provided by the STOPV-DA assessment allowed determinations of achievement to be made across the class. Such achievement was defined through levels of response to each of the seven tasks, through allocation of a stage of development of understanding, and in reference to the curriculum, through the Mathematics K-6 Outcomes.