The Smith Family

Let's Count Longitudinal Evaluation

Final Report

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Evaluators

Associate Professor Ann Gervasoni (Monash University) has worked in teacher education, professional learning and primary teaching for 33 years. Ann was a member of the research team for the *Early Numeracy Research Project* (1999-2001) in Victoria, and research director for the *Bridging the Numeracy Gap* project in Western Australia and Victoria (2009-2010). Ann's research interests include Mathematics Education in early childhood and primary school settings, young children's mathematics learning in home contexts, and assisting children who experience difficulty learning mathematics. Ann developed the Extending Mathematical Understanding Intervention Program that is used across Australia to support children who are mathematically vulnerable.

Professor Bob Perry (Charles Sturt University) has worked in teacher education in Australia for the last 42 years with specific foci on mathematics education, early childhood education, Indigenous education, and transition to school. More recently, he has been able to bring these areas together in the development of community capacity, particularly in Indigenous communities. Bob's current major areas of research include early childhood mathematics education, educational transitions, Indigenous mathematics education, social justice in and through education. He is currently working with the Queensland Department of Education, Training and Employment on the longitudinal evaluation of a school leadership and transition to school project and on a series of school reviews. In April, 2015, Bob was invested as an Honorary Doctor (Hedersdoktor) at Màladarlen University, Vàsterås, Sweden.

Bob and Ann have been very ably assisted by our research assistants Linda Parish (ACU Ballarat), Emma Kearney and Paige Quinnell (CSU, Albury) and by the impressive ACU MAI assessment team: Peter Whelan, Rona Parker, Denise Whelan, Rasma Kradzins, Kyra Wood, Kyra Ives, Caitlin Mauric, Kaitlyn Dunstone, Shawnee McIntosh, Olivia Kent, Thea Nipress, Jane Carter, Melissa Portelli, Tamara EllenBroek, Mistelle Moore, Michaela Fenner, Jane Greenlees, Sharyn Ahern, Toni Constable, Emma McLennon and Lucy Walker.

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Executive Summary

Background

Children are more likely to have positive experiences of mathematics during their early years if their educators, parents and other family members also have positive dispositions towards mathematics. *Let's Count* is a new early mathematics learning approach that has been designed by The Smith Family, Professor Bob Perry and Associate Professor Ann Gervasoni in order to assist educators in early childhood contexts to work in partnership with parents and other family members to promote positive mathematical experiences for young children (3-5 years). The program aims to foster opportunities for children to engage with the mathematics encountered as part of their everyday lives, talk about it, document it, and explore it in ways that are interesting, fun and relevant to them.

Let's Count involves a program of professional learning for early childhood educators consisting of two modules that each involve a full day of professional learning workshops with approximately two months between each module for site based learning and activities. Ongoing interactions between educators, parents and other family members and children over the period of an educational year follow from this professional learning.

Evaluation aims

The *Let's Count* Longitudinal Evaluation explores the experiences of children, educators and parents and other family members of the *Let's Count* program as implemented in early childhood educational settings in six geographical sites across Australia during 2012, and these plus another six sites during 2013 and 2014.

The three key research questions framing the evaluation were:

1. How does participation in *Let's Count* impact on children's numeracy knowledge and dispositions as they make the transition to school?
2. What is the impact of *Let's Count* on the educator participants' knowledge, interest and confidence in mathematics learning and teaching?
3. What is the impact of *Let's Count* on the participating families' confidence, and knowledge about noticing, investigating, and discussing mathematics with their children?

Evaluation methods

The *Let's Count* Longitudinal Evaluation used a multi-methods approach, collecting information from adult participants through both surveys and telephone interviews, and from children in the year before they started formal schooling through individual assessment interviews. Data were gathered in two of the implementation sites in 2013 and these two plus another two new sites in 2014. The data about children's mathematics knowledge were analysed to gauge growth in knowledge for the cohort of children who experienced *Let's Count* during 2013 and 2014, the years before they started formal schooling, and to compare the mathematical knowledge of this cohort at the end of either 2013 or 2014 with a quasi-experimental 'comparison' group of preschoolers from the original two evaluation sites. For adult participants, the evaluation focused on determining the success of the *Let's Count* program in bringing early childhood educators, parents and other family members together, to enhance children's mathematical engagement, learning outcomes and dispositions.

Sample

In November, 2012, the mathematical knowledge of 125 children eligible to start school in 2013 was assessed using the *Mathematics Assessment Interview* (MAI). These formed the quasi-experimental comparison group. The assessment interview is used widely throughout Australia to measure the mathematical knowledge of children when they begin school and throughout schooling.

In early 2013, 142 children eligible to start school in 2014 and who were going to participate in *Let's Count* during 2013 were assessed using the MAI. At the end of 2013, 117 of these children were assessed again using the same instrument. In early 2014, another 195 children eligible to start school in 2015 and who were going to participate in *Let's Count* during 2014 were assessed using the MAI. At the end of 2014, 172 of these children were re-assessed using the same instrument.

Educators undertook a brief survey on two occasions in the year in which they participated in *Let's Count*– immediately prior to the commencement of the first professional learning workshop and immediately after the completion of the second workshop. Telephone interviews with educators were conducted on three occasions – within three weeks of the first workshop, mid-year and near the end of their *Let's Count* year.

A small number of parents were interviewed twice during 2013. In 2014, a larger number of parents were interviewed up to three times using a similar schedule to that of the educators.

Both the surveys and the interviews focused on matters relating to existing attitudes towards mathematics, to what extent the *Let's Count* program had impacted on attitudes towards mathematics and the ways in which the *Let's Count* program had influenced how both educators and parents interacted with children in relation to mathematics learning.

Results

Children

The findings demonstrate clearly that the cohorts of children who experienced *Let's Count* in 2013 and 2014 showed noteworthy growth in their performance on the MAI from the beginning of their preschool year to its end. The extent of this growth is further reinforced by comparison of the *Let's Count* cohort's end of year scores on the MAI compared with those of the 'comparison' group and another cohort measured by the *Early Numeracy Research Project* in 2001. On almost every measure, the *Let's Count* cohort has bettered the scores of the other two groups, with some comparisons showing statistically significant differences. This shows that involvement in *Let's Count* is associated with greater mathematics learning than might be typically expected.

Educators

Data drawn from both the interviews and surveys suggested that *Let's Count* provided educators with many opportunities to enhance the mathematical outcomes of children and their families. As well, educators enhanced their dispositions and confidence towards mathematics.

Key themes that arose from analysis of interviews with educators were:

1. Engaging families with mathematical learning and *Let's Count*;
2. Continuity of mathematical learning between early childhood setting and home;
3. Impact of *Let's Count* on educator confidence, professional identity and pedagogical practice;
4. Awareness of the potential of everyday tasks for prompting mathematics discussion;
5. Sustainability of *Let's Count* over time;
6. Children's engagement with mathematical learning and mathematical concepts;
7. Importance of mathematical language.

Parents and Family Members

A small number of *Let's Count* parents (mothers) were interviewed on two occasions during 2013. A larger number of parents, including some fathers, were interviewed on three occasions in 2014. These parents were unanimous in their praise for *Let's Count* and for its value in enhancing their children's mathematics learning. As well, they commented on their own improved understanding of 'mathematics in everything' and their improved ability to 'notice' mathematics in their children's everyday environments.

Key themes that arose from analysis of interviews with parents were:

1. Noticing children's mathematical learning and facilitating that learning in the everyday;
2. Parent – educator communication about mathematics and *Let's Count*, with an emphasis on strengths of all involved;
3. Children's growing confidence, knowledge and enjoyment of/engagement with mathematics;
4. Importance of mathematical language;
5. Positive impacts within families, extending to older and younger siblings' inclusion in mathematical activities at home;
6. Sustainability of *Let's Count* over time.

Recommendations

The following recommendations are made as a result of the Longitudinal Evaluation of *Let's Count* reported in this document. They are made with the aim of continuing to implement what has been shown to be a successful approach to enhancing young children's mathematical dispositions, knowledge and skills, as well as those of the children's early childhood educators and families.

1. That The Smith Family, in conjunction with early childhood education providers and appropriate funding authorities, seek to implement the *Let's Count* program in all sites in which it has a presence.

2. That the authors of the *Let's Count* program consider strengthening program content dealing with sustaining educator/parent communication across the entire year of implementation, including considering the feasibility of an enhanced resource for parents/families.

3. That consideration be given to the appropriate publications that might emanate from the *Let's Count* program and its Longitudinal Evaluation, including Research Reports, academic chapters and journal articles, and extended guidebooks for educators and parents.

4. That The Smith Family, in conjunction with appropriate tertiary institutions, continue to investigate the online offering of the educator professional learning modules with consequent accreditation.

5. That The Smith Family seek funding opportunities to research the impact of *Let's Count* on children's mathematics learning following their transition to school.

Background to the *Let's Count* Program

Let's Count is a new early mathematics program that has been designed by The Smith Family, Professor Bob Perry and Associate Professor Ann Gervasoni to assist educators in early childhood contexts to work in partnership with parents and other family members to promote positive mathematical experiences for young children (3-5 years). The program aims to foster opportunities for children to engage with the mathematics encountered as part of their everyday lives, talk about it, document it, and explore it in ways that are fun and relevant to them.

Let's Count is not a mathematics teaching program. However, it does involve early childhood educators in the role of advisers to the parents and family members of the children in their care about ways they can notice, discuss and explore mathematics with their children. *Let's Count* includes a professional learning program for educators to assist them in their critical role of advising parents and family members. Also, this professional learning enables educators to consider their own pedagogical approaches in mathematics and add to their repertoire of successful practices.

Let's Count aligns with the *Early Years Learning Framework for Australia* (Department of Education, Employment and Workplace Relations (DEEWR), 2009) through its use of play and investigation as its key pedagogical approaches and through its contribution to Learning Outcome 5: Children are effective communicators.

> Children bring new mathematical understandings through engaging with problem solving. It is essential that the mathematical ideas with which young children interact are relevant and meaningful in the context of their current lives. Educators require a rich mathematical vocabulary to accurately describe and explain children's mathematical ideas and to support numeracy development. Spatial sense, structure and pattern, number, measurement, data, argumentation, connections and exploring the world mathematically are the powerful mathematical ideas children need to become numerate. (DEEWR, 2009, p. 38)

The importance of early childhood educators working in partnership with families to assist children's learning is a key aspect of *Let's Count*, as it is with the *Early Years Learning Framework for Australia*:

> Learning outcomes are most likely to be achieved when early childhood educators work in partnership with families. Educators recognise that families are children's first and most influential teachers. They create a welcoming environment where all children and families are respected and actively encouraged to collaborate with educators about curriculum decisions in order to ensure that learning experiences are meaningful. (DEEWR, 2009, p. 12)

In summary, *Let's Count* is an early mathematics approach with the following characteristics:

- partnerships among early childhood educators and families;
- play and investigation for all;
- recognition of all as potentially powerful mathematicians;
- realisation that mathematics learning can be fun for all when it is undertaken in relevant and meaningful contexts;
- advice for families provided by early childhood educators;
- meaningful documentation of learning; and
- strong links to the theoretical and practical bases of the *Early Years Learning Framework for Australia*.

Further details of *Let's Count* can be obtained from the website (The Smith Family, 2015).

Longitudinal Evaluation of *Let's Count*

Purpose of the Longitudinal Evaluation

The aim of the longitudinal evaluation was to ascertain the success of the *Let's Count* program in bringing early childhood educators, parents and other family members together, to enhance children's mathematical engagement, learning outcomes and dispositions. The three key research questions framing the evaluation were:

1. How does participation in *Let's Count* impact on children's numeracy knowledge and dispositions as they make the transition to school?
2. What is the impact of *Let's Count* on the educator participants' knowledge, interest and confidence in mathematics learning and teaching?
3. What is the impact of *Let's Count* on the participating families' confidence, and knowledge about noticing, investigating, and discussing mathematics with their children?

The evaluation was conducted by teams from Charles Sturt University, Monash University and Australian Catholic University, led by Bob Perry and Ann Gervasoni.

Methodology

The evaluation concentrated on two regions in 2013 (Springfield, NSW and Ballarat, Victoria) and then, in 2014, continued in these two regions and expanded to include another two: Gosnells, WA and Wagga Wagga, NSW.

The evaluation study used a multi-methods approach, particularly for the adult participants who were involved in both surveys and telephone interviews. The children who participated in the evaluation completed individualised task-based assessment interviews.

Data Collection - Adult participants

Educators undertook a brief survey on two occasions in the year in which they participated in *Let's Count*– immediately prior to the commencement of the first professional learning workshop and immediately after the completion of the second workshop. Telephone interviews with educators were conducted on three occasions – within three weeks after the first workshop (post-workshop 1), mid-year and near the end of their *Let's Count* year (post-program). There was a small reduction in the numbers involved in both surveys and interviews as the year went on as well as a few educators who did not complete the earlier survey or interview but joined in later.

A small number of parents were interviewed twice during 2013. In 2014, a larger number of parents were interviewed up to three times using a similar schedule to that of the educators.

The distributions of educators and parents across the four evaluation sites (two in 2013 and these plus another two in 2014), and their participation in the various data generation activities are shown in Tables 1 and 2.

Table 1
Educator participation in data generation during 2013 and 2014. ('na' denotes that the site was not part of the data collection represented by the cell.)[1]

Region	Survey 1		Survey 2		Interview 1		Interview 2		Interview 3	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Ballarat	11	10	10	7	5	11	5	9	7	8
Springfield	12	8	8	5	9	8	8	8	9	7
Gosnells	na	9	na	6	na	6	na	3	na	2
Wagga Wagga	na	6	na	0	na	2	na	2	na	2
Other Sites	26	0	15	0	na	na	na	na	na	na
Totals	**49**	**33**	**33**	**18**	**14**	**27**	**13**	**22**	**16**	**19**

In total, there have been 133 surveys and 111 telephone interviews completed by educators.

Table 2
Parent participation in data generation during 2013 and 2014. ('na' denotes that the site was not part of the data collection represented by the cell.)

Region	Interview 1		Interview 2		Interview 3
	2013	2014	2013	2014	2014
Ballarat	4	8	5	8	8
Springfield	4	26	5	25	22
Gosnells	na	0	na	0	0
Wagga Wagga	na	4	na	3	3
Totals	**8**	**38**	**10**	**36**	**33**

In total, there have been 125 telephone interviews completed by parents.

Data Collection - Child participants

In November, 2012, the mathematical knowledge of 125 children eligible to start school in 2013 was assessed using the *Mathematics Assessment Interview* (MAI) (Gervasoni et al., 2011). These formed the quasi-experimental comparison group. The assessment interview is used widely throughout Australia to measure the mathematical knowledge of children when they begin school and throughout primary schooling.

In early 2013, 142 children eligible to start school in 2014 and who were going to participate in *Let's Count* during 2013 were assessed using the MAI. At the end of 2013, 117 of these children were

[1] In 2013, surveys were completed by educators in the two evaluation sites and some other implementation sites. All of these data have been included in the relevant analyses reported.

assessed again using the same instrument. In early 2014, another 195 children eligible to start school in 2015 and who were going to participate in *Let's Count* during 2014 were assessed using the MAI. At the end of 2014, 172 of these children were re-assessed using the same instrument. The small reducton in numbers of children re-assessed in December was either due to children leaving the centre during the year or not being present during the December assessment period.

The distribution of students across the four evaluation regions is shown in Table 3.

Table 3
Number of children's assessment at each evaluation region in December 2012, March 2013, December 2013, March 2014, and December 2014.

Region	No. Children Assessed					Total (First assessment)
	Dec 2012	Mar 2013	Dec 2013	Mar 2014	Dec 2014	
Ballarat	61	75	60	67	60	203
Springfield	64	66	57	47	46	177
Gosnells				45	41	45
Wagga Wagga				36	25	36
Totals	**125**	**141**	**117**	**195**	**172**	**461**

The MAI was chosen to assess the children's mathematical knowledge because it is task-based, interactive, based on extensive research, designed for young children, and enables progress to be measured in nine mathematics domains. It also has a section focused on early mathematics concepts that is designed for children beginning school – the Foundation Detour. This interview was developed as part of the *Early Numeracy Research Project* (ENRP) (Clarke et al., 2002) and refined during the *Bridging the Numeracy Gap* project (Gervasoni et al., 2011). An additional section of the interview focuses on early mathematics concepts for children beginning school.

The principles underlying the construction of the tasks and the associated growth points in the MAI were to:

- describe the development of mathematical knowledge and understanding in the first three years of school in a form and language that was useful for teachers;
- reflect the findings of relevant international and local research in mathematics (Fuson, 1992; Gould, 2000; Mulligan, 1998; Steffe, von Glasersfeld, Richards, & Cobb, 1983; Wright, Martland, & Stafford, 2000);
- reflect, where possible, the structure of mathematics;
- allow the mathematical knowledge of individuals and groups to be described; and
- enable a consideration of students who may be mathematically vulnerable.

The interview focuses on early mathematics concepts in nine mathematical domains. There are four whole number domains (Counting, Place Value, Addition and Subtraction, and Multiplication and Division); two measurement domains (Time, Length and Mass); and two geometry domains (Properties of Shape and Visualisation). The assessment tasks in the interview take between 30-45

minutes for each child and were administered by independent, trained assessors who followed a detailed script. Each child completed about 50 tasks in total, and given success with one task, the assessor continued with the next tasks in a domain for as long as a child was successful, according to the script. The processes for validating the growth points, the interview items and the comparative achievement of students are described in full in Clarke et al. (2002).

A critical role for the assessor throughout the interview is to listen and observe the children, noting their responses, strategies and explanations while completing each task. These responses are recorded on a detailed record sheet.

Ethics

The evaluation project has ethics approval from both Charles Sturt University (CSU) and Australian Catholic University (ACU) and from the participating centres, educators, parents and family members.

No participant was required to be involved in the evaluation of *Let's Count* and participation in the evaluation was not a condition of participation in the *Let's Count* program. There were separate consent procedures for the surveys and the interviews for adults and for the children's participation in the MAI assessment. Children were asked for their assent before each MAI implementation.

Methods of Analysis

Children

MAI data was independently coded to determine whether or not a response was correct; identify the strategy each child used to complete a task, and the growth point reached by a child overall in each domain. This information was entered into an SPSS database for analysis. Of particular interest for this research were the children's responses to tasks in the early mathematics concepts section of the MAI and the initial tasks in each of eight other domains. Simple statistical analysis was carried out, including frequency counts, crosstabs and χ^2 calculations to measure for statistical significance of key differences.

Adult participants

All data from the two rounds of educator surveys in both 2013 and 2014 were entered into SPSS for quantitative analysis. For the most part, these analyses consisted of frequency counts and simple statistical techniques such as crosstabs and χ^2 calculations. Qualitative data from the surveys was used in conjunction with interview data to provide a clear picture of the respondents' attitudes to mathematics and mathematics pedagogies

All the interviews were audio-recorded and transcribed for analysis. An initial coding frame was established for the interview data using a coding procedure based on the principles of grounded theory (Charmaz, 2004; Strauss & Corbin, 1998). Each interview was then double coded using this coding frame as a starting point. Any discrepancies in coding were resolved through discussion and agreement between the coders. The coded data were entered into NVivo. The qualitative analysis was undertaken in this software environment.

Results

Children

All children in the 2012 comparison group were assessed using the MAI Foundation Detour, the four whole number domains, two measurement domains and two geometry domains to establish base-line comparison data. In 2013 and 2014 children participating in *Let's Count* were assessed using the Foundation Detour, the four whole number domains, and were randomly assigned for assessment in one measurement and one geometry domain. This reduced the length of the interview for children but maintained the opportunity to compare the cohorts' growth in measurement and geometry during the preschool year. Summaries of the children's results for each task are presented in the tables that follow. The tasks are grouped into mathematics topics according to the associated *Australian Curriculum - Mathematics* Foundation Year Standard or Proficiency (Australian Curriculum, Assessment and Reporting Authority, 2013). This enables some judgements to be made about the preschool children's knowledge in December (just prior to beginning school) with the curriculum aims for children's learning at the end of their first year at school.

In each of the following sections, the first table shows the percentage of children who were successful with each task for the 2013 and 2014 *Let's Count* cohorts to show their growth in understanding from March to December across their preschool year. The second table in each section shows the percentage of children who were successful with each task in December (just priorto beginning school) for the comparison group (2012), the 2013 *Let's Count* group and the 2014 *Let's Count* group, as well as for 1438 children in the February/March 2001 ENRP First Year at School cohort (Clarke et al., 2006)[2]. The December percentage scores for the 2013 and 2014 groups were compared for statistical significance with the 2012 comparison group. These results are presented in the first columns of the associated tables. Results for some tasks were not available for the ENRP comparison group as indicated with 'na' in the Tables. This was due to the addition of some new tasks in the intervening period.

[2] For a brief description of the Early Numeracy Research Project (ENRP), see Appendix B of this report.

Tasks with Small Sets

Table 4 and Table 5 focus on children's success with tasks involving small sets of objects, usually small plastic teddies. The tasks were all associated with the Australian Curriculum Foundation Standard: students make connections between number names, numerals and quantities up to 10.

The results in Table 4 for the *Let's Count* preschoolers suggest that about three-quarters of children demonstrate the Standard just before they begin school. Large numbers of the children assessed at the beginning of preschool in March were also successful with these tasks, but less so than later in the year. Growth across the year is clearly evident.

Table 5 shows the results for each cohort in December and for the ENRP Comparison Group in Februrary of their first year at school. The results suggest that the majority of students have met the Australian Curriculum objective for the first year of school prior to beginning school. This has implications for children's transition to school.

The performance of the *Let's Count* cohorts on each task involving small sets was compared with those from the comparison group to determine whether children's participation in *Let's Count* was associated with improved performance. The *Let's Count* cohorts at the end of 2013 and 2014 were significantly different to the comparison group with respect to four tasks involving making sets of objects and reducing them by one. The December, 2014 *Let's Count* group was also significantly different from the comparison group in being able to conserve a group of five teddies.

Table 4
Percentage Success on Tasks with Small Sets

Tasks	LC Mar 2013 (*n*=141)	LC Dec 2013 (*n*=117)	LC Mar 2014 (*n*=195)	LC Dec 2014 (*n*=172)
Tasks with Small Sets				
Count a collection of 4 teddies	88	96	92	97
Identify one of two groups as "more"	68	92	73	87
Make a set of 5 teddies when asked	63	90	64	91
Conserve 5 when rearranged by child	67	88	68	90
Conserve 5 when hidden		77	60	86
Combine 5+3 blue teddies & total	57	71	48	79
Make collection of 7 (when shown number 7)	27	84 (*n*=92)	32	89 (*n*=135)
Knows one less than 7 when 1 teddy removed	23	82 (*n*=85)	28	88 (*n*=131)
Knows one less than 7 without recounting	10	40 (*n*=85)	5	33 (*n*=131)
Part Part Whole Tasks				
Show 6 fingers (usually 5 & 1)	51	78	42	82
6 fingers 2nd way	5	40	10	18
6 fingers 3rd way	1	15	2	8
One to one Correspondence Task				
Know 5 straws needed to put 1 straw in each of 5 cups	74	87	76	95

Table 5

Percentage Success on Tasks with Small Sets

Tasks	Significance: Comparison (Dec, 2012) to (Dec, 2013) (χ^2, *p*)	Significance: Comparison (Dec, 2012) to (Dec, 2014) (χ^2, *p*)	Comp Dec 2012 (*n*=125)	LC Mar 2013 (*n*=141)	LC Dec 2013 (*n*=117)	LC Mar 2014 (*n*=195)	LC Dec 2014 (*n*=172)	ENRP Feb 2001 (*n*=1438)	Australian Curriculum Foundation Standard
Tasks with Small Sets									
Count a collection of 4 teddies	NS	NS	95	88	96	92	97	93	
Identify one of two groups as "more"	NS	NS	90	68	92	73	87	84	
Make a set of 5 teddies when asked	7.043, *p*<0.01	10.735, *p*<0.01	77	63	90	64	91	85	
Conserve 5 when rearranged by child	NS	6.748, *p*<0.01	79	67	88	68	90	58	
Conserve 5 when hidden					77	60	86		
Combine 5+3 blue teddies & total	NS	NS	75	57	71	48	79	na	
Make collection of 7 (when shown number 7)	11.016, *p*<0.01	23.852, *p*<0.01	63	27	84 (*n*=92)	32	89 (*n*=135)	na	Students make connections between number names, numerals and quantities up to 10.
Knows one less than 7 when 1 teddy removed	12.018, *p*<0.01	24.804, *p*<0.01	61	23	82 (*n*=85)	28	88 (*n*=131)	na	
Knows one less than 7 without recounting	12.018, *p*<0.01	24.804, *p*<0.01	25	10	40 (*n*=85)	5	33 (*n*=131)	na	
Part Part Whole Tasks									
Show 6 fingers (usually 5 & 1)	NS	NS	79	51	78	42	82	78	
6 fingers 2nd way	4.566, *p*<0.05	3.870, *p*< 0.05	27	5	40	10	18	20	
6 fingers 3rd way	NS	NS	10	1	15	2	8	8	
One to one Correspondence Task									
Know 5 straws needed to put 1 straw in each of 5 cups	NS	NS	88	74	87	76	95	92	

Recognising and Matching Quantities and Numerals

Table 6 and Table 7 show the percentage of children able to recognise the number of dots on a card without counting them (subitising), and also their ability to match a numeral to the number of dots on a card. These results highlight that the majority of preschool children can recognise quantities up to about four items without counting and about one-tenth of children at the end of preschool can recognise nine dots without counting. This ability to recognise quantities without counting is an important ability for teachers to build upon when planning learning experiences, and is an important basis for exploring pattern and structure.

Table 7 shows that there was little difference between the *Let's Count* groups and comparison groups for the subitising tasks, except for recognising 0, 2 and 3 dots. For these tasks either the 2013 or 2014 *Let's Count* group was more successful. There were also some statistically significant differences between the 2014 *Let's Count* and comparison groups in matching numerals to more than three dots. Overall, the vast majority of children in all groups at the end of preschool could match numerals to the number of dots on a card, although nine was much harder to match than the other numbers.

Table 6

Percentage Success in Subitising Tasks and Matching Numerals to Dots

Tasks	LC Mar 2013 (*n*=141)	LC Dec 2013 (*n*=117)	LC Mar 2014 (*n*=195)	LC Dec 2014 (*n*=172)
Subitising Tasks				
Recognise 0 without counting	65	91	68	87
Recognise 2 without counting	91	99	90	97
Recognise 3 without counting	63	91	64	93
Recognise random 3 without counting	66	87	69	87
Recognise 4 without counting	52	79	52	74
Recognise random 4 without counting	39	53	36	54
Recognise 5 without counting	33	41	28	48
Recognise 9 without counting	14	9	5	12
Matching Numerals to Dots Tasks				
Match numeral to 0 dots	38	81	46	87
Match numeral to 2 dots	69	89	66	92
Match numeral to 3 dots	53	83	62	90
Match numeral to 3 random dots	57	83	56	85
Match numeral to 4 dots	49	75	58	87
Match numeral to 4 random dots	49	76	56	83
Match numeral to 5 dots	44	68	46	76
Match numeral to 9 dots	28	47	27	51

Table 7

Percentage Success in Subitising Tasks and Matching Numerals to Dots

Tasks	Significance: Comparison (Dec, 2012) to (Dec, 2013) (χ^2, *p*)	Significance: Comparison (Dec, 2012) to (Dec, 2014) (χ^2, *p*)	Comp Dec 2012 (*n*=125)	LC Dec 2013 (*n*=117)	LC Dec 2014 (*n*=172)	ENRP Feb 2001 (*n*=1438)	Australian Curriculum Foundation Standard
Subitising Tasks							
Recognise 0 without counting	4.690, $p<0.05$	NS	81	91	87	82	
Recognise 2 without counting	5.133, $p<0.05$	NS	94	99	97	95	
Recognise 3 without counting	NS	6.976, $p<0.01$	83	91	93	84	
Recognise random 3 without counting	NS	NS	86	87	87	na	
Recognise 4 without counting	NS	NS	70	79	74	71	
Recognise random 4 without counting	NS	NS	50	53	54	na	
Recognise 5 without counting	NS	NS	44	41	48	43	
Recognise 9 without counting	NS	NS	16	9	12	9	
Matching Numerals to Dots Tasks							Students make connections between number names, numerals and quantities up to 10.
Match numeral to 0 dots	NS	8.925, $p<0.01$	73	81	87	63	
Match numeral to 2 dots	NS	NS	90	89	92	86	
Match numeral to 3 dots	NS	14.902, $p<0.01$	73	83	90	79	
Match numeral to 3 random dots	NS	NS	82	83	85	na	
Match numeral to 4 dots	NS	8.629,$p<0.01$	73	75	87	77	
Match numeral to 4 random dots	NS	7.813, $p<0.01$	69	76	83	na	
Match numeral to 5 dots	NS	3.891, $p<0.05$	65	68	76	67	
Match numeral to 9 dots	NS	4.250, $p<0.05$	38	47	51	41	

Pattern and Structure

The importance of pattern and structure in young children's mathematical learning is gaining increased attention (Mulligan, Mitchelmore, English, & Crevensten, 2013). The Australian Curriculum Foundation proficiencies of fluency and reasoning focus on continuing and creating patterns. The results in Table 8 show that almost all children can identify colours at the beginning of preschool. However, children are less likely to be able to match a pattern or continue a pattern. This knowledge developed across the preschool year for the *Let's Count* cohorts and appears to be a profitable area for teaching and learning.

The data presented in Table 9 suggest that for the comparison groups about three-quarters of children can match patterns when they begin school, and about one third of children can continue and explain a pattern. However, the December success rate on these tasks is statistically significantly greater for children in both the 2013 and 2014 *Let's Count* groups. This is an important outcome for the *Let's Count* children.

Table 8
Percentage Success in Pattern Tasks

Tasks	LC Mar 2013 (*n*=141)	LC Dec 2013 (*n*=117)	LC Mar 2014 (*n*=195)	LC Dec 2014 (*n*=172)
Pattern Tasks				
Name colours in pattern	90	99	91	96
Match pattern	49	85	55	86
Continue pattern	16	48	23	56
Explain pattern	16	42	20	51

Table 9
Percentage Success in Pattern Tasks

Tasks	Significance: Comparison (Dec, 2012) to (Dec, 2013) (χ^2, *p*)	Significance: Comparison (Dec, 2012) to (Dec, 2014) (χ^2, *p*)	Comp Dec 2012 (*n*=125)	LC Dec 2013 (*n*=117)	LC Dec 2014 (*n*=172)	ENRP Feb 2001 (*n*=1438)	Australian Curriculum Foundation Standard
Pattern Tasks							
Name colours in pattern	NS	NS	98	99	96	94	
Match pattern	5.623, *p*<0.05	8.824, *p*<0.01	72	85	86	76	Fluency Proficiency includes: continuing patterns.
Continue pattern	5.102, *p*<0.05	14.765, *p*<0.01	34	48	56	31	Reasoning Proficiency includes: creating patterns.
Explain pattern	NS	8.464, *p*<0.01	34	42	51	31	

Counting and Ordering Numerals

While continuing, creating and describing patterns is likely to be a profitable aspect of instruction for most children in their preschool and Foundation years at school, many children need greater mathematical challenge right from the start of school. The Foundation standard also focuses on students counting to and from 20 and ordering small collections within this number range. Several tasks focused on sequence counting, counting a larger collection of at least 20 items and ordering numerals. The percentage of students able to complete these tasks is presented in Table 10 and Table 11.

The results shown in Table 10 suggest that the majority of children at the end of preschool can count to 10 and that many can forward count to 20, but not back from 20. However, few students could count 20 teddies successfully and also identify how many teddies remained when one teddy was removed. This focus on the cardinal value of 20 is a profitable area for instruction in the first year at school, but is not highlighted in the Foundation Standard. There was a clear growth in the *Let's Count* children's abilities to order numeral cards at the beginning and end of preschool.

The tests of significance shown in Table 11 show that the *Let's Count* 2013 and 2014 cohorts were more likely to count a collection of at least 20 teddies and order 1-digit numbers than was the 2012 comparison group.

Table 10
Percentage Success with Counting and Ordering Numerals

Tasks	LC Mar 2013 (*n*=141)	LC Dec 2013 (*n*=117)	LC Mar 2014 (*n*=195)	LC Dec 2014 (*n*=172)
Counting Tasks				
Rote count to 10	66	93	79	93
Rote count to 20	17	55	22	59
Count a collection of at least 20	17	55	22	58
Count a collection of at least 20 & when one item is removed knows total without recounting	2	16	2	11
Ordering Numbers Tasks				
Order numeral cards 1-5	30	68	35	74
Order numeral cards 1-9	16	60	24	54
Order numeral cards 0-9	10	52	15	45
Orders 3 one digit numbers	4	52	12	68
Orders 3 two digit numbers	1	15	2	23
Orders 3 three digit number	0	1	0	3

Table 11

Percentage Success with Counting and Ordering Numerals

Tasks	Significance: Comparison (Dec, 2012) to (Dec, 2013) (χ^2, *p*)	Significance: Comparison (Dec, 2012) to (Dec, 2014) (χ^2, *p*)	Comp Dec 2012 (*n*=125)	LC Dec 2013 (*n*=117)	LC Dec 2014 (*n*=172)	ENRP Feb 2001 (*n*=1438)	Australian Curriculum Foundation Standard
Counting Tasks							
Rote count to 10	NS	NS	93	93	93	na	
Rote count to 20	NS	6.117, *p*<0.05	45	55	59	na	
Count a collection of at least 20	8.079, *p*<0.05	13.165, *p*<0.01	37	55	58	39	
Count a collection of at least 20 & when one item is removed knows total without recounting	8.079, *p*<0.05	13.165, *p*<0.01	8	16	11	na	Students count to and from 20 and order small collections.
Ordering Numbers Tasks							
Order numeral cards 1-5	na	na	na	68	74	na	
Order numeral cards 1-9	NS	NS	48	60	54	46	
Order numeral cards 0-9	10.354, *p*<0.01	5.924, *p*<0.05	31	52	45	38	
Orders 3 one digit numbers	NS	9.777, *p*<0.01	47	52	68	na	
Orders 3 two digit numbers	NS	NS	14	15	23	na	
Orders 3 three digit number	NS	4.002, *p*<0.05		1	3		

Measuring Time and Length

Several tasks in the interview focused on measuring length and time. Table 12 highlights that many children by the beginning of school are able to compare and order lengths, in line with the Foundation Standard, and are also aware of the purpose of a clock. Children's ability to order lengths increases a lot across their preschool year.

Table 13 shows that the 2014 *Let's Count* group was significantly more successful in ordering four candles, comparing two lengths, and using informal units to measure a straw. However, this was not so for the 2013 *Let's Count* cohort. Seventeen percent of children in the 2012 comparison group could read 2 o'clock and knews some days of the week and months. Table 12 shows that very few of the *Let's Count* children at the beginning of preschool were successful with these tasks. Further, only 5 percent of children were successful at the end of the year in 2013, and 10 percent at the end of the year in 2014. These were the only items in which the comparison group outperformed the *Let's Count* cohorts.

Table 12
Percentage Success with Length and Time Measurement Tasks

Tasks	LC Mar 2013	LC Dec 2013	LC Mar 2014	LC Dec 2014
Ordering Length Tasks	*(n*=109)	(*n*=117)	*(n=194)*	(*n*=172)
Ordering 3 candles small to largest	43	78	52	82
Ordering 4 candles small to largest	23	63	28	66
Length Measurement Tasks	*(n*=77)	(*n*=60)	*(n=100)*	(*n*=95)
Accurately compares two lengths string and stick	43	73	53	87
Measures length - informal units	1	7	5	17
Time Measurement Tasks	*(n*=69)	(*n*=60)	*(n=92)*	(*n*=81)
Aware of the purpose of a clock	74	83	73	81
Knows some days/months & 2 o'clock	0	5	3	10

Table 13

Percentage Success with Length and Time Measurement Tasks

Tasks	Significance: Comparison (Dec, 2012) to (Dec, 2013) (χ^2, *p*)	Significance: Comparison (Dec, 2012) to (Dec, 2014) (χ^2, *p*)	Comp Dec 2012	LC Dec 2013	LC Dec 2014	ENRP Feb 2001	Australian Curriculum Foundation Standard
Ordering Length Tasks			(*n*=125)	(*n*=117)	(*n*=172)	(*n*=1438)	
Ordering 3 candles small to largest	NS	NS	73	78	82	61	
Ordering 4 candles small to largest	NS	4.148, *p*<0.05	54	63	66	50	
Length Measurement Tasks			(*n*=125)	(*n*=60)	(*n*=95)		Students compare objects using mass, length and capacity.
Accurately compares two lengths string and stick	NS	15.690, *p*<0.01	65	73	87	na	
Measures length - informal units	NS	15.690, *p*<0.01	8	7	17	na	
Time Measurement Tasks			(*n*=125)	(*n*=60)	(*n*=81)		Students connect events and the days of the week
Aware of the purpose of a clock	NS	NS	83	83	81	na	
Knows some days/months & 2 o'clock	NS	NS	17	5	10	na	

Shapes and Visualisation

Spatial reasoning is a key aspect of learning mathematics. The data presented in Table 14 and Table 15 show children's success with tasks involving describing and interpreting locations, recognising the properties of shapes and using mental imagery to manipulate shapes. The data in Table 14 suggest that many of *Let's Count* children were proficient in these aspects of mathematics even at the beginning of preschool, and almost all children could meet the Foundation Standard prior to beginning school (Table 15), including the comparison group. *Let's Count* was associated with more children being able to demonstrate the meaning of the location term 'behind.' The most difficult task in this group of tasks involved tracing a partially hidden shape, and only 16-21 percent of the children assessed in December were successful. This is a profitable area for learning and teaching during children's first year at school.

Table 14
Percentage Success on Spatial Tasks

Tasks	LC Mar 2013 (*n*=141)	LC Dec 2013 (*n*=117)	LC Mar 2014 (*n*=195)	LC Dec 2014 (*n*=172)
Language of Location Tasks				
Beside	77	96	82	94
Behind	76	96	78	94
In front of	63	88	71	87
Properties of Shapes Tasks	(*n*=81)	(*n*=61)	(*n*=95)	(*n*=81)
Knows square	75	92	80	92
Knows circle	90	95	84	97
Knows rectangle	54	76	62	80
Knows some triangles	81	95	79	94
Knows all triangles	59	58	67	58
Visualisation Tasks	(*n*=83)	(*n*=58)	(*n*=99)	(*n*=95)
Recognises static images in embedded situations	68	95	78	94
Identifies a reoriented rectangle in room and traces possible shapes when a shape is partially hidden	5	17	6	21

Table 15
Percentage Success on Spatial Tasks

Tasks	Significance: Comparison (Dec, 2012) to (Dec, 2013) (χ^2, *p*)	Significance: Comparison (Dec, 2012) to (Dec, 2014) (χ^2, *p*)	Comp Dec 2012 (*n*=125)	LC Dec 2013 (*n*=117)	LC Dec 2014 (*n*=172)	ENRP Feb 2001 (*n*=1438)	Australian Curriculum Foundation Standard
Language of Location Tasks							
Beside	NS	NS	94	96	94	88	
Behind	4.304, *p*<0.05	4.423, *p*<0.05	87	96	94	87	Students use appropriate language to describe location.
In front of	NS	NS	91	88	87	83	
Properties of Shapes Tasks			(*n*=125)	(*n*=61)	(*n*=81)		
Knows square	NS	NS	85	92	92	na	
Knows circle	NS	NS	92	95	97	na	
Knows rectangle	NS	NS	74	76	80	na	
Knows some triangles	9.548, *p*<0.01	9.404, *p*<0.01	83	95	94	na	
Knows all triangles			63	58	58	na	Students group objects based on common characteristics and sort shapes and objects
Visualisation Tasks			(n=125)	(*n*=58)	(*n*=95)		
Recognises static images in embedded situations	7.894, *p*<0.05	NS	90	95	94	na	
Identifies a reoriented rectangle in room and traces possible shapes when a shape is partially hidden			16	17	21	na	

Calculating

The MAI includes a range of tasks involving increasingly difficult calculations, although few children progressed far in these domains. Results for four calculation tasks are presented in Table 16 and Table 17. All tasks were presented orally and involved the use of materials.

The two addition tasks required children to work out the totals for 5 teddies and 3 teddies, with the 5 teddies being screened and then revealed if needed. The second task was similar but involved 9+4 teddies. Most children needed the screens lifted so that the teddies could all be seen and counted one by one. A small number of students used the count-on strategy when the teddies were screened.

Most children who solved the division task that involved distributing 12 teddies between 4 mats used grouping strategies rather than sharing by ones. Most children solved the multiplication task by counting all the objects, one by one. This task involving placing two teddies in each of four cars and then working out the total number of teddies in the cars.

The results in Table 16 show that preschool children's ability to calculate increased significantly across theyear. The data presented in Table 17 indicate that a large group of children were able to meet the Foundation problem solving proficiency before beginning school. It was statistically significant that the 2013 *Let's Count* Group were more likely than the 2012 comparison group to successfully add 9 teddies and 4 teddies and successfully divide 12 teddies between 4 mats, whereas the 2014 *Let's Count* Group were more likely than the 2012 comparison group to successfully add 9+4 teddies and successfully calculate the total for two teddies in four cars.

Table 16
Percentage Success on Calculation Tasks Involving Materials (Teddies)

Tasks	LC Mar 2013 (*n*=141)	LC Dec 2013 (*n*=117)	LC Mar 2014 (*n*=195)	LC Dec 2014 (*n*=172)
Calculation Tasks				
Adds 5+3 when screen over 5 removed	27	63	31	72
Adds 9+4 when screen over 9 removed	11	42	18	40
Calculates total for 2 teddies in 4 cars	39	64	45	76
Divides 12 teddies between 4 mats	1	61	9	44

Table 17

Percentage Success on Calculation Tasks Involving Materials (Teddies)

Tasks	Significance: Comparison (Dec, 2012) to (Dec, 2013) (χ^2, *p*)	Significance: Comparison (Dec, 2012) to (Dec, 2014) (χ^2, *p*)	Comp Dec 2012 (*n*=125)	LC Dec 2013 (*n*=117)	LC Dec 2014 (*n*=172)	Australian Curriculum Foundation Standard and Proficiencies
Calculation Tasks						
Adds 5+3 when screen over 5 removed	NS	17.081, *p*<0.01	49	63	72	Problem Solving Proficiency: using materials to model authentic problems, sorting objects, using familiar counting sequences to solve unfamiliar problems, and discussing the reasonableness of the answer
Adds 9+4 when screen over 9 removed	9.664, *p*<0.01	7.627, *p*<0.05	25	42	40	
Calculates total for 2 teddies in 4 cars	NS	12.005, *p*<0.01	58	64	76	
Divides 12 teddies between 4 mats	15.497, p<0.01	NS	31	61	44	

Whole Number Growth Point Distributions

The Mathematics Assessment Interview enables the associated growth points that children have reached in the whole number, measurement and spatial reasoning domains to be determined. The growth points (see Appendix A) represent key milestones in children's learning. The following figures show the growth point distributions in each domain for the 2014 and 2013 *Let's Count* Cohorts at the beginning and end of preschool and for the 2012 comparison group. The growth points describe key milestones that children reached in their mathematical learning. There are typically six growth points in each domain.

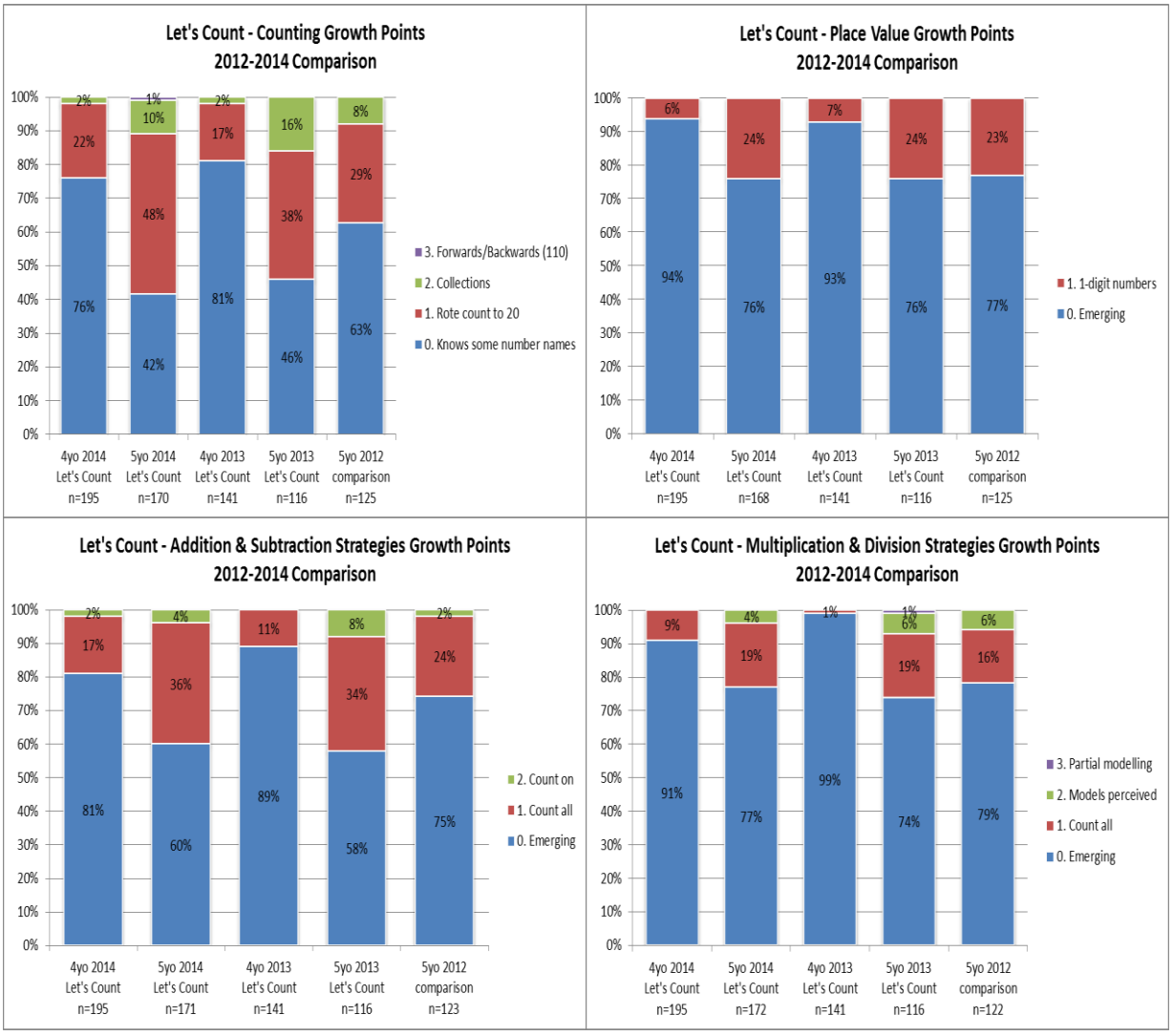
Figures 1-4 show the growth point distributions for the four whole number domains. As may be expected of preschool children, the majority are on the emerging growth points in each number domain. About 10%-20% of the *Let's Count* children in March and about one quarter of these children at the end of the year have reached Growth Point 1 or Growth Point 2 in most domains. It is clear that a larger proportion of the *Let's Count* cohorts have reached higher growth points than for the comparison group in the Counting, and Addition & Subtraction domains. This corresponds with statistically significant differences in task performances shown in Table 5, Table 11 and Table 17.

Figure 1. Counting Growth Point Distributions

Figure 2. Place Value Growth Point Distributions

Figure 3. Addition and Subtraction Strategies Growth Point Distributions

Figure 4. Multiplication and Division Strategies Growth Point Distributions



Measurement and Spatial Reasoning Growth Point Distributions

Figures 5-8 show the growth point distributions for the measurement and spatial reasoning domains. The growth point distributions indicate quite a range in knowledge in each at both the beginning and end of preschool. The growth point distributions highlight that the majority of children, including at the beginning of preschool, have progressed to at least Growth Point 1 in most domains. This is in contrast to the growth points reached by children in the whole number domains. There are some apparent differences between the cohorts at the end of the year. In Time fewer children in the *Let's Count* group knew some times, days and months than for the comparison group. In Length 10% more children in the *Let's Count* group could compare, order and match lengths than for the comparison group. In Properties of Shape almost 20% more children in the *Let's Count* group could sort and compare shapes than could children in the comparison group. In Visualisation and Orientation the percentage of children on the emerging Growth Point 0 was half that of the comparison group, and 5% of *the Let's Count* group could use dynamic imagery (Growth Point 3) while no students in the comparison group could do so.

Figure 5. Time Growth Point Distributions

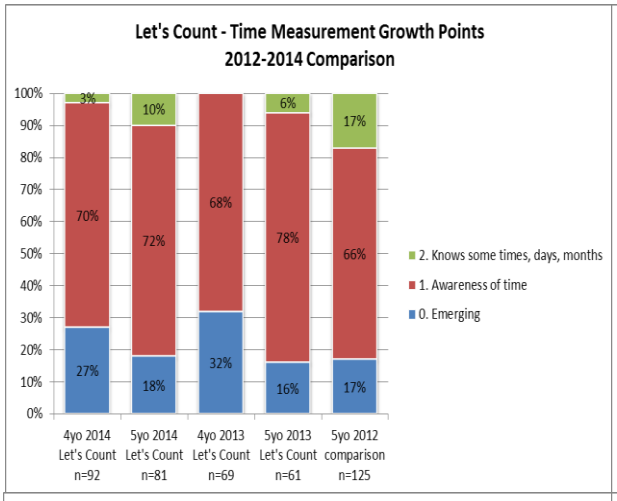


Figure 6. Length Growth Point Distributions

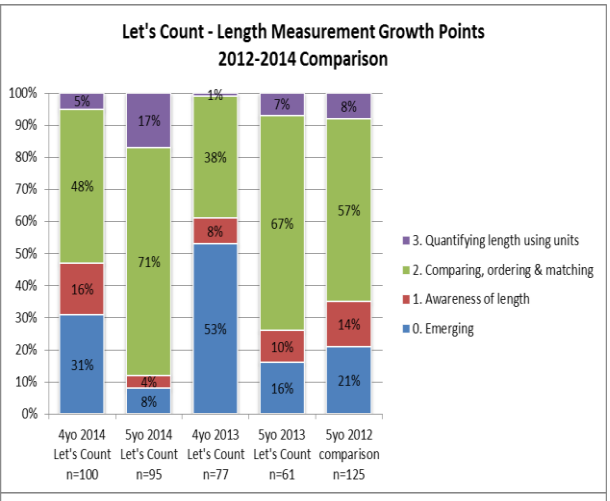


Figure 7. Properties of Shape Growth Point Distributions

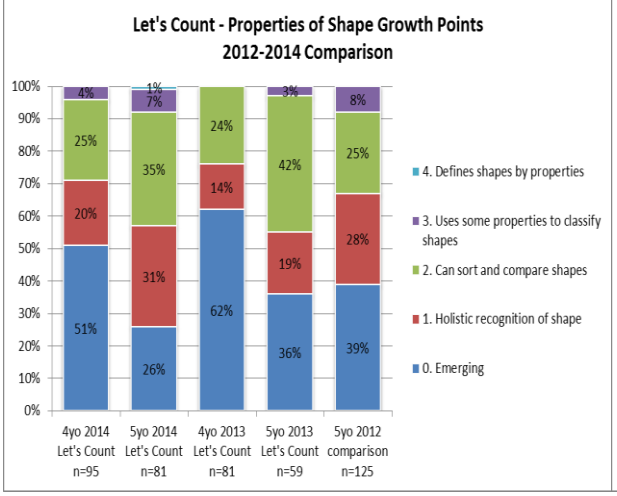
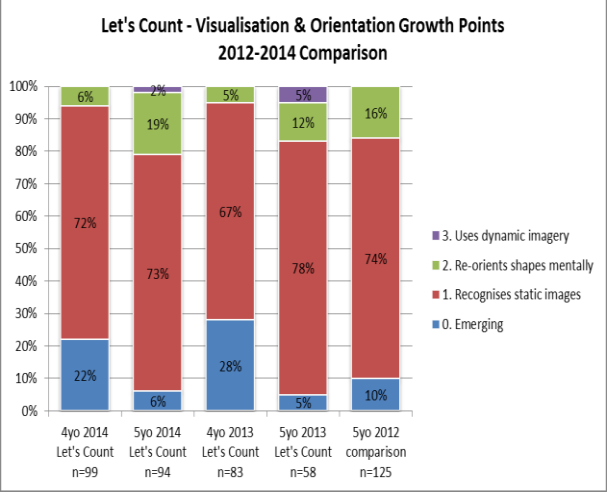


Figure 8. Visualisation and Orientation Growth Point Distributions



Adults

In this report, data from the adult participants has been aggregated across the two years of the evaluation (2013 and 2014) into educator and parent[3] participants. In this way, results can be reported more easily and are relevant to the complete groups of educators and parents involved in the evaluation.

Educator Surveys

Survey 1

Survey 1 was completed by *Let's Count* educator participants during the initial part of professional learning workshop 1 in early 2013 (n=49) and early 2014 (n=33). The first part of Survey 1 collected participant demographics. The second part of Survey 1, which was repeated as Survey 2 (2013: n=33; 2014: n=18) near the end of the respective years, sought information concerning participants' current interactions with parents and other family members in relation to their children's mathematics/numeracy learning and about participants' attitudes to mathematics and to certain pedagogical approaches with mathematics (Dunphy, 2007; 2009). Survey 1 has been designated as being completed at Time 1 (T1) and Survey 2 at Time 2 (T2)[4].

Demographic Data from Survey 1 (n=82)

The participants were predominantly female (94%), with only three males in the entire cohort. Four of the educators identified as Aboriginal and/or Torres Strait Islanders. Seventy-five (91%) reported that they spoke English, with only five reporting that they spoke other languages. Seven per cent (n=6) were between 18 and 25 years, 61% (n=50) between 26 and 45 years and another 31% (n=25) were between 46 and 65 years.

Nineteen per cent (n=15) of those who responded to the question concerning the length of time people had been early childhood educators had less than 5 years of such service while another 24% (n=19) had between 5 and 10 years. The remainder had between 12 and 35 years of experience as early childhood educators. Approximately 39% (n=32) of respondents had at least a bachelor's degree, with another 29% (n=24) attaining various diplomas and 12% (n=10) a Certificate 3 qualification. There were three respondents (4%) with postgraduate qualifications. Sixteen per cent of the respondents had studied mathematics only to Year 10 level; 20% only to Year 11 level; 39% to Year 12 level; and 18% to university level. Questions about the nature of this university 'mathematics' were not asked. Only 33% (n=26) of the responding participants had previously undertaken professional learning related to mathematics and/or numeracy.

Surveys 1 and 2

Communication with parents

In Surveys 1 and 2 for each year, early childhood educators were asked what proportion of parents and family members talked with them about their children's mathematics/numeracy learning and how often this occurred. Tables 18 and 19 show the results for both Times 1 and 2.

[3] In this report, the word 'parent' is used to denote the primary carer of a child. For this evaluation, this was most often a mother, but on rare occasions was a father, grandparent or aunty.

[4] In the following presentation of results it should be noted that not all respondents answered every question.

Table 18
What proportion of parents talk with you about their child's mathematics/numeracy learning? (T1: n=81; T2: n=52)

Proportion of parents	Percentage at T1[5]	Percentage at T2
All	0	4
Most	10	14
Some	65	75
None	24	8

Table 19
How often do parents talk with you about their child's mathematics/numeracy learning? (T1: n=81; T2: n=52)

Proportion of parents	Percentage at T1	Percentage at T2
Daily	0	0
Weekly	4	28
Occasionally	72	63
Never	34	10

It is evident from Tables 18 and 19 that the educators perceived that not only was a greater percentage of parents talking about their child's mathematics/numeracy but that they were doing it more often. These are certainly expected outcomes from the *Let's Count* approach and it is reassuring that such large increases in interactions around mathematics have occurred.

Liking or disliking mathematics

In the surveys at both times T1 and T2, educators were asked to indicate where they felt they fitted along a continuum from 'absolutely disliking' mathematics to feeling that mathematics was the 'best thing ever'. Table 20 shows the responses to this question.

Table 20
Responses to educators' ratings of liking/disliking mathematics

Scale score between 1 (absolute dislike) and 10 (best thing ever)	Percentage of respondents at T1 (n=81)	Percentage of respondents at T2 (n=52)
1.0-1.9	0	0
2.0-2.9	4	0
3.0-3.9	7	4
4.0-4.9	5	0
5.0-5.9	22	15
6.0-6.9	14	23
7.0-7.9	25	33
8.0-8.9	19	17
9.0-10.0	5	8

[5]Please note that in some tables of percentages presented in this report, rounding may cause totals to be slightly less or slightly more than 100%.

The results in Table 21 indicate that there was an increase in the educators' rating of their liking mathematics over the period of the professional learning workshops in *Let's Count.* Fifty-one educators answered this question at both T1 and T2. Table 21 shows that 42% of these educators increased their liking of mathematics rating, some by many scale points. Another 39% remained steady in their ratings but 20% showed a decreased liking of mathematics though not on the large scale of the more positive movements.

Table 21
Change in educators' ratings of liking mathematics (n=51)

Amount of change	Percentage
Increase by 5 scale points	4
Increase by 4 scale points	2
Increase by 3 scale points	2
Increase by 2 scale points	8
Increase by 1 scale point	26
No change	39
Decrease by 1 scale point	16
Decrease by 2 scale points	2
Decrease by 3 scale points	2

Confidence in own mathematics

At both T1 and T2, educators were asked to indicate where they felt they fitted along a continuum from having 'no confidence' to feeling 'very confident' about doing mathematics themselves. Table 22 shows the responses to this question.

Table 22
Responses to ratings of educators' confidence about doing mathematics themselves

Scale score between 1 (no confidence) and 10 (very confident)	Percentage of respondents at T1 (n=81)	Percentage of respondents at T2 (n=52)
1.0-1.9	3	2
2.0-2.9	3	0
3.0-3.9	7	2
4.0-4.9	7	2
5.0-5.9	15	12
6.0-6.9	21	19
7.0-7.9	20	29
8.0-8.9	17	17
9.0-10.0	7	17

The results in Table 22 indicate that there was an increase in the educators' rating of their confidence to do mathematics themselves over the period of the professional learning workshops in *Let's Count.* Fifty-one educators answered this question at both T1 and T2. Table 23 shows that almost half of these educators increased their rating about their confidence to do mathematics themselves, some by many scale points. However, 28% of the educators who answered this question at both T1 and T2 showed a decrease in their confidence to do mathematics, albeit only by one or two scale points. Perhaps, this could be the result of these educators getting to know more about mathematics and more about what they do not know.

Table 23
Change in educator's ratings of confidence in doing mathematics themselves (n=51)

Amount of change	Percentage
Increase by 7 scale points	2
Increase by 6 scale points	4
Increase by 5 scale points	0
Increase by 4 scale points	4
Increase by 3 scale points	2
Increase by 2 scale points	20
Increase by 1 scale point	14
No change	28
Decrease by 1 scale point	24
Decrease by 2 scale points	4

Confidence in developing the mathematical knowledge of children

In both surveys, educators were asked to indicate where they felt they fitted along a continuum from having 'no confidence' to feeling 'very confident' about developing the mathematical knowledge of the children in their settings. Table 24 shows the responses to this question.

Table 24
Responses to ratings of educators' confidence about developing the mathematical knowledge of children

Scale score between 1 (no confidence) and 10 (very confident)	Percentage of respondents at T1 (n=81)	Percentage of respondents at T2 (n=52)
1.0-1.9	3	0
2.0-2.9	1	0
3.0-3.9	5	0
4.0-4.9	0	0
5.0-5.9	5	4
6.0-6.9	12	12
7.0-7.9	13	12
8.0-8.9	28	28
9.0-10.0	37	45

The results in Table 24 indicate that there was an increase in the educators' rating of their confidence in developing the mathematical knowledge of children over the period of the professional learning workshops in *Let's Count.* Comparison with Table 22 suggests that these educators were much more confident about their ability to develop children's mathematical learning than they were in their own mathematical ability.

Only 50 educators answered this question at both T1 and T2. Table 25 shows that 44% of these educators increased the rating of their confidence in developing the mathematical knowledge of children in their setting while 28% decreased their rating of this confidence. Perhaps, the *Let's Count* program had set them to question some of their own pedagogical approaches and, by the relatively short time to the end of the second professional learning workshop, they had not had enough time to resolve some of these questions.

Table 25
Change in educator's ratings of confidence in developing children's mathematical knowledge (n=50)

Amount of change	Percentage
Increase by 7 scale points	2
Increase by 6 scale points	0
Increase by 5 scale points	0
Increase by 4 scale points	2
Increase by 3 scale points	2
Increase by 2 scale points	8
Increase by 1 scale point	30
No change	28
Decrease by 1 scale point	14
Decrease by 2 scale points	8
Decrease by 3 scale points	4
Decrease by 4 scale points	2

Educators' attitudes to mathematics

The evaluation was also interested in educators' *attitudes to mathematics* and, in particular, the extent to which these changed over the period in which the professional development workshops took place. At both T1 and T2, educators were presented with 12 statements about mathematics and asked to indicate whether they agreed or disagreed on a five-point Likert scale. Table 26 shows the raw results provided by the educators.

Table 26

Educators' responses to attitudes to mathematics questions (T1: n=81; T2: n=52) (Percentages of respondents)

		Strongly Agree		Agree		Undecided		Disagree		Strongly Disagree	
		T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
1	At school my friends always came to me for help in mathematics	3	2	20	29	24	17	36	42	18	10
2	I am quite good at mathematics	5	8	33	50	27	37	37	4	4	2
3	I find many mathematical problems interesting and challenging	5	10	51	52	25	21	15	15	5	2
4	I have always done well in mathematics classes	3	6	36	37	22	22	33	29	6	6
5	I have never felt the need to study mathematics beyond high school	15	14	49	52	20	19	14	12	3	4
6	Mathematics is something that I do every day.	49	64	47	37	1	0	3	0	0	0
7	I have trouble understanding anything that is based upon mathematics	0	2	10	6	16	12	55	61	21	20
8	I never do well on tests that require mathematical reasoning	3	2	24	15	25	23	41	52	8	8
9	Mathematics is a thing of beauty	1	8	33	35	48	45	19	10	0	0
10	It's important for everyone to pass Year 12 mathematics	12	12	30	12	21	31	33	29	5	17
11	Mathematics makes me feel inadequate	4	2	25	22	20	14	41	52	10	10
12	Right answers are much more important in mathematics than the ways in which you get them	0	4	11	6	12	8	59	62	16	21

To reduce these data on educators' attitudes to mathematics, two broad categories of response – 'agree'[6] or 'not agree' were developed to examine shifts in participants' attitudes to each statement. Table 27 shows these reduced data for both T1 and T2.

[6] The 'agreed' category includes those who indicated they 'strongly agreed' or 'agreed' with the statement while the 'not agree' category includes those who indicated they 'strongly disagreed', 'disagreed' or were 'undecided' about the statement.

Table 27
Educators' responses to attitudes to mathematics questions: Data Reduced to 'agree' or 'not agree' (T1: n=81; T2: n=52)

		Percentage of respondents who agreed with statement	
		T1	T2
1	At school my friends always came to me for help in mathematics	23	31
2	I am quite good at mathematics	38	58
3	I find many mathematical problems interesting and challenging	56	62
4	I have always done well in mathematics classes	39	43
5	I have never felt the need to study mathematics beyond high school	64	66
6	Mathematics is something that I do every day.	96	100
7	I have trouble understanding anything that is based upon mathematics	10	8
8	I never do well on tests that require mathematical reasoning	27	17
9	Mathematics is a thing of beauty	34	43
10	It's important for everyone to pass Year 12 mathematics	42	24
11	Mathematics makes me feel inadequate	29	24
12	Right answers are much more important in mathematics than the ways in which you get them	11	10

Table 27 shows that there is a general trend across the *Let's Count* workshops towards what might be named as more positive attitudes about mathematics, particularly in terms of the educators' perceptions of themselves as "good at mathematics" and whether they found "mathematics is a thing of beauty". However, while the trend is 'positive' the scale is not large and caution must be exercised in the interpretation of these results.

Educators' attitudes to a range of mathematical teaching strategies

At both T1 and T2, educators were presented with 24 statements about a range of mathematical teaching strategies and asked to indicate whether they agreed or disagreed on a five-point Likert scale. Table 28 shows the raw results provided by the educators. The results from the T1 survey with regards to mathematical teaching strategies highlight that there were some areas in which almost all participants agreed and that these views did not change over the course of the workshops. For example, prior to commencing the *Let's Count* program, 100% of participants agreed or strongly agreed that 'engaging in play/a playful approach assists young children's development of mathematical ideas' and this was maintained at T2. Similarly, 99% (T1) and 96% (T2) agreed that 'children's informal knowledge of mathematics should be taken into account in early years settings'.

Table 28

Educators' responses to attitudes to mathematical teaching strategies questions (T1: n=81; T2: n=52) (Percentages of respondents)

		Strongly Agree		Agree		Undecided		Disagree		Strongly Disagree	
		T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
1	Children's informal knowledge about aspects of mathematics should be taken into account in early years settings.	64	63	35	33	1	4	0	0	0	0
2	Engaging in play/a playful approach assists young children's development of mathematical ideas.	83	89	18	12	0	0	0	0	0	0
3	Young children's interests, concerns and everyday activities should be exploited when developing different aspects of mathematics	55	65	25	18	17	16	4	2	0	0
4	Children talking about mathematics with the teacher helps develop their understanding.	62	74	36	24	3	2	0	0	0	0
5	Ensuring children's understanding of the particular use of language in mathematics is an essential part of teaching mathematics in early years settings.	44	33	44	56	7	2	3	10	1	0
6	It is not necessary for the teacher to help children make mathematical connections (e.g. between mathematics and everyday life).	1	0	11	6	9	4	41	58	38	33
7	It is important to find out what aspects of mathematics interest children and the reasons for this interest.	30	29	48	55	17	10	5	6	0	0
8	It is not particularly helpful for children in early years settings to talk with other children about mathematics in order to deepen their understandings.	1	0	1	6	6	0	46	46	46	48
9	The investigation and presentation of their own mathematical solutions to everyday problems enables children to develop mathematically.	48	53	47	45	3	0	0	2	3	0
10	Whole class teacher-initiated activity is the most important aspect of teaching mathematics in early years settings.	3	6	11	6	13	12	50	50	23	25
11	Children in early years settings cannot set their own goals/tasks in mathematical activity.	1	2	5	0	15	10	58	64	21	25
12	Children's own methods of recording and their own symbols are not particularly important in the early stages of recording mathematical ideas and processes.	1	2	4	2	7	2	53	60	35	35
13	The teacher's task is to follow the mathematics curriculum in a systematic structured way.	0	0	6	4	17	10	49	44	27	42

Table 28 (continued)

		Strongly Agree		Agree		Undecided		Disagree		Strongly Disagree	
		T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
14	Small-group teacher-led activity is essential for developing mathematics with young children.	10	15	43	37	23	17	20	25	4	6
15	Open-ended activity (where there is more than one solution/right answer) is essential for promoting mathematical understanding.	26	33	55	65	15	2	4	2	0	0
16	Assessment is a critical aspect of providing appropriately challenging mathematical activity for young children.	9	12	35	25	30	37	20	20	6	8
17	Justifying mathematical ideas and making mathematical arguments are not important at the early stages of learning mathematics.	3	2	5	10	26	12	47	59	20	18
18	A great deal of mathematical understanding is developed during informal activity/discussion.	46	55	44	43	8	2	1	0	1	0
19	It is important that children represent their mathematics through the use of conventional symbols.	3	2	18	4	23	21	49	51	9	10
20	Workbooks and worksheets are essential in learning and teaching mathematics in early years settings.	3	2	9	0	4	6	41	39	44	54
21	Children in early years settings should report verbally on their mathematical activity.	6	6	30	43	32	14	25	35	6	2
22	Children in early years settings should be encouraged to engage in the mental manipulation of mathematical ideas.	13	10	55	61	18	22	11	6	4	2
23	Parents and family members play a key role in assisting their preschoolers to learn mathematics.	74	71	25	29	0	0	1	0	0	0
24	Children's ability to use conventional mathematics symbols is important in assessing their mathematical ability.	1	8	21	17	31	19	36	46	11	10

To reduce these data on educators' attitudes to mathematical teaching strategies, it was determined to consider only two broad categories of response – 'agree' or 'not agree'. – as for the attitudes to mathematics scale reported above. Table 29 shows these reduced data for both T1 and T2.

Table 29

Educators' responses to attitudes to mathematical teaching strategies questions: Data Reduced to 'agree' or 'not agree' (T1: n=81; T2: n=52)

		Percentage of respondents who agreed with statement	
		T1	T2
1	Children's informal knowledge about aspects of mathematics should be taken into account in early years settings.	99	96
2	Engaging in play/a playful approach assists young children's development of mathematical ideas.	100	100
3	Young children's interests, concerns and everyday activities should be exploited when developing different aspects of mathematics	80	83
4	Children talking about mathematics with the teacher helps develop their understanding.	98	98
5	Ensuring children's understanding of the particular use of language in mathematics is an essential part of teaching mathematics in early years settings.	88	89
6	It is not necessary for the teacher to help children make mathematical connections (e.g. between mathematics and everyday life).	12	6
7	It is important to find out what aspects of mathematics interest children and the reasons for this interest.	78	84
8	It is not particularly helpful for children in early years settings to talk with other children about mathematics in order to deepen their understandings.	2	6
9	The investigation and presentation of their own mathematical solutions to everyday problems enables children to develop mathematically.	95	98
10	Whole class teacher-initiated activity is the most important aspect of teaching mathematics in early years settings.	14	12
11	Children in early years settings cannot set their own goals/tasks in mathematical activity.	6	2
12	Children's own methods of recording and their own symbols are not particularly important in the early stages of recording mathematical ideas and processes.	5	4
13	The teacher's task is to follow the mathematics curriculum in a systematic structured way.	6	4
14	Small-group teacher-led activity is essential for developing mathematics with young children.	53	52
15	Open-ended activity (where there is more than one solution/right answer) is essential for promoting mathematical understanding.	81	98
16	Assessment is a critical aspect of providing appropriately challenging mathematical activity for young children.	44	37
17	Justifying mathematical ideas and making mathematical arguments are not important at the early stages of learning mathematics.	8	12
18	A great deal of mathematical understanding is developed during informal activity/discussion.	90	98
19	It is important that children represent their mathematics through the use of conventional symbols.	21	6

Table 29 (continued)

		Percentage of respondents who agreed with statement	
		T1	T2
20	Workbooks and worksheets are essential in learning and teaching mathematics in early years settings.	12	2
21	Children in early years settings should report verbally on their mathematical activity.	36	49
22	Children in early years settings should be encouraged to engage in the mental manipulation of mathematical ideas.	68	71
23	Parents and family members play a key role in assisting their preschoolers to learn mathematics.	99	100
24	Children's ability to use conventional mathematics symbols is important in assessing their mathematical ability.	22	25

Table 29 shows that there is a general trend across the *Let's Count* workshops towards what might be called more constructivist and child-centred attitudes about mathematical teaching strategies, particularly in terms of the importance placed by educators on "what aspects of mathematics interest children and the reasons for this interest" and the role of open-ended and informal activities. This is further emphasised in the lessening of the importance given to the use of conventional mathematical symbols and the use of workbooks or worksheets. There is a very strong belief that children should be documenting their own mathematics activity.

Overall, however, Table 29 shows that on most items, there is not a lot of shifting of attitudes to the ways in which mathematics learning and teaching might be undertaken in the year before children start school. Perhaps this is a reflection of the impact of the *Early Years Learning Framework* (DEEWR, 2009) and that *Let's Count* is closely aligned with the national curriculum framework, particularly in terms of recommended pedagogies.

Educator interviews

As part of the *Let's Count* evaluation process, educators at the four evaluation sites (two in 2013 and four in 2014) were invited to participate in a series of three interviews. Across the sites, there were 41 who agreed to be interviewed within three weeks of the first workshop. Of these, 35 were interviewed for a second time within three weeks of the second workshop. As well, 35 educators were interviewed close to the end of the calendar year in which they were involved with *Let's Count.* The interviews were undertaken via telephone, transcribed, and the transcripts analysed to establish the key themes that emerged.

Themes from Interviews

Seven themes emerged from the analysis of the educator interviews. Six had been noted in the first year of the evaluation while the seventh only arose substantially during the second year. Each of these themes indicates that *Let's Count* has had an impact of educators' pedagogical practice, while also highlighting the challenges educators face as they navigate how the program does work in their individual settings. The seven themes are:

1. Engaging families with mathematical learning and *Let's Count*;
2. Continuity of mathematical learning between early childhood setting and home;
3. Impact of *Let's Count* on educator confidence, professional identity and pedagogical practice;
4. Awareness of the potential of everyday tasks for prompting mathematics discussion;
5. Sustainability of *Let's Count* over time;
6. Children's engagement with mathematical learning and mathematical concepts;
7. Importance of mathematical language.

Illustrative interview excerpts for each of these themes are provided below.

Engaging families with mathematical learning and *Let's Count*

Educators used a range of strategies to get families involved in *Let's Count*. These ranged from hands on, one-off events and sending home maths resources, to more day-to-day strategies incorporating mathematical learning into their everyday dialogue with families. One-off events were initially really successful, but sustained dialogue with families about their children's mathematical learning was a challenge for a number of educators.

> *The families who are part of the Let's Count program, which is probably about a third of our families I suppose, everybody, every child gets a chance to take this bag home. So it's got so much stuff in it, and play the games with their families and really having the conversations with the families and getting them more confident in the fact that they can help their children with their maths.*
>
> ***Interviewer: How have the families responded to the bags?***
>
> *Oh they've loved it. Loved it. Yeah, no we've had some fantastic comments. In the back of … I've done up a little book to go home and in the front it has like an introductory letter and then it's got instructions to all the games and then at the back it's got parent comments. And we've had some fantastic comments through there about what the children have learned, what the children have been doing. One little girl went home and measured absolutely everything in the house, including the dog.*
>
> *It's been really nice to hear parents saying that it's been beautiful to spend that sort of quality family time together and they'd forgotten how much fun it was to play games, board games and things with the children. How they'd gotten out in the environment and looked for things. Like, there was a lot more around to do with maths than what they'd realised. And so it's been really nice. And one of the parents actually nabbed me the other day and she said how fantastic it was, they had a fantastic time with the bag over the weekend and it was a great idea.*

> *At one of the first Let's Count sessions, there was a stick with beads and it was a little challenge between two children. They roll the dice and they took whatever number came up on the dice across the stick. It's just like a little game between siblings even at home. I had a parent telling me they were taking them to bed and hiding them under the pillow. They were enjoying them that much.*

> *I will talk about Let's Count and show them that this is what we're doing to encourage*

mathematics. But a lot of them as I said before, one mum said 'Oh I did that with the slice of bread' but she didn't actually realise she was doing maths. She was 'just saying look, we've got two parts now and they're equal, rather than one big one' and I said 'well that's what we're doing but now we're bringing it to the front, to say Oh you've just learned a little bit of maths, that's fantastic'.

When they come to the information session, we were going to set up a few things that we might do with the children here and get them to participate in that. One of our educators is actually going to read a book that isn't about maths to the families but showing them how she draws the maths out of it even though it's not a counting or number book. And then we were just going to have some discussions and we was going to talk to them about how things can be done in a play based, fun way, when you're already doing them. Letting them know they don't have to sit down and do maths activities as such to get them ready for school. … Some of the resources we were given at Let's Count we were going to make into a pack with a book and we're going to send that home with the parents to do with their children, games and things, at home. And get them to write a little bit in the book about what they've done and what they might have learnt from it.

I didn't want to get ahead of myself but yes. Yes, I can. We've got some thoughts. On one of our boards we're going to have a big almost like a mind map of noticing maths and during our normal day, not our actual intentional teaching moments but just things that happen during the day. Say we're outside playing and we notice what's floating and what's sinking. And taking those photos and adding the children's words and showing examples, visually, of what is maths. And hoping to sort of take some of that stigma away of that fear of maths if other people perhaps are like me and only have had that sort of negative feeling about it.

I think [Let's Count] was very beneficial to the non-English speaking families. When I demonstrated how to play just your very basic games like snap and dominoes, they had no idea, they had never played those games before so in actually demonstrating how to play them they were very enthusiastic about going home with them. They've said how much they've enjoyed playing [the games] with their children.

The way that you can communicate to parents about maths is probably like the biggest thing that I got out of it because a lot of parents that I've observed is that once you start talking about maths they sort of will shut down a little bit and just think about maths as numbers. Whereas it's sort of opening up that book about that … Just reading their favourite bedtime story you can bring out how many mice are in the story or just opening that up so it's not so textbook type maths learning, it's more everyday living and it's everywhere that you can see it and how to communicate with the parents effectively to get that sort of message across.

We've been trying to send maths bags home with activities for them to do but I still think parents are still of the opinion that maths is adding things together, or recognising a number, or … They don't consider the wider aspect of volume or time or … Just those wider things that are part of maths, the problem solving things.

Maybe I think the positive thing about that is we really do need to get the parents to meetings, they need to discuss this with parents. We can't really do this … Although we are trying it through the centre, by sending home maths activities, I really don't think we're still connecting to the parents the right way and I think parents almost need to go to these facilitation workshops as well, in some way. I think that would be an excellent thing to do, to actually have the opportunity to send parents to that original workshop to show them that maths is all around them..

I think the main difference that it made was the way we engaged the parents in it and we didn't do a lot, it was just little things like putting notices out, putting little newsletters out about it and also we had a board out the front where we just put a little maths problem on there and the parents could sort of get involved. It was just something they could do on the way home or something they could do on the way in. Like counting buses or plan your trip somewhere, things like that. It was just little problems that we posed on the board. And that sort of got the parents really interested and talking about maths a lot more. And so I think that was probably the main thing but it made us more aware within the centre, even though we do integrate it quite well I think it was being conscious of using the language, the maths language with the children because we do play the games and we do do all the mathematical concepts but we weren't using the language, so I guess that's what we seem to be a bit more aware of.

The maths nights were really good. We had a couple of maths nights and then we had an afternoon for those parents who couldn't come to the nights and they were really good. But it's trying to engage parents on an on-going basis is pretty tricky. You've only got them for that year and the time that you see them they're not necessarily as interested in maths.

I think because we're always talking about maths on what we call our day sheet and really absorbing the families I guess, each afternoon when they [talk about] all the different things that we're doing. And we did do a parent share sheet where parents could share all the things that they might be doing at home or in their environment with maths and parents are often commenting on little things that the children might be bringing home in regards to maths and things like that and maybe we could do some more of that at home, maybe you could measure me mum. So I think it's a flow on effect with things that we're doing and that we're writing it in our program, the parents are reading it and they're able to contribute to our share sheets. I think it's been really good.

And we're seeing things happen so I think it makes it work itself out. Because we're getting results from the families who do more. If people weren't doing anything for us you sort of tend to give up on it a little bit. But we're seeing feedback, which is good.

Continuity of mathematical learning between early childhood setting and home

Many of the interviews discussed continuity of mathematical learning between home and preschool and the importance of established communication strategies among educators and parents.

Well even through our daily program I include what maths we have done that day. If the parents don't bother reading, which a lot don't, I try and … You know how you greet and farewell parents and all that, we just say briefly give them an outline of what we have done and how we have included maths in that too. And usually they say they'll try and carry it on at home, which is … Oh yeah, so beneficial. A lot of the parents, even though they couldn't participate in the program as they wanted all parents to do in the beginning, they are more aware of it and trying to do their little bit at home to back us up type thing, you know and encourage the children to learn more about it. Yeah, yeah, it's good.

Cooking is a big one and we do a lot of that here as well. But the children often comment on what they've made at home. So that we think that has a lot of maths in it. Because we've been talking about things like water displacement at preschool I know that they're now jumping in and out of their baths and watching the water go up and down and things like that.

Great. Making a mess at home, that's fantastic!

Yeah, yeah. That's all part of it. Let me think … They're becoming … I started talking today to one of my little groups about patterns and patterning and I know that they were really able to sort of say Oh it's like this at home, it's like my pants at home, it's like this. So I perceived from that that there was talk about patterning and patterns at home. They all understood that concept and were even able to help with me to draw three different pieces of a pattern sort of thing and carry it on.

Oh just one little boy came in today and said 'I really want to measure my bed'. So we made a measuring tape for him. I said 'You could use your hands' and he said 'No, I want a measuring tape'. So we made a measuring tape. ... the information came from his mother first and then we discussed it with the child. The mother came in and said 'Oh he really wants to measure his bed' and I went Ok, we can do that, we can work out a way to do that for you. So sometimes … It depends on developing a rapport between the educator and the parent.

I have noticed an improvement in some of the children's recognition of numbers. I've been concentrating on that. And some of them actually come from home and say 'Miss XXXX we did … ' because we were recognising circles in certain things around the room and the centre, because we did a little session with shape, and they come back in and they say that they have seen these circle shapes at home as well, and they told me what they were. And I thought well they're obviously thinking about it and extending on it.

Well I'm trying to look at new ways of presenting things for the children's interest. We're looking at the children's cultures at the moment. ... we have one child from Nigeria, a child from Spain and another one who is from South Africa and we've been looking at numerals and things. And using items from their culture, like their animals and how they pronounce their letters and things. So we're trying to make it more, maths more cultural with regards to their family like, so that they can go home and try and share it with their family.

Well we've sent out emails on a regular basis with our parents. And so they've been emailing things that have been happening in their home. We also have a feedback journal-type thing that parents can write things up in, in the mornings or and we pose questions to the parents relating to maths. You know, we might just pop on a question, you know, what did you do over the weekend that involved mathematics or that kind of thing. … So they're able to see what the children are interested in doing here and then maybe continue that on. So I think that's been a good way of doing it. Rather than having portfolios that go home at the end of the year and they go 'Oh I didn't realise you liked that'.

And some of the families have been sharing the dice play, so they've … I've had comments made of some parents said 'Oh we couldn't even remember how to play dice but our children taught us'. So I think it's become a very family orientated project at home, especially with Let's Count. We have a Let's Count bag that's gone home with individual children that are in the program, plus we've sent home one that can go weekly to a different family and we've found that it's brought the family on board a lot more and thinking about maths at home. So they've got quite excited and I've had some children come up for show and tell and share their stories of how they're working at home.

It's probably more the families. Like we've got a book out that we have asked the parents for ideas about what they do at home and we've been getting lots of good ideas in there, like socks snap, if they're doing the washing and playing a game of snap. ... You've got to do your washing anyway don't you. So just things like that and the parents are talking a bit more about it and feeling that they can contribute to that. So that's really good because we can see that the children are then continuing that at home as well, it's not just something that … Like the parents don't

now feel like it's something that we teach them here and they can't do that at home, do you know what I mean?

We had one little girl who went into Coles and her mum asked for … No, she got her daughter to ask for a kilo of bacon. And so the lady in Coles actually counted how many pieces of bacon made a kilo of bacon. And there's like a photo on the [Facebook] page of the little girl and the lady from Coles counting the bacon. So the parents have actually given photo records as well of catching their children doing everyday maths as well.

I think what's been nice to hear is what the children are doing as well at home. That's been nice. And I think that's come from the way we're talking about it and getting it out there to families. One little girl in particular has been showing such an interest in hopscotch and aware of the numbers and counting as she hops. And also setting out, actually like problem solving, when she's been drawing the hopscotch on the cement and 'Oh look XXXXX, I've made a square and that's part of my hopscotch'.

I think a lot of the discussion was more around people's perception of maths and what their experience was as children or in school with mathematics. And the majority of parents when you talk to them about maths just baulked at it and thought well I was never any good at maths. Most people said that, especially mothers, I mean we didn't really speak to the fathers much. But generally the mothers would say that they were terrible at maths, no good at maths. But when we sort of showed them a bit more about what we were doing at the kinder that was maths they sort of realised that they weren't really that bad at maths at all. So it was a nice way of educating the parents without them realising that they were being educated. And it wasn't overt, like we didn't push it. We didn't … I would feel that even if you talked to the parents they wouldn't even realise what we had been doing as much because it was quite well disguised within the program.

Our day book; it's got different things that we've been doing and I know parents look at that and go home and do it. Like we have parents that made a volcano with their child. So they looked at the measurement side of things and ingredients and things that they would need. So that was good to see that what we'd done at kinder had followed on at home. We've just got a recipe book that we've made with the kids and we know that families are making recipes with their child. It's good for measurement and volume point of view, like just looking at that sort of thing. And just the children's counting in general. Most of them can count past 20. ... they've got older siblings doing counting with them. But yeah, this year we've noticed we've got a lot more children that are really strong in their counting. So I definitely put that down to parent and even grandparent involvement.

I can definitely see and notice a real difference in their maths comprehension. Even the parents are referring back to us saying how they know this and this and this at home, which they haven't taught them. So like with the fractions, we did an activity where the children made their own sort of … It was like their honey bread and they had to eat a quarter at a time. And then when they've taken that home and demonstrated it to their parents, 'Oh I've eaten a half of my sandwich' and sort of that way.

[Mum] was just gobsmacked that her child at 4 even knew that there were sixty seconds in a minute and sixty minutes in an hour just from us talking about it in the everyday experiences. … It's sinking in and it's making a difference, which is really, really nice. We've had lots of parents emailing and lots of parents bringing in photos and showing us photos on their phones and telling us all these wonderful stories about mathematical things that their children are doing. It's just amazing that they're taking that home and they're kind of teaching their parents and their

families as well. So it's been really, really good.

I just think it has been a good thing for us to do and particularly I like the way the parents are really involved and it's more about them, because that will hopefully continue on for the rest of their child's schooling and for other children that they may have in their family as well.

I think it's been a positive thing for building relationships with parents because they've felt that we're acknowledging them as their child's educator. And you know, respecting the ideas that they have, like we're not pretending that we're the experts, we're asking them for their ideas and passing those on to other people and even using some of them here. So I think it's a good way to build positive relationships with parents.

Impact of *Let's Count* on educator confidence, professional identity and pedagogical practice

Many of the educators interviewed expressed the feeling that *Let's Count* had impacted on their confidence and practice. Equally, educators had noticed and commented on the growth in confidence and competence around mathematics of many of their colleagues and of parents. Others have harked back to their own teacher education with a nostalgic view of what they had been reminded of through their involvement with *Let's Count.*

Well I think the more that we introduce maths into the environment the more aware the children are going to become of those concepts. It's a ripple effect really on our awareness being heightened will heighten children's awareness. And now they're becoming, especially with our large group activity in the morning, they're becoming more aware instantly of the divisions. Say we have twenty children come they're now aware that twenty divided by two is ten. So it's that ripple effect that if we can invent new games then of course if it's done on a daily basis it's going to create an awareness for them as well. And they've enjoyed sharing different aspects with their parents and bringing back that information to us.

I suppose what we've taken away from going to the inservice or the training the other day is that maths is in everything you do. It's just making it more visible. So looking at what you're actually doing and making the maths in it more visible to the children and talking about it more literally so it's actually brought to their attention.

It's just been overwhelming how staff once they get that concept in their head how they're looking for it everywhere. It's been really beneficial to enlighten staff who might not have actually thought of activities in that way before. So it's been really fantastic in that respect. And XXX and I are always looking for new ways to invent, both outside and inside, to create that maths in our kinder environment.

[Let's Count is happening] also in the under 3s room, just through general talking. I might see them doing something and saying 'that's a really good tool that you can use for mathematics as well'. So just through that and observing the way that the other educators are working with children, that's happened, definitely. … they didn't realise how easy it has been to just introduce that language into just general, everyday routines, activities and talking with children.

Yeah, I think it's just really broadened our understanding of it but it's also given us lots of really great ideas that we can put into our program. Sort of simplified it. I think you get stuck in your head that it has to be a complicated sort of thing or that little kids can't do it or whatever. But it's really sort of opened our eyes to the things that the children already could do and then how we can expand on that and work with that.

How do I feel about maths? ... I used to think of maths as sums. You know, when you think of maths you think of sums, like sitting at a high school desk trying to do these sums that you can't work out. But having now looking at maths in a different way I kind of see that it is everywhere and we do use it every day. So I'm starting to feel a bit more confident with that.

I think the Let's Count program has made me more aware of maths in my language and in my encouraging propositions for children. So I'm asking them to solve it but because I know about it, I can direct it. So I think the Let's Count program has made me aware of maths in our society or how children can be involved in developing the process of thinking.

I'm probably more confident with doing things now with the kids where before I would have been like Oh that's just too hard. But it's not and I suppose the measurement side of things we've been really working on with the kids and water volume and things. We've been looking at fractions and different things and the kids really love it. And I suppose if you're confident in being able to present that the kids just take more out of it than if you're not so confident they won't be as interested. Does that make sense? I guess if you're not captivating your audience they're going to lose interest quickly.

Like the lady that I was speaking to, we were doing it just within whatever we already were doing and just using it that way, which we have continued to do because we thought that was the main focus of the program, to just continue with what you're always doing but recognise the maths, talk to the children about it then point it out. And it's been really good because even when we had our ratings and assessments recently the assessor had noticed the mathematics display we had up and then she commented that she'd heard one of the educators in the sandpit talking to the children about the mathematics that they were learning in what they were doing in the sandpit. So I could really see that the other educators had taken it on board as well.

I can remember learning all this when I was at university and learning to be a teacher so I think for me it was really good to revisit that because we don't really talk as much in the … Because of the new framework and that the language has changed with what we're doing. So it is nice to still talk sort of about mathematics rather than … Because it's always literacy and numeracy which sounds like it's just all about numbers all the time and that children just need to learn to count. But when it's mathematics it covers everything and that's the lovely thing, because I'm not sure that it's being taught in university the way it used to be when I was doing it a long time ago. I really don't think it's there and I think this program is filling that gap. I think it needs to get out to all the teachers and staff that are out there, that mathematics is everywhere. And it is, it's a very valuable thing to be doing within your program. Because I think we hide it so well that we don't even realise we're doing it. And it needs to be on more of a conscious level and I think that's where it's … I think it's very worthwhile. I think everyone should be doing it.

You want to be a mathematician for life, not just while you're in school. Like we're readers for life, I think it's very important for children to be mathematicians for life now as well.

Awareness of the potential of everyday tasks for prompting mathematics discussion

The notion that there is mathematics in everything has clearly been accepted by many of the educators. Over the life of *Let's Count,* the depth of the mathematics being noticed has increased, and mathematics has broadened beyond the study of counting and numbers. In some cases, 'noticing mathematics' has become an integral part of educators' normal daily procedures. This is a very positive aspect that many of the educators have drawn from their experiences with *Let's Count.*

> *I had a conversation a little while ago about setting up activities for the children and we were talking about students and I said it's really important that we actually ask the questions of students what's the learning that can happen within this activity and I just reeled off a few things that could be learnt out of just a simple activity of having farm animals on the table. We started talking about how many legs the farm animals might have and those sorts of things. So I think it's really made me think about the learning that can take place within every activity that happens that may have some sort of maths attached.*

> *Whatever we're involved in, even with the gardening outside, we look at how many plants we have planted, we look at the pictures of them when their fruits develop, what shape is it. Colours and everything, whatever we do we're attempting to incorporate maths throughout.*

> *I'm getting better at incorporating it, yes. I like maths anyway but some of it is … It's back to … I was telling the girls, it's back into things like we're always going 'Wash your hands, they've got germs on them', 'Don't touch that, it's got germs on it', 'Don't forget to swish and swallow and clean your teeth' but we're getting at incorporating maths in a 'Oh look how tall that is, it's not as tall as something else and sort of taking those moments of … It might not be a huge big lesson planned but it is pointing something out or … If they find a long stick 'Do you think that's as long as the garbage bin', so we're predicting and like doing size comparisons and doing those observations and things like that. So it's sort of becoming more second nature now, as opposed to sort of 'Oh my God, I've got to do this maths stuff'.*

> *I think doing the workshop increased my heightened awareness of the everyday aspect of maths. So everything we do, literally everything we do, even cutting up the streamers today to put out to blow in the wind was about how long we will we make them. I've got a big piece of material, how will I make many of them. Well, we can cut it in half and then we can cut it in half again. So like, everything you do becomes a maths experience. Today one of the children brought in oranges from her tree. So we talked about healthy eating but we also talked about how many oranges there were and what was happening if we were going to share one. Because that was our learning from today was approaching the issue of sharing. So we shared it between the children. What will we do next, we cut it in half. Was that enough? No, it's not, we need to do more. What will we do? Cut it in half again. That gives us what? … They're quarters and these four quarters will make a whole. Oh a new word, Ok. So you know, that's how we're going along. It just happens. It's just heightens awareness.*

> *And straight away the staff were almost like whatever situation we were doing, it wasn't just about the book, it was also about the maths concept in it. It wasn't just about group time, suddenly it was also about maths concepts sort of thing. So it became more of our day to language whereas previously it had really been biased towards literacy.*

> *I probably feel more comfortable. Let's just say, it's something that we've always used and I've always felt Ok using but just the different ways I think it was sort of more of an eye opening, how much we bring it into our gardening experiences and just generally day to day. It's so easy to add*

terms and different things to just about everything we do. Even just down to children talking about the shapes and sizes of their sandwiches or the number of packages in their lunchbox. I've noticed even with the kiddies there, when they're making a circle at group time they'll describe whether it's not a circle and the shape they feel it is. So yeah, it's definitely something that I feel quite comfortable doing now. I've never been an overly confident mathematical person but I'm finding it quite easy to do it with the children, which is great. And just how frequently we were actually doing it anyway. So that's good.

Sustainability of *Let's Count* over time

The sustainability of programs like *Let's Count* depends not only on the quality of the initial professional learning but on the continued enthusiasm and drive of the participants. Many challenges need to be faced, particularly around the mobility of the early childhood education workforce in Australia (Productivity Commission, 2011). Some of the educators interviewed were very keen to see a sustainable future for *Let's Count* in their settings. Many of those interviewed felt that *Let's Count* would provide its own momentum to continue. For the educators, seeing the results of the program for the children, parents and themselves was a strong motivation to keep going.

I think with the current staff we have got it will continue very well but again, if that staff changes it would depend on the abilities and the interests of those staff I suppose. It would be certainly something that I would like for anyone to continue but it would just really depend on how that kindergarten teacher wanted to work and their own knowledge of those things. And usually you find when a program is introduced like this it works really well but when the momentum stops so does the program.

Every year we set a program of things that we want to ensure that we have focused on or thought of while we're developing our program. So we will definitely put it in there as one of those things that we want to keep in our mind while we're developing our program and running projects and things, because mathematics can go into any project that you're doing whatsoever. So it would go onto there and it can be something that we can continue to talk about at our staff meetings and things like that, so that those who have done the program have passed that on. So even if they were to leave, the other educators that are still at the centre would have the skills to continue.

I think that we'll probably just keep going with what we're doing because it's making a difference and it's probably not to the extent that all the parent nights and all that sort of stuff, but just incorporate the maths program, like our literacy program and everything and just keep on going with it. … and if we give it another 12 months it will be ingrained like the literacy thing and our sustainability stuff, that we won't even know we're doing it and it will make a big change.

I think because we're all so positive about it, I think that is going to be a big part. I think if we were to go 'Ok we've done our bit now. We've done our two sessions, our job is done'. I think the interest would go. … It's very, very much a part of our day, so I think that because we're doing it almost on auto … well, not on auto pilot but almost without thinking, we're doing it now as part of all day every day. The children are going home and talking about it and they're wanting to share their new knowledge with their parents. So they're really excited. That excitement, I think, will help keep the families motivated as well, because they're going to be going home and talking about it and wanting to do it and wanting to show them and wanting to come in and tell us what else they know. So I think that will be a big part of it. So we're hoping it will anyway.

No, we're actually looking forward to doing it again next year, just so that we can move on and further … Because although it's mainly for our ones going off to school our younger ones have been involved in it too so just to see where we can take them after two years of doing it. So we're

just sort of looking forward to what they're going to come up with, having been involved in it twice, to see basically what they're going to get out of it and what other concepts we can do and what challenges lie ahead really.

Children's engagement with mathematical learning and mathematical concepts

So much of educator's knowledge of what children are capable of doing, how they engage with activities and how they are disposed to this learning comes from their observations of the children in play and other, perhaps more structured, contexts. The *Let's Count* educators interviewed often described their awareness of advances in children's mathematics learning that they have noticed. In some circumstances, these advances have been quite dramatic. Many of the educators put changes of the children's engagement down to changes in confidence in both the children and the educators and the educators' increased ability to provide meaningful, mathematical feedback to the children. There was little mention of any impact of increased engagement with mathematical ideas at home might be having on the children's engagement with mathematics in the centres.

We were actually drawing patterning and even if I had like three … Say I had red, blue, green, red, blue, green, red, blue and then we were working out what would be next and seeing how far along we could get with the patterns and showing that patterns could go up and down and all sorts of things. It just sort of evolved. But I said to them … 'Do you think you understand what we're drawing?' and everyone was like 'Yes' except for this little boy, he said 'No. I would have said it was yellow next, why did I get it wrong?' And so we started again and I sort of had the line of like, I think by that stage we had nine circles sort of thing, three groups of three, so I drew a line to show that that's a grouping of three and then that's a grouping of three and he said 'Oh now I know'. But he was the only one … Maybe others didn't understand too but they weren't confident enough or interested enough to say 'No, let's go back to this, I really want to do it'. That's why he's on my mind, because he's that sort of child.

So far I think it's fantastic. I'm really seeing the children … Just their knowledge is just blown me away, of what concepts they're understanding. Their understanding of like symmetry and patterns. And now it's starting to be more about adding. Last week we worked out that 10 x 3 is 30 and that was from a story book: '10 Red Apples' from Dr Seuss. They had noticed that there were 10 on each of the animal's heads and then I chose three children to show me 10 fingers. And then they were able to count along and find out that that actually meant 30 apples in total. And that all came from the children … So they just have been absorbing the maths and really extending them further with just like the slightest bit of encouragement, which is fantastic.

The child that's really taken to the graphs is one that I would not have expected. ... It's a little boy, but he's also getting other friends involved too, both boys and girls. And so it started off as being just him and a female friend, writing their names and arguing about who had the most letters. ... But then we ended up measuring feet, so it was two of the girls talking about who had the prettier and bigger shoes. Yeah, so then we chased around and made a graph of everyone's feet. And he then came along and wanted to do that as well because it would go with his graph on his name.

So it's sort of been, like the graph part, has really taken on them on board but it's been tailored to obviously what they're interested in, which has then brought them into the maths concept better too, because it's not just 'these are numbers, this is …'. It's whatever topic it is.

I suppose they've all grown through confidence. I guess there's a couple that from the start of the year would never, ever have had a go. Because we usually do a little counting game at the start of the kinder session and they're now the ones that have always got their hand up first to get in there and start the counting game. So that's a big improvement, just children's self-confidence,

which sometimes they don't even know that they're doing or interacting in an activity that you're getting a lot of positives out of.

Actually one interesting thing just from today, and I mean, I'm still processing in my head because I took it down as an observation but we have a construction set out at the moment which it's basically all of these spinning wheels and the children hook them together and then they can build up blocks to make a tree. And then there's these little vines that hang down and there's monkeys that can link arms. I turned around and one of the boys had just sort of taken it off the shelf and decided that he was going to link the monkeys' arms to measure how high the shelf was with the monkeys. And I just thought it was just an interesting using that … Oh we've talked so much about measurement but it's all been with a measuring tape and talking about centimetres and talking about like difference in height and things like that. And he just pulls out this alternative unit of measurement. Just you know that they have that innate ability to … Like he's measuring without even thinking about it. He's getting the monkeys to go from the top to the bottom and we were talking about well, how many more monkeys do you think you might need to get to the bottom of the trolley and we would try to hook some on and then we had too many and they were dangling on the ground. So well, we need to take some off so we can get it just touching the ground. Yeah, so that was an interesting one just from today's observations.

I can remember that child and once again I'd have to say that she's now increased dramatically compared to where she was. She would usually just sit there and not have a go and now she's probably the first one in to have go.

I think because we are sort of recognising and celebrating those moments and those times, talking about them being mathematicians and things like that. And seeing them sort of then taking that on board and then sort of wanting to show you … So you might be discussing something at the table with them, something that they're doing and then turn away for a few minutes and then they'll be wanting to show you something more that they've done. They're extending their own experiences I think because of that; because of that feedback that they're getting back from us.

My children have built so much over this year that their concepts all around are starting to grow. I mean, they're transitioning to school so really we've studied a lot of maths this year so probably there's one that I've noticed is how they ask for the maths to be incorporated. If we're doing something they ask for the maths. Like have we divided the groups for the day or can we play one of the games that are maths components. … I have got one little boy who is very negative at the beginning of the year about actually engaging in games, full stop. And now I've actually got him requesting to stay in the group that has the games each day and actually sharing in the maths with other children and yeah, look, that's just been brilliant. He's so excited about playing these games of maths, with our support of course, because he is from probably a less academic environment, if I can say that, and so for him to embrace the games and really take on board the maths is just brilliant. So it's really good.

I think they surprise us all the time, in a good way and I think they surprise each other too because they're kind of constantly sort of sitting there and wanting to share their ideas with their friends as well. So I think then their friends don't want to be … They want to be sharing their ideas too so you kind of get this … Not competition, but you get this kind of springboard that keeps getting moved up and up and up because they're just thirsty for everything. Yeah, we can't keep up sometimes with what they want to know and how to find out and so yeah, it's been really, really good. I think that confidence has been one of the best things that's come out of it, is their willingness to ask and ask and ask and ask some more. They want to know more, they want to know this, they want to how to do this and how this will work and what about if we try this. So quite often it's them kind of taking on the role of the teacher sometimes and they're the ones leading it, which is really, really good.

I wish that everybody had the opportunity to do the Let's Count, like as in the whole of New South Wales, because I've just seen such big improvement in the children's concepts of maths and preparing them for school next year … if they've got one more ability … to comprehend maths and how it works then they're going to be so much more comfortable in a new setting and really participate to their fullest.

Importance of mathematical language

This theme was much more obvious in the analysis of 2014 data than in the 2013 data. Mathematical language had been mentioned in conjunction with learning in 2013 but, in 2014, it was regularly discussed as an end in itself and an important addition to the pedagogies of educators. While children's use of mathematical language does not necessarily show that a particular concept has been learned, it does show awareness of particular aspects of communication of mathematical ideas.

Well they do a lot of maths but they don't realise it. We talk about how long … We give them the words, the language for what they're doing. One little boy this morning said to me 'Look what I've made, come and see, we've made a really long thing' and I said 'How long is it?' and he said 'Well it's longer than this'. We kept going on about it, I said 'What have you used?', he said 'I made some long and some short blocks' and I said 'Well what else can we do with it?', sort of thing. So it's just conversation.

Oh yes, definitely over the year. I just feel that yeah, I'm just using more mathematical language and that's getting passed on to the children. So yeah, and just like velocity and distance. It's just using it how we would speak in everyday to an adult, so it's great.

The Let's Count training we had gave us a different approach as well, where we can talk to parents and talk with children. … We use mathematical language, a lot more mathematical language, so the children know this is a part of our vocabulary but it's also part of real life. Iinstead of just counting twenty children, or twenty five children, who have turned up for the day … [we can say] how many boys and how many girls. So if there were two away, how many … So we can use that as a mathematical game as well.

It is, just how simple and important it is to mention that terminology. I suppose that's my biggest thing, is you've always done mathematics stuff with the children but not necessarily saying well actually, you know what, this is mathematics and this is sorting and classifying and that sort of stuff. Just actually really using the words. I suppose that's been my biggest change. It used to be just like rote counting or just this or that sort of thing.

Yes, there's two little boys who are just amazing. They just pick up your language and they're coming out with the language of maths. The quarter, it's how long, longer than or higher than. They're then doing estimation. Because we're trying to teach them that as well, to say you don't have to count first, you can make a judgement, you can make an estimation. If there's a lot, if there's less as to how many there are. And they're doing that. They're saying 'I think there's 6' and then I say now you need to check, so they're checking sort of thing. So there's two little boys who are just … Their language of maths has just come out in them. It just increased their vocabulary.

We've all just become more aware of taking advantage of when we can use that [mathematical] language in other areas of learning. In those little times and just using the language that we didn't do maybe as much before. So that's probably been a really big thing. There's always something every day. Like we have a section in our program dedicated to Let's Count and numeracy and mathematics. So every day in the program that fills up really easy. We have no problem with putting different mathematical elements into that. I think it's just that awareness of how you can incorporate mathematical language into everyday things. And we're all getting quite good at it, so we're all just like 'Oh I've got another thing'. So the actual program itself hasn't changed, just our awareness of those moments has become stronger.

Parent Interviews

In 2013, a small number of parents was interviewed on two occasions, once at the beginning of their involvement in the program and again near the end of the year. On the first occasion, four parents were interviewed in each of the two evaluation sites while, at the end of 2013, these parents plus another one in each site were interviewed. All interviews were conducted by phone. In 2014, a much larger number of parents was interviewed on three different occasions: the first shortly after they had begun in the program (38 parents); the second around July, 2014 (36) and the third at the end of 2014 (33). These parents were spread over only three of the evaluation sites as educators in the fourth site were unable to nominate potential parent interviewees. As in 2013, all interviews were conducted over the telephone by trained interviewers.

Themes from parent interviews

Six themes have been identified through the analysis of the parent interviews: some of these relate to the impact of *Let's Count* while others relate to the processes around its implementation.

The identified themes are:

1. Noticing children's mathematical learning and facilitating that learning in the everyday;
2. Parent – educator communication about mathematics and *Let's Count*, with an emphasis on strengths of all involved;
3. Children's growing confidence, knowledge and enjoyment of/engagement with mathematics;
4. Importance of mathematical language;
5. Positive impacts within families, extending to older and younger siblings' inclusion in mathematical activities at home;
6. Sustainability of *Let's Count* over time.

Noticing children's mathematical learning and facilitating that learning in the everyday

Every parent interviewed talked about how their abilities to 'notice' mathematical concepts as part of their every day interactions with their children, and to extend those concepts when children showed interest, had increased. There were many suggestions made that there was mathematics in everything and that what the parents now saw as their part in their child's mathematics was to notice, explore and talk about this mathematics. While this noticing of mathematics was not always attributed to their family's involvement in *Let's Count*, in many cases, parents indicated that this was an influential aspect of the program.

The major difference I think has been I'm much more aware of how she can learn from everyday things. An example of that was yesterday my husband brought home a little thermometer, he works in refrigeration, and she wanted to know how it worked. And I was just trying to explain and I couldn't be bothered, and then I thought 'Oh put it in the fridge'. And then she put it in the fridge and we looked at the degrees and she wanted to put it in the freezer and look at the differences in temperature. Yeah, from that it kind of snowballed into looking at why were there different numbers, what's Fahrenheit, what's Celsius, all that kind of stuff. So I think it was good. At the start of the year I wouldn't have bothered, I wouldn't have even thought about it but it just occurred to me like, this is a good moment for her to explore it. Whereas before I wouldn't have done that and I would have just said 'I don't know, I can't be bothered teaching you that

I guess looking at it, he will say 'What do these two numbers make mummy'. So he's looking at double digit numbers. So say the numbers on our letterbox. He'll say there's a 7 and a 3, although it's 3 and a 7, he just wants to know what do those two numbers make mummy and so for him to actually ask me that, I think that's pretty good. And then I'll say it doesn't really make 37 but that's what he's asking, is what number is it joined together so I'll say 37 and he's like Oh Ok. So to be interested and eager to know, that's what surprised me at the moment.

It's made me be more active, to make sure that I keep reminding him about mathematics in everyday stuff. … doing the shopping, making sure I keep them active in it, not just doing it. It's easier to just grab three containers of milk instead of saying to him 'We need three containers, we've got one, how many should we get'. You know, we're doing that a lot more now instead of just doing it and it's really shown through with him as well. And he's actually showing his brother.

So the other morning XXX came in with her mega sketcher to me and she said 'Let's make a pattern'. She directed the game, obviously she was the teacher and she was saying 'First I want a flower'. So I did a flower, then circle, a square, a triangle, and then she said 'Now a flower again, a circle, a triangle' and then she realised, she's like 'No, that's not right' and she said 'Let's start again' because she self-corrected that she'd forgotten the square. So we went back again and we started again and we repeated the pattern three times. And she's like 'Great work mum, great work'. And off we went for breakfast or whatever happened after that. So that was fun.

We were outside the other day because it was a nice day and he was jumping on the trampoline and he was counting. He counted past 100 and I'm like 'Wow, that's pretty good'. Every time he jumped he counted how many times he jumped. I think he got to 140, I'm like 'Oh my goodness, I didn't know he could count that high'. I am probably more interested when he starts talking about it or he's playing a game that involves numbers. I do, I get involved with him and listen to him and I'll tell him stuff if I need to.

So having that program there has just boosted my confidence enough to say Ok well XXX is catching on to this very quickly, she's doing all the right things, she's talking about it at home, just in general conversation, not even … Even if I bring it up like … I'm not bringing up 'So how did you do with your mathematics today?'. Like, she's just coming up and saying 'I did this and this today'. Like it's just a bit of a confidence boost and saying Ok maybe she is a bit ready. Maybe she is going to be Ok to go to school."

"I don't know that it will change substantially, probably because of me being a primary teacher but I think it will definitely make me more mindful of just bringing it up more often and making her more involved in everyday activities I suppose."

Probably one category would be more intentional so whether it'd be sitting down and playing a game of Uno or a game of dominos where we're focusing on that maths. And he has also developed an interest in dot to dots and stuff like that. So that was what I'd say more intentional whilst other opportunities just sort of a spontaneous. So whether it's like he's helping me set the table, well how many forks are we going to need for our family or just things that coincidentally pop up in our everyday lives. Like swimming groups this week he noticed that there was numbers on the side of the pool so he wanted to know what it meant, so we talked about depth and then he went on his own tangent of measuring the depth of the pool in different areas, on his own body. So how high the water would reach. So yeah, I guess it's a whole range of experiences, some are planned for and others have just cropped up coincidentally throughout each day, everyday living really.

Her birthday was on the 16th of October so I wrote '16' down the bottom and then I took thirty days away from that, adding squares and numbers, counting down and she realised that it was only twenty eight days or something like that until her birthday. And each day we'd cross it off and it would have the date of the month on it, until it got to October it will say the first of October and then she would know that she would only have sixteen days until her birthday by counting the blocks in between.

The other night we were having beans for dinner and both the girls, XXX and YYY sat up in their PJs on the counter and they had to cut … They each had their own board and they had their own little knife and they were asked to cut up beans. So they started to cut. XXX started to cut the beans up and then she was like 'Oh mum, I'm going to make two piles' and she put all of the medium beans, she called them, in one pile and the small ones in the other. And then she counted there was thirty-five small beans ready for the pot and only five medium ready for the pot. Yeah, and I didn't actually say it. She actually came out with it. She was like 'These are the medium and this is the small' and I was like Ok cool.

His skills have certainly picked right up. As I said, he's always been a bit interested in maths type things anyway but certainly he's very good at … Like he's at a point now where he counts forward and backwards, he can count well over 100. He has started to do things like negative subtractions and stuff like that, so he'll be 'Mum what's 2 – 8' and all of those sorts of things, so there's a lot of those concepts coming in. And he's very good with his concepts around big, medium size and small, front end and middle and all of those sorts of sequencing type things. So yeah, he definitely has come on board in leaps and bounds this year with his understanding about a lot of those concepts.

Yeah, it's definitely increased, because he's so vocal with it you realise that there's a lot of maths in almost every situation that you're in. Whereas you forget about that when you're not … You just do it on automatic pilot. So that brought that back to being more of a focus.

Parent–educator communication about mathematics and *Let's Count*, with an emphasis on strengths

One of the central tenets of *Let's Count* is the need for educators and parents/family members to talk about the mathematics in which the children are involved both at home and in the centre. The effectiveness of parent-educator communication, both about children's mathematical knowledge and activities and about *Let's Count*, varied across the interviews. For most parents, the level and intensity of this communication increased across the year in which *Let's Count* was implemented, as did the parents' satisfaction with it. In some cases, poorer levels of communication around the

mathematics children were doing and *Let's Count* itself, were attributed to parents' own acknowledgement of being time poor or their child not attending the centre regularly.

If something pertinent to the Let's Count thing crops up then they will mention it. Probably like on the Facebook page they're seeing what we're doing at home so I guess they're learning more about us as well, through a different way than just chatting. Because I mean, pick ups and drop offs are always so busy, you don't always shave that opportunity, so I think that it is giving them a little bit more insight into each child. It's probably giving them a greater awareness of each child's strengths and needs as well because maybe they're getting surprised by some of the stuff that the kids do know. Or seeing areas where they could focus on more.

Not so much and it's probably I'm probably not a very good case in terms of that because I work the days that XXXX goes to preschool and I increased my days of working so as the year went on I went to preschool less. So that was … So for me personally, in terms of my experiences of that it's probably not a very good indicator of whether or not the program would have impacted on that.

Well honestly I do not know that much. From what I've been given and from what I've been shown at the preschool, like I've been shown a few different things and I was given that pack to take home and stuff like that, but honestly I don't know much about it. Maybe when you're introducing it to parents maybe have an hour thing where they explain to the parents what's actually going on. I'm not sure if you actually did because now I feel silly.

Look there has [been some communication] but it was quite a while ago and there hasn't been follow up since. … she gave us all the information and she gave us a little talk about it and then yeah, that was sort of all we knew. There's always so much going on.

We had a parent information night earlier in the year and she talked about maths in everyday situations and real life and how you can integrate it at home as well as in the classroom and at kinder. What to look for and things like that. Like, I don't know, like lots of different everyday activities I suppose, is the main thing I got out of it.

I guess there was a concentrated effort when the program was introduced at kinder and certainly as I said, with some of the things that came home there was that focus. The kinder teacher then provided an information night for families and that's when some of those products were distributed to families and she discussed each item in the bag and how they could work in your everyday life with your child and how you could try different activities, some with family members, children as well as the mums and dads being involved. She said you don't have to have dedicated time for times tables at night, there are so many, as we know, other examples of the way you can introduce maths into their young daily lives now. Yeah, so it was good that she had that information night and there were a lot of good tips that came home to the kinder families with the bag of things that was involved.

Earlier in the year our kinder teacher ran a night with ideas about reminding families about how you can utilise your home environment and what's around you to introduce these basic maths concepts to children. And more than just your simple counting. There's just so many other sorts of things with spatial awareness and patterns and so forth. And so there were various activities that were run on the night following a little power point presentation from the kindergarten teacher. And activities that the children engaged in with parents supporting. And then there were some resources that were taken home. So it was probably the catalyst for everything that took place in kinder this year. And the kinder teacher has touched base on that occasionally throughout the year but it was probably mainly for parents just to see what we can do at home.

Oh I think it's fabulous, that's exactly how I think kids should learn most things, particularly when it can start at home from such a young age and not just at school in a formal setting. And I think sometimes you don't realise as a parent that you're actually doing it, quite often, much more than you probably think. And I think it's great that education and programs are going in this direction and trying to educate parents too, on how to teach maths and use it every day in a much more holistic approach rather than just 'Let's count to 10'. (Time 1)

The three girls [educators] that I usually spend most of my time with and talking to them and they're all for it. I mean, this is one of those kindergartens that I've come into and had a delight in actually learning myself better ways how to educate kids in learning maths, just by looking around how they make that classroom look like a play area for kids. It's wonderful. And just even them sitting down with the kids and going through it and making it fun and seeing that they're enjoying it too it makes a big thing for kids to learn, if you're happy learning too.

Like, we haven't had another meeting to be updated on what they're doing but they have a look book which is really good. It shows what they've demonstrated … What they've been doing and how they've enhanced it. And even we've just had sort of like parent/teacher chats so yeah, they explained what we've been doing and they've really noticed the difference in how inquisitive Kingston is, so that's really good.

I think from what … Like to be honest with you, I walk in the centre, I drop off and I pick up quite late in the afternoon. But from what I do read and see around the room and from what XXXX tells me with her experiences of what she's had done and all of that, I think that they are definitely implementing it more there. Like for example yesterday they had measured a tunnel and they were going to put a tunnel outside and they had to make sure it fitted, the angle of the hill didn't work right with one plank and then they had to figure out how to get the second plank to make it all work and was it going to fit right. And they have to do all these things and it's all mathematical elements to it, angles and things. I thought that the teachers at the preschool are already so great at it but I think bringing this program in it's kind of made them go 'Hey let's really do heaps more'.

They've focused areas of their program on it but also they've really taken advantage of the incidental things that happen, where they can then incorporate some of those concepts. So they've been able to extend play that he's had and so certainly when the school … Like they do observations and stuff so we see at the end of the day certain things that the kids have done and so there have certainly been a few of those during the year where they've been able to extend on the concepts that they've got in the program and apply them to play games and things that they're doing. I guess that's probably the highlight is that he's learning all this stuff without really … It hasn't had to be sit down and just rote, boring learning.

Well I definitely think that my relationship with XXX, who is the one who is heading the Let's Count with YYY, like I just talk to her so much more. Like we're engaging so much more. Even with other parents, you know. Because we have this Facebook page as well we're all communicating, we're all uplifting each other. Every day I come in and Emma actually has been amazing. Like, she has done so much in the room. They've got this little mathematics table where they're constantly changing things. They've got scales, they've got estimation, they've got all these types of things and she's so into it that it kind of is … What's the word I'm looking for? Like you take it on board. It's awesome. It's so much fun. And we talk so much more. Like on an every other day basis she's like 'Oh I did this with the kids' and I'm like 'Oh my gosh, it's awesome'. And she'll mention something that I've done on Facebook and she'll be like 'It was so cute'. The language is open. The communication is open. It's great.

Children's growing confidence, knowledge and enjoyment of/engagement with mathematics

Parents reported their genuine surprise at their children's increased mathematical capabilities and, particularly, their children's confidence in trying out new mathematical ideas. In some cases, this mathematical development has exceeded the parents' expectations of children's capabilities at their age. For the most part, the parents attributed these increases to the emphasis on mathematics in both the centre and the home, as a result of the introduction of *Let's Count*.

> *He is more mathematically literate than he was, which is really good. In particular, when he did his primary school screener to see if he was school-ready, they commented on his mathematics understanding as a really positive thing that he was quite excelling in. … that was really good feedback for us too. And we knew as soon as we heard that we went 'Oh we know why that's happened, because that's the Let's Count program'. So that's really good, because the screener that he did was really comprehensive. It was a two and a half hours [assessment that] covered a whole heap of things.*

> *I think it was the dominoes with the dots on them and counting the dots that got him more familiar and I don't know, he never used to like the dice before, rolling the dice with the numbers on it and so now he's more willing to count the dots on the dice. I don't know whether it was because of the dominoes or whether he's just getting older now, but he's more willing to have a play with that. Because they're fun, interactive-type activities I think I'm finding it a lot easier to engage him in that learning. … He engages a lot more when it's in everyday fun type things rather than sitting down with a book or a piece of paper. Like, tracing numbers and things like that he's not really very interested in.*

> *She probably didn't need any more help with her confidence. Yeah, when she knows she's right, so you know, she counted whatever and the boys are saying 'No, that's not right' she's adamant and she won't back down. So you have to at least provide a reason if she isn't right as to how she got it wrong. But yeah, she's definitely very confident.*

> *I loved it after the first couple of months of it. They don't do any structured really teaching at kinder but stuff like this, just to get the kids interested and thinking about numbers is a really good way for them to get comfortable with it without being scared of it. Because sometimes numbers can really intimidate kids if they don't have any background of it when they get to the school level, so I think it's really … Because even just playing around with it is such a good way to get them comfortable with using numbers and the concept of maths. And even just hearing the language and stuff has to be positive for them getting a good head start at school.*

> *And he'll come home and tell me about it and talk about it. Like, they had a rain gauge and it was measuring the water and he was telling me how many mls were in the rain gauge. I'm like, 'Oh wow'. So they are interested in all the things that they've been doing at kinder.*

> *Yes, we were playing … We've got a kids' Monopoly game and I was … Oh well actually dad and I were quite surprised at how quickly she could break down numbers, so with money changes. She likes to have every denomination in front of her and if she has to pay like $5 or something she likes to use a 3 and a 2 or a 4 and a 1 or 4 you know, 5, instead of taking that last five dollar note. And she can do it very quickly.*

Just knowing that she can probably count 1 to 100 is like a big thing to me. But the other day she picked up counting by 10s to 100. So that kind of threw me off and I went 'wow, now let's just go with this' because this could be the easier way to count to 100.That's one of those things that she said to me that's kind of spun me out, when she learnt how to count by 10s, that was cool.

Well he just … I suppose we had to change doing things with him because he's further along than my older son was as well. So he wants you to help, he wants you to do stuff with him rather than just not caring. He'd rather sit there and do stuff.

She comes out with things every day, basically. Something that really surprised me … Oh, [?] were talking about my birthday and that I'm turning 22 and she said 'Oh mummy, you're turning 22, isn't that two two', as in like 2-2' and I was like 'Yes, that's a number' and then she's just like 'So how do we add …' like 'What do we do to get to that number', like … You know. She was just trying to work out how to get to twenty two, like all different scenarios on how to get to the number 22.

I think just lately a lot of it has been his addition, which is very surprising because I suppose you don't expect them to be doing any of that yet. Like it's not just a once off, he's walking up to you nearly every day. It's only started the last couple of days kind of thing but he's just got a lot more confident I think with it, because he could always count and stuff but now he'll walk up to you out of the blue and go … And it's most nights. Last night I was sitting there and he comes up and he goes '6 + 2 is this' or you know, he's just coming up doing addition which is really good but it's out of the blue. Like it's not like we've asked him to do it or …he's very excited about it and it's like you praise him a lot because it's good but he's just so happy with himself that he can do it.

He loves to bake as most children do when it comes to licking the spoon and probably making more of an effort to just slow down a little bit and actually go through the required measurement of content, ingredients and so forth. He's been terrific to pick up on a few basic things there. A another thing he's been doing a little bit more of lately is a dot to dot book that he's had, that he's looked at on and off but I think with some improved confidence with his counting that he's happily saying it out aloud as he's going from one dot to the next dot without realising that it's reinforcing his ability to continue to count on and on.

I haven't noticed anything really come home. I do notice that the preschool itself they do a lot like on a daily basis with them in regards to counting and measuring and all other aspects to do with mathematical concepts. For me personally, with XXXX things that I've noticed are things like she always says … For setting the dinner table, she's started to do that now and she's like 'How many forks do I need? I need two kids' spoons, two big spoons, that equals four spoons'. She says things like that. She says things like, her sister is there with her and she's like 'I've only got five clips and I need six to make it match together'. Things like the other day we were driving and she's like 'What's the distance from Newcastle to home?' Just thinking of other examples, we also had this boomerang at home and she's asked me for a measuring tape so she could … .And she lined the tape up from one end to the other and she began to read the numbers. So she was like '5, 6, 7, 8, 9' and then she's like 'It's 300'. Which was a bit whacked but … Not obviously correct but it was about her using the lingo and the skills and all of those things that she's obviously picking up from the program.

Well for me with XXXX being able to see him work on those areas that interest him. That there's been opportunities provided in the school for him to develop those skills. I'm certainly seeing him be really confident and be able to … Oh what's the word? He's able to really identify different things and be really confident in saying 'No mum, that's this' or … And he'll happily count things.

If he says 'Oh mum what's 5 + 8' and I can quite easily say to him 'Well you tell me' and he's very confident to do those things himself, so that's been good.

Importance of mathematical language

The development of children's mathematical language is a critical part of their mathematical development overall. *Let's Count* emphasises the importance of the use of appropriate mathematical language in discussions about mathematical activities as well as ways in which such language can be introduced incidentally, in everyday and fun approaches. Parents interviewed seem to have developed an understanding of the importance of mathematical language and how they can assist in its development in their children.

Before the Let's Count program started I used to take XXX shopping and work with a budget and everything and she used to help me remember the numbers and stuff like that. So we've always sort of had that sort of learning mathematics basis but it's definitely just made me a little more aware of using the more technical terms with her. Because she's going to learn what they mean eventually so it's really important to start using those straight away.

Maybe I'm using that word mathematics with him more. So like perhaps before we might say he's helping me, we're making muffins or something and we're measuring half the cup, before I might have just said to him 'Ok, this is half a cup, let's measure it'. Whilst now I would highlight to him that this is actually mathematics, so that he puts the connection together. So yeah, just perhaps using that terminology more often. And even perhaps within the different areas of mathematics actually using adding and minusing, taking away, like using all that terminology more so that he's comfortable with it. That's probably the main thing that I've changed.

He does things like we went into a surf shop, I was looking for new boardies for him and he saw the surfboards and he was talking about how they were almost … He said 'They weigh almost as much as dad', but what he meant was they're almost as tall as dad. So he's using the technical terms that he wouldn't have normally talked about. And we, my husband and I, have been more explicit with our maths with him as well. And he's starting to get more the concept of addition and subtraction. So he and I have been talking more about his numbers. His individual number recognition is getting better and his understanding of numbers representing groups and adding and subtracting from those groups. He's exploring that a lot more than he has done before. And we've always done a lot of cooking and things with him. So we've been talking about wholes and halves and thirds and all that sort of stuff with him for that. But yeah, he has had definitely an emergence in his mathematical and scientific literacy, which is really good. At the moment he's all about cyclones and hurricanes so we're just … He makes me Youtube it all the time because he's absolutely convinced that if a twister comes through it will lift the house up and we'll be off like the Wizard of Oz, which he's not very happy about. So we're having lots of chats at the moment about how we don't actually get twisters on the central coast of New South Wales.

It's been a lot of noticing things in her surroundings that I don't think she would have noticed before, based on the fact that she has had exposure to the words and the language and the concepts. So you know, like an example was the other day she just noticed a clock they had at Bunnings and then she was trying to tell me the time and talking about the hands and things like that. Even playing games she uses language like halves and that's a quarter. Before she would never have, never, you know, been talking like that.

Positive impacts within families, extending to older and younger siblings inclusion in mathematical activities at home

While *Let's Count* has clearly impacted on the children and the parents who have been immediately involved with it, there is some evidence to suggest that some impact has also been felt by other members of the family, both older and younger than the focus child. The approaches drawn from the program seem to have impacted on the overall position of mathematics and mathematical learning in the family. This augurs well for the future sustainability of *Let's Count.*

> *I've noticed the little one actually taking things more so than XXX did because XXX is showing him which numbers are what and how to count. It's really good.*

> *We've got two school-aged boys. And you know there's a lot of focus on literacy and not necessarily numeracy. So you know, they bring home their home readers but there's never really anything numeracy in that. So it's been good for us all to kind of do that, measurements, counting the time. Yeah they've definitely participated in it.*

> *He tends to use it every day, whether it's counting the steps up in a building or yeah, just every time when he's buying things. And he's also encouraging his brother to do the same, which is good. So yeah, he's telling him and also commenting and when he does something right he goes 'Yes, that's right!'. Yeah, it's really good. … And he was trying to show him how to play dominoes too. Yeah, it's really good. I've noticed the little one actually taking things in more so than Xavier because … Yeah, he seems to be noticing numbers because Xavier is showing him which numbers are what and how to count. It's really good.*

> *Even if it's just being in the back of my mind. It's really, really taking advantage of moments where she can learn and enjoy maths without having to be sitting in a classroom learning. That's been really good, because then I've thought about it, the rest of the family have thought about it. Her brother has really benefited because he gets excited because she is, and he's only 3. So I think it's been really good.*

Sustainability of *Let's Count* over time

While many of the educators involved with *Let's Count* were quite positive about the steps that they were taking in their centres to maintain the program beyond the year of initial implementation, parents were not so forthcoming. Communication around the mathematics children were engaging with in both the centres and homes seemed to be maintained or, in some cases, intensified, but some parents felt that 'organisational information' was lacking. Often, parents expressed that there was a feeling of an initial flurry of information when the program commenced followed by a relative lack of input into what parents might do next. This situation is likely to impinge on the sustainability of the *Let's Count* within families.

There were also more positive data to report about the sustained impact of Let's Count. Two parents, who had children involved in both the 2013 and 2014 *Let's Count* cohorts, spoke in glowing terms about the 'start' that *Let's Count* had given their children as they began school and how this start had endured during the first year of school.

> *They [educators] really follow up the kids' interest l and let the parents know what's going on … That's one thing I've noticed different over the year. Much more feedback, specific feedback so that we can then follow that up at home and continue it.*

Well, in regards to the Let's Count program that really was promoted by the preschool that Thomas attended many months ago when it all came out and when the bags were given to parents and so forth. From then it was a primary focus and everyone was doing it and it was reported on by the preschool educators on the day sheets that we were receiving. But obviously now it being six months post that and it really went out the window. It's not really continuing. Everyone is back to their same routine.

Oh no, that was about it. We just got a letter home to say what they'd been doing at kinder to do with numbers and stuff like that. That was about it.

at the beginning they would talk about the Let's Count program to me, when the first initial stages, and they would tell me about how he was progressing but nothing since the beginning.

And it was exciting because he had his own little bag with something in it that was going to help him and he had to learn it and he really enjoyed that. Actually, he still looks … They've got the bags hanging up in the centre there ready to go and he still looks at it each time he goes in there, to see if there's something new. So it doesn't stop.

So it's not always me who picks up, sometimes it's my husband, sometimes it's me, sometimes it's my sister-in-law, I think maybe the thing that's lacking is the take home part of it, for me. I don't really know the connection between home and what they're doing at the centre. So that's the thing that is confusing me. I do know they're doing a lot at the centre but as far as what I'm meant to be doing at home, if I'm meant to be doing something, I have no idea what that is.

Conclusion

Three research questions frame the longitudinal evaluation of *Let's Count*:

1. How does participation in *Let's Count* impact on children's numeracy knowledge and dispositions as they make the transition to school?
2. What is the impact of *Let's Count* on the educator participants' knowledge, interest and confidence in mathematics learning and teaching? and
3. What is the impact of *Let's Count* on the participating families' confidence, and knowledge about noticing, investigating, and discussing mathematics with their children?

The evaluation of *Let's Count* used both qualitative and quantitative techniques to generate data and analysis around each of these questions. In this conclusion, the insights gained through investigating each of these questions will be considered separately.

How does participation in *Let's Count* impact on children's numeracy knowledge and dispositions as they make the transition to school?

The assessment of children's formal mathematics knowledge for the 2013 *Let's Count* cohort of children using the MAI yielded highly positive results in terms of growth in most aspects of mathematical knowledge and skill. The extent of this growth was further reinforced by comparison of the *Let's Count* cohort's end of 2013 scores on the MAI compared with those of the 'comparison' group and another cohort measured by the Early Numeracy Research Project in 2001. On almost every measure, the *Let's Count* cohort has bettered the scores of the other two groups, with many comparisons showing statistically significant differences.

These highly encouraging results for the 2013 *Let's Count* cohort were replicated in the results for the 2014 *Let's Count* cohort. A larger sample of children, across four, rather than two, evaluation sites, were assessed on the MAI and reported substantially similar results to those of the 2013 cohort. This consistency is a compelling sign of the impact of *Let's Count* on young children's mathematical development in the year before they commence formal schooling.

Although the 'comparison' group is not a sample matched exactly with the *Let's Count* cohort, both groups are of a similar age, come from the same 2013 sites and are at the same level of their education (end of the preschool year before they start school). As well, the ENRP cohort can also be used as a comparative group, even though they were slightly older than the *Let's Count* cohort and had started school. In most items on the MAI for which comparison with the ENRP cohort is possible, the *Let's Count* cohort has done better. Hence, it can be claimed that *Let's Count* does assist young children in their mathematical learning of some concepts (as measured by the MAI) to a significantly greater level than for young children who have not had the benefit of *Let's Count* and for almost all other concepts to at least the same level as for the comparison groups.

One further observation is that, for a number of tasks in the assessment interview administered in December, just prior to children beginning school, a very large proportion of children in all cohorts were successful. These tasks included: matching numerals (1-9) with dot collections, matching repeating patterns, counting to ten, ordering three objects by length, comparing two items by lengths, naming common shapes, following directions to position items, calculating totals for 5 and 3 teddies and for 4 groups of 2 teddies.

In terms of children's dispositions toward mathematics, there is evidence that *Let's Count* makes a real and perceivable difference. One of the key themes identified in the analysis of the parent interview data was that the *Let's Count* children showed growing confidence in, knowledge of, enjoyment of, and engagement with mathematics. These data include many examples of parents noticing that their *Let's Count* children seek out and explore the mathematics in their everyday experiences. A number of parents specifically commented on changes that have occurred in their children's positive dispositions towards mathematics. These parents almost always see *Let's Count* as the cause of these changes.

In a similar vein, educators, in their interviews, have commented on the increasingly positive dispositions of the children towards mathematics. The educators also noted some of the 'amazing mathematics' that their children do. There are many examples of educators being surprised by the level of mathematics that the *Let's Count* children undertake either at their own volition or in activities initiated by the educators. Clearly, many of these children are capable of mathematising well beyond the level anticipated by the educators or established for the Foundation Year of the *Australian Curriculum – Mathematics* (Australian Curriculum and Reporting Authority, 2013). This has been surprising for many educators.

Given what is already known about the impact of enhanced mathematical knowledge and dispositions in young children as they start school on their prospects as mathematics learners in later life (Clements & Sarama, 2007; Ginsburg, Klein, & Starkey, 1998; Sarama & Clements, 2015), it would seem that *Let's Count* can claim an important role in future considerations about approaches to the mathematical learning of young (and older) children. There seems to be little doubt that *Let's Count* has had an important, positive impact on children's numeracy knowledge and dispositions as they make the transition to school.

What is the impact of *Let's Count* on the educator participants' knowledge, interest and confidence in mathematics learning and teaching?

One of the key themes identified in the analysis of the *Let's Count* educator interviews highlights the impact of *Let's Count* on educator confidence, professional identity and pedagogical practice. Many of the educators have commented on how they feel much more knowledgeable and confident in both their own mathematics and also in understanding how their mathematical education practice can be improved.

The survey data generated by the *Let's Count* educators reinforces the claim that participation in the program does impact on educators' knowledge, interest and confidence in both mathematics learning and teaching. Large increases have been demonstrated in the educators' ratings of their own confidence in doing mathematics from before the first *Let's Count* workshop till after the second workshop. There has been similar positive movement in the educators' ratings of their confidence in developing the mathematical knowledge of children. Even in their ratings of liking or disliking mathematics, almost all of the educators have moved in a positive direction from one workshop to the next.

There is a general trend across the *Let's Count* workshops towards the educators adopting what could be described as more positive attitudes about mathematics, particularly in terms of the educators' perceptions of themselves as "good at mathematics" and whether they found

"mathematical problems interesting and challenging". Such a trend is repeated in the educators' attitudes towards certain pedagogical approaches. There appears to be a general trend towards more 'constructivist' and 'child-centred' attitudes about mathematical teaching strategies, particularly in terms of the importance placed by educators on "what aspects of mathematics interest children and the reasons for this interest" and the role of open-ended and informal activities. This is an important outcome.

These positive trends in educators' knowledge, interest and confidence in mathematics learning and teaching are reinforced through many of the interview quotes recorded in this report. It seems clear that participation in *Let's Count* has made a substantial positive impact on the educator participants' knowledge, interest and confidence in mathematics learning and teaching.

What is the impact of *Let's Count* on the participating families' confidence, and knowledge about noticing, investigating, and discussing mathematics with their children?

Many parents and many educators have commented in their interviews with the researchers that families are much more able to notice mathematics in their and their children's environments and that they are willing to talk about mathematics with both the children and educators.

Both educators and parents commented on the much greater levels of communication with parents about their children's mathematics that has arisen from participation in *Let's Count.* One of the key themes to come from analysis of the educator interviews was about ways in which educators and families could engage much more positively and regularly around mathematical learning than they did prior to the introduction of *Let's Count*.

Data drawn from both the interviews and surveys suggested that *Let's Count* provided educators with many opportunities to enhance the mathematical outcomes of children and their families.

Another theme concerned the ways in which mathematics learning in homes and early childhood settings were able to be more related. *Let's Count* impacted on the abilities of family members and educators to follow up on the activities that had been undertaken in the other setting. This provided a reason for communication which was embraced by many educators and parents, thereby building relationships and increasing the confidence of both groups.

Many parents reported on the impact of *Let's Count* on their ability and confidence to observe and learn from the mathematics their children were able to demonstrate and to extend this learning through questioning and the use of mathematical language. On a number of occasions, self-confessed 'math phobics' found that not only could they assist their children notice, explore and talk about mathematics but they were enjoying doing so and would continue. *Let's Count* clearly has had major positive impacts on the participating families' confidence, and knowledge about noticing, investigating, and discussing mathematics with their children.

Summary

The responses to all three research questions show that the data from the Longitudinal Evaluation of *Let's Count* indicate clearly that *Let's Count* does make positive differences to the confidence and other critical dispositions of all participants – children, educators and family members – as the children learn mathematics. Moreover, there is clear evidence that *Let's Count* is at least as successful as other mathematics learning programs used previously in the evaluation sites in terms of children's mathematical knowledge and skills outcomes. In fact, it appears that, with some mathematical concepts, *Let's Count* may be a superior approach. These findings, sustained over two separate data collection periods over two years, provide great confidence of the efficacy of the simple mantra of 'notice, explore and talk about mathematics' that is the foundation of the *Let's Count* approach.

Recommendations

The following recommendations are made as a result of the Longitudinal Evaluation of *Let's Count* reported in this document. They are made with the aim of continuing to implement what has been shown to be a successful approach to enhancing young children's mathematical dispositions, knowledge and skills, as well as those of the children's early childhood educators and families.

1. That The Smith Family, in conjunction with early childhood education providers and appropriate funding authorities, seek to implement the *Let's Count* program in all sites in which it has a presence.

2. That the authors of the *Let's Count* program consider strengthening program content dealing with sustaining educator/parent communication across the entire year of implementation, including considering the feasibility of an enhanced resource for parents/families.

3. That consideration be given to the appropriate publications that might emanate from the *Let's Count* program and its Longitudinal Evaluation, including Research Reports, academic chapters and journal articles, and extended guidebooks for educators and parents.

4. That The Smith Family, in conjunction with appropriate tertiary institutions, continue to investigate the online offering of the educator professional learning modules with consequent accreditation.

5. That The Smith Family seek funding opportunities to research the impact of *Let's Count* on children's mathematics learning following their transition to school.

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Appendix A: Growth Point Descriptors

Notes:

- *Growth Points based on ENRP Numeracy Interview November 2001/2006 + Number Domain Refinement 2011*
- *Growth points are not necessarily hierarchical, but involve increasingly complex reasoning and understanding.*
- *It must be emphasised that the conclusions drawn in relation to placing students at levels within this framework are based on a 30-minute (approx.) interview only. Ongoing assessment by the teacher during class will provide important further information for this purpose.*
- *Student understanding may be reported as a "0". This should not be taken as an indication of "no knowledge" or "no understanding", but rather as an indication of a lack of evidence of "1".*

A. Counting

0. Not apparent.
   Not yet able to state the sequence of number names to 20.
1. Rote counting
   Rote counts the number sequence to at least 20, but is not yet able to reliably count a collection of that size.
2. Counting collections
   Confidently counts a collection of around 20 objects.
3. Counting by 1s (forward/backward, including variable starting points; more/less)
   Counts forwards and backwards from various starting points between 1 and 100; knows numbers before and after a given number.
4. Counting from 0 by 2s, 5s, and 10s
   Can count from 0 by 2s, 5s, and 10s to a given target.
5. Counting from x (where x >0) by 2s, 5s, and 10s
   Given a non-zero starting point, can count by 2s, 5s, and 10s to a given target.
6. Extending and applying counting skills
   Can count from a non-zero starting point by any single digit number, and can apply counting skills in practical task

B. Place value

0. Not apparent.
   Not yet able to read, write, interpret and order single digit numbers.
1. Reading, writing, interpreting, and ordering single digit numbers
   Can read, write, interpret and order single digit numbers.
2. Reading, writing, interpreting, and ordering two-digit numbers
   Can read, write, interpret and order two-digit numbers.
3. Reading, writing, interpreting, and ordering three-digit numbers
   Can read, write, interpret and order three-digit numbers.
4. Reading, writing, interpreting, and ordering numbers beyond 1000
   Can read, write, interpret and order numbers beyond 1000.

5. Extending and applying place value knowledge
   Can extend and apply knowledge of place value in solving problems

C. Strategies for addition and subtraction

0. Not apparent.
   Not yet able to combine and count two collections of objects.
1. Count all (two collections)
   Counts all to find the total of two collections.
2. Count on
   Counts on from one number to find the total of two collections.
3. Count back/count down to/count up from
   Given a subtraction situation, chooses appropriately from strategies including count back, count down to and count up from.
4. Basic strategies (doubles, commutativity, adding 10, tens facts, other known facts)
   Given an addition or subtraction problem, strategies such as doubles, commutativity, adding 10, tens facts, and other known facts are evident.
5. Derived strategies (near doubles, adding 9, build to next ten, fact families, intuitive strategies)
   Given an addition or subtraction problem, strategies such as near doubles, adding 9, build to next ten, fact families and intuitive strategies are evident.
6. Extending and applying addition and subtraction using basic, derived and intuitive strategies
   Given a range of tasks (including multi-digit numbers), can solve them mentally, using the appropriate strategies and a clear understanding of key concepts

D. Strategies for multiplication and division

0. Not apparent.
   Not yet able to create and count the total of several small groups.
1. Counting group items as ones
   To find the total in a multiple group situation, refers to individual items only.
2. Modelling multiplication and division (all objects perceived)
   Models all objects to solve multiplicative and sharing situations.
3. Partial modelling multiplication and division (some objects perceived)
   Solves multiplication and division problems where objects are not <u>all</u> modelled or perceived.
4. Abstracting multiplication and division (no objects perceived)
   Solves multiplication and division problems where objects are not modelled or perceived.
5. Basic derived and intuitive strategies for multiplication
   Can solve a range of multiplication problems using strategies such as commutativity and building up from known facts.

6. Basic, derived and intuitive strategies for division
   Can solve a range of division problems using strategies such as fact families and building up from known facts.
7. Extending and applying multiplication and division
   Can solve a range of multiplication and division problems (including multi-digit numbers) in practical contexts

E. Time

0. Not apparent
   No apparent awareness of time, its descriptive language and features of clockfaces.
1. Awareness of time, its descriptive language, and some features of clockfaces

   Can describe at least one feature and one purpose of clockfaces.
2. Knowing some clock times, some days of week and months of year, and relating key events (personal, community) to these
   Knows some clock times, some days of week and months of year, and can relate key events to these.
3. Knowing clock times to half-hour, all days of week and months of year (including order)
   Knows clock times to half-hour, all days of week and months of year (including order).
4. Facility with clocks and calendars
   Can read analogue clock times to nearest five minutes and has good working facility with calendars.
5. Extending and applying knowledge, skills and concepts with time
   Can solve a range of problems involving duration, and digital and analogue time to the nearest minute.

F. Length Measurement Framework

0. Not apparent
   No apparent awareness of the attribute of length and its descriptive language.
1. Awareness of the attribute of length and use of descriptive language
   Awareness of the attribute of length and its descriptive language.
2. Comparing, ordering, & matching with the attribute of length
   Compares, orders, & matches objects by length.
3. Quantifying length accurately, using units and attending to measurement principles
   Uses uniform units appropriately, assigning number and unit to the measure.
4. Choosing standard units for estimating and measuring length, with accuracy
   Uses standard units for estimating and measuring length, with accuracy.
5. Applying knowledge, skills and concepts of length
   Can solve a range of problems involving key concepts of length.

G. Mass Measurement Framework

0. Not apparent
   No apparent awareness of the attribute of mass and its descriptive language.

1. Awareness of the attribute of mass and use of descriptive language
   Awareness of the attribute of mass and its descriptive language.

2. Comparing, ordering, & matching with the attribute of mass
   Compares, orders, & matches objects by mass.

3. Quantifying mass accurately, using units and attending to measurement principles
   Uses uniform units appropriately, assigning number and unit to the measure.

4. Choosing and using standard units for estimating and measuring mass, with accuracy
   Uses standard units for estimating and measuring mass, with accuracy.

5. Applying knowledge, skills and concepts of mass
   Can solve a range of problems involving key concepts of mass.

H. Properties of Shape

0. Not apparent
   Not yet able to recognise and match simple shapes.

1. Holistic recognition of shape
   Can recognise resemblances and match some simple shapes, using standard "prototypes".

2. Classification of shapes, attending to visual features
   Can sort and compare shapes, using some geometrical language to describe features.

3. Identification of "classes of shapes" by some properties
   Uses properties of shapes to classify shapes into classes, using appropriate language.

4. Definition of shapes using properties
   States and understands conditions for defining key shapes.

I. Visualisation and Orientation

0. Not apparent
   Not yet able to visualise simple shapes.

1. Static, pictorial images formed in conjunction with models or manipulatives
   Able to recognise static images in embedded situations.

2. Re-orientation of shapes mentally
   Can visualise the effect of simple flipping, sliding and turning of shapes.

3. Dynamic imagery
   Uses dynamic imagery to visualise manipulation of shapes by transforming and rearranging.

4. Extending and applying visualisation and orientation
   Can combine a range of visualisation strategies in increasingly complex situations.

Appendix B: The Victorian Early Numeracy Research Project (ENRP)

This description of the ENRP is taken from the following paper:

Bobis, J., Clarke, B., Clarke, D., Thomas, G., Wright, R., Young-Loveridge, J., & Gould, P. (2005). Supporting Teachers in the Development of Young Children's Mathematical Thinking: Three Large Scale Cases. *Mathematics Education Research Journal, 16*(3), 27-57.

Mathematics Education Research Journal 2005, Vol. 16, No. 3, 27–57

Supporting Teachers in the Development of Young Children's Mathematical Thinking: Three Large Scale Cases[1]

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Recognition of the importance of the early childhood years in the development of numeracy is a significant characteristic of the New Zealand Numeracy Development Project, the Victorian Early Numeracy Research Project and the Count Me In Too program in New South Wales, Australia. This article outlines the background, key components and major impacts of these three innovative and successful professional development and research initiatives. Juxtaposing the three projects highlights important commonalities—research-based frameworks, diagnostic interviews, and whole-school approaches to professional development. Each program has been significant in rethinking what mathematics and how mathematics is taught to young children.

Increasingly researchers have demonstrated that children begin to think mathematically from an early age. There is considerable research to show that many children arrive at primary school already equipped with an extraordinary understanding of the number system and how it works (Aubrey, 1999; Wright, 1994; Young-Loveridge, 2004). However, even as early as age five, there is huge variation in the kinds of understanding children bring with them to school (Ginsburg, Klein, & Starkey, 1998). Evidence shows that differences among children at school entry are quite stable – students tend to remain at about the same rank order position with respect to their peers throughout the primary and secondary school years (Newman, 1984). Furthermore, disparities in mathematics achievement evident at school entry tend to increase as students advance through the school system; that is, the gap between the most and the least competent students increases over time (Young-Loveridge, 1991). Research shows that intervention in the

[1] Please note that slightly different terminology is used in the NSW, Victoria, and New Zealand sections of this article e.g., Year 2 (NSW and NZ), Grade 2 (Vic); count-on (NSW), count on (Vic).

early childhood years can be effective in reducing disparities in mathematics achievement (Gervasoni, 2003; Wright, Martland, & Stafford, 2000; Young-Loveridge, Peters, & Carr, 1998). Tutoring of individuals or small groups of students by specially trained teachers can be very effective (Wright, Stanger, Cowper, Dyson, 1996; Young-Loveridge, 2004). The poor performance of many western countries on international comparisons of mathematics achievement in the 1990s (e.g., National Center for Educational Statistics, n.d.) reinforced the need for a radically different approach to be taken across the whole education system, but particularly in the early years of school.

In Australia and New Zealand, like many other western countries, major initiatives have been put in place to raise student achievement in numeracy and improve the professional capability of teachers. This article focuses on initiatives undertaken in New Zealand, and the Australian states of New South Wales and Victoria. Several key features characterise all three initiatives including the use of research-based frameworks to describe progressions in mathematics learning, and individual task-based interviews to assess children's mathematical thinking. This commonality is mostly due to the research-base from which the elements originated as well as the exchange of ideas among the projects. However, the ways in which the various elements have evolved are unique. This paper gives an overview of each initiative, outlining the key features and their linked theoretical basis, followed by a discussion of common themes and their implications for practitioners.

Count Me In Too-An Evolving Design Experiment

Background

The Count Me In Too (CMIT) numeracy program is an on-going initiative of the Department of Education and Training in New South Wales (NSW). This large school system caters for a population of about seven million people. The CMIT program melds findings from research about how children learn mathematics, with research on effective professional development. Hence, its two main aims are to help teachers understand children's mathematical development and to improve children's achievement in mathematics.

CMIT represents new directions from what characterises traditionally conceived professional development programs. There is a change in emphasis from the transmission of knowledge at one-shot workshops to long-term classroom-based learning. Teachers are viewed as active learners and are encouraged to examine their own teaching practices and to focus on the mathematics children *can* do and *how* they do it. The principles upon which the program is based support those of early childhood learning and teaching through the recognition and development of young children's intuitive numeracy strategies.

The development of CMIT has been cyclical over a period of approximately eight years. This cyclical approach is characterised by on-going phases of development, implementation and evaluation. Parallel with

this cyclical approach has been an approach involving expansion and scaling up of the program.

The school system in which CMIT has been developed and implemented has approximately 1700 primary schools. The system is organised into geographic and administrative districts (40 districts prior to 2004), each with 40 or more primary schools. CMIT began in 1996 as a pilot program involving 13 schools across four of the 40 districts. In 1997, CMIT was expanded to all 40 districts, and involved 4 to 6 new schools in each district. This pace of implementation continued each year, and by 2003 almost every one of the 1700 schools had implemented CMIT.

A second aspect of the expansion of CMIT began in 1999, and involved extending the focus on the number strand of the curriculum, to the measurement strand (Outhred, Mitchelmore, McPhail, & Gould, 2003) and the space (geometry) strand (Owens, Reddacliff, Gould, & McPhail, 2001). In 2000, the focus of CMIT on number in the first three years of school (K-2) was extended to the third and fourth years of school (i.e. K-4). Since 2001, there have been two other significant expansions of the program. One of these involved the development of a related program called Counting On (Perry & Howard, 2001), focused specifically on low-attaining students in Year 6—the last year of primary school—and Year 7—the first year of secondary school. The other expansion involved an adaptation of the CMIT number program to more appropriately meet the needs of Indigenous students. Each of these extensions of the program had their own on-going phases of development, implementation and evaluation, as well as scaling up from an initial pilot to large numbers of schools in the system.

As stated earlier, CMIT was developed by and for the government school system of NSW. However, the program has had considerable impact beyond the NSW government school system. The program has been adopted by many Catholic schools and many independent schools in NSW. As well, government systems in other Australian states and territories have adopted the program. Aspects of the program have been used by school systems in the United States, the UK, and Papua New Guinea. In 2000, the New Zealand Ministry of Education conducted a pilot of CMIT (Thomas & Ward, 2001). This pilot informed the New Zealand Numeracy Development Project which was implemented from 2001.

Key Features of CMIT

The Learning Framework in Number. The key theoretical component of CMIT is the Learning Framework in Number (LFIN). This framework was initially developed by Wright (1994) for the purpose of researching and documenting progress in number learning of students in the first three years of school (five- to eight-year-olds). In the early 1990s, use of the framework was incorporated into a professional development program for teachers (Wright, 2000) focusing on an intervention program that involves intensive teaching of low-attaining students (Wright et al., 1996). The framework has since

been used extensively with students of all levels of attainment, and has been used as a basis for classroom teaching, as well as for intensive intervention for low-attaining students. This intervention program—*Mathematics Recovery* (Wright, 2003; Wright, Martland, Stafford, & Stanger, 2002) has been used extensively by school systems in several countries including the United States and the UK. As well, *Mathematics Recovery* provided the basis for CMIT in several respects—the learning framework, the approach to interview-based assessment and teacher's use of video-taped interviews as learning tools.

A key aspect of the LFIN is Steffe's psychological model of the development of children's counting-based strategies (Steffe, 1992; Steffe, Cobb, & von Glasersfeld, 1988). In Steffe's model, and in the LFIN, the term counting is used in a special sense. A distinction is made between counting and saying a number word sequence because it is assumed that students' mental processes are quite different when they are counting, compared with when they are saying a number word sequence without intending to coordinate number words and items.

Steffe's model of the development of counting incorporates the notion of distinct progressions (or stages of development) in the ways children use counting to solve problems. The progressions relate to qualitative differences in the meanings of number words and are characterised by limitations in the ways students use counting to solve problems. In the LFIN these stages, in order of increasing sophistication, are: *emergent*, *perceptual*, *figurative*, *counting-on* and *counting-back*, and *facile*. Detailed descriptions of this model are beyond the scope of this article (see Wright et al., 2000).

The key components of the LFIN are:

- Building addition and subtraction through counting by ones;
- Building addition and subtraction through grouping;
- Building multiplication and division through equal counting and grouping;
- Building place value through grouping;
- Forward number word sequences;
- Backward number word sequences;
- Number word sequences by 10s and 100s; and
- Numeral identification.

Each of the key components of the LFIN is elaborated into a progression of up to six levels (or stages). Thus one of the goals of assessment using LFIN, is to profile the student's knowledge across the spectrum of the key components (Wright et al., 2000). Profiling of students' knowledge in this way forms a basis for instruction that is targeted to each student's current levels of knowledge and strategies.

The research by Steffe and colleagues is important in CMIT for several reasons. As well as providing the model of students' development of

counting used in CMIT, Steffe pioneered an approach to research involving detailed and extended observation of students' learning via videotaped episodes of one-to-one assessment interviews and teaching sessions. Significant aspects of this approach have been incorporated into teachers' professional learning in CMIT.

Since its initial development in 1990, the LFIN has undergone further development and extension through the influence of a wide range of research in early number learning (e.g., Bobis, 1996; Cobb & Wheatley, 1988; Gravemeijer, 1994; McClain & Cobb, 2001; Mulligan & Mitchelmore, 1997).

The Professional Development Model. The CMIT professional development model "creates a climate for learning for four linked groups within the project—academic facilitators, consultants, teachers and students" (NSW Department of Education and Training, 2003, p. 3). Due to this focus on collaborative learning, CMIT operates best when groups of teachers from the same school are involved in the program. The program normally involves a close relationship between the district mathematics consultant and a team of three to five teachers at each school. Teachers are viewed as active learners as they engage in observational assessment, diagnostic interviews, and reflection upon students' work and their teaching. The consultants, in their roles as co-learners, assist teachers as they individually assess the mathematical development of their children. They guide the teachers as they learn to plan their instruction based on the ideas inherent in the LFIN. Hence, the focus is on the learning of both children and teachers in often confusing and messy contexts, such as classrooms (Gould, 2000).

An important aspect inherent in the CMIT professional development model is the synergy of research and practice. Such an "intimate relationship between theory and practice is a defining characteristic of Design Research" (Cobb, 2003, p. 3). This design aspect clearly drives much of the program's innovative practices, since its purpose is not to simply affirm that the program's initial instructional design succeeds, but to improve it. Such development is guided not only by the on-going, formal evaluations that systematically address various aspects of CMIT, but also by informal, anecdotal evidence gathered from consultants, teachers and children on a daily basis. Consistent with a design research methodology, development occurs in small increments. Each development is followed by a cycle of implementation, evaluation and revision. Additionally, each cycle is viewed as an iterative process. Short cycles make the process more efficient as elements envisioned "behind the desk" (Gravemeijer, 1994, p. 449), are immediately put into practice and scrutinised as part of the on-going evaluation. Insights gained are used to *feed forward* into the theory development and instructional design loops of CMIT. In this way, the program remains dynamic, an essential component if professional development is to be long-term and a generative process.

As mentioned, on-going, systematic evaluation is inherent in design research methodology—the principles upon which CMIT is based. The

formal evaluation component has resulted in over ten separate reports and numerous conference papers aimed at synthesising the findings. Parallel to these documents is a growing body of literature associated with the developmental research that feeds into the theoretical and instructional design of CMIT. The following section briefly summarises the major findings of this increasing body of literature and highlights the impact of CMIT on classroom practices and systemic changes at the curriculum development level.

Key Outcomes of CMIT

A research-based agenda of evaluations has systematically explored the impact of CMIT. Each evaluation has focused on specific aspects or anticipated outcomes of the program, with some aspects being re-evaluated at different times. The following overview will only focus on the impact of CMIT on teachers and student achievement.

Student achievement: In 1999, assessment interview data were collected from 162 primary schools involved in the program. Children (N = 15,176) in Kindergarten to Year 3 (ranging in age from 4 years 5 months to 7 years 11 months) were interviewed twice—at the start of the program and approximately 3 months later. Interviews were conducted by classroom teachers as part of the CMIT professional development program. Interview results were used to produce a set of matched information for 10,075 children. Students with incomplete data for either of the assessments were excluded from the study. Figures 1 and 2 present the percentage of students in age groups achieving each stage of Early Arithmetical Strategy at the time of the initial and final interviews. It can be seen in both figures that the percentage of emergent and perceptual counters across age groups tends to decrease with a corresponding increase in counting-on and facile strategy use. More importantly, a comparison of strategy use at the initial interview (Figure 1) with that at the time of the second interview (Figure 2) shows significant improvement. In particular, the percentage of emergent stage students aged less than 5 years at the start of the program fell from 61% to 16% at the final interview. The rate of progression through the various stages is far greater than could normally be expected within this population.

White and Mitchelmore (2001) surveyed the Basic Skills Test (BST) results of 71 schools that had been implementing CMIT for two or more years. The BST are standardised tests in literacy and numeracy implemented in Year 3 and Year 5 across the state of NSW.

Figure 3 shows the overall mean z-scores on literacy and numeracy BST results for Years 3 and 5 from 1996–2001 for each of the 71 schools. The graph shows a clear upward trend in BST results for Year 3 numeracy. White and Mitchelmore (2001) concluded that the implementation of CMIT in NSW public schools had caused a definite improvement in Year 3 BST numeracy performance.

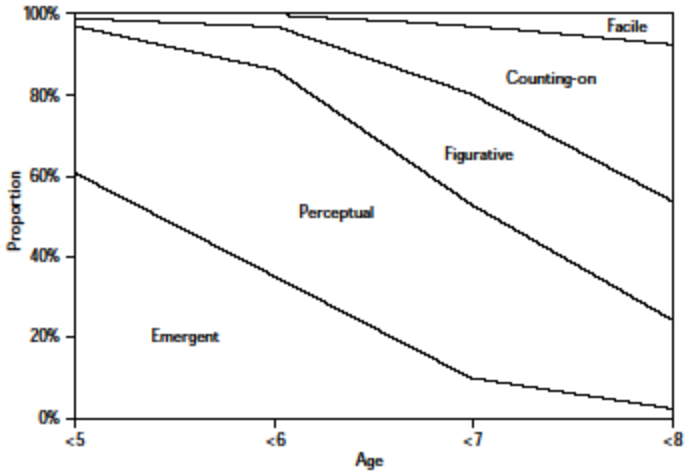

Figure 1. Strategy use by age on initial interview.

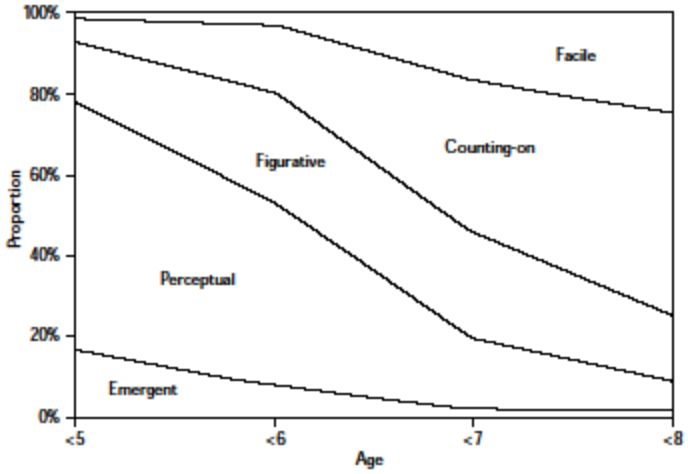

Figure 2. Strategy use by age on final interview.

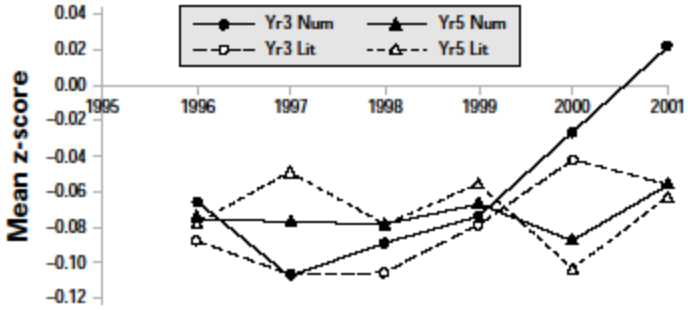

Figure 3. Mean BST scores of 71 schools 1996–2001.

Teacher data. Several studies have assessed the impact of various elements of CMIT on teachers. For example, Bobis and Gould (2000) investigated the anecdotal evidence provided by teachers in earlier reports more explicitly. Rather than relying on teachers' self-reports of changes to their knowledge, the study documented what knowledge changed, and how it changed, through the use of concept mapping and interviews with teachers. The study found that teachers' knowledge of pedagogy and children's cognition underwent a great deal of change, but the most significant change was to their knowledge of how children learn mathematics. While findings indicated little or no change had occurred to the mathematical content knowledge of teachers, it was evident that they started to see the connectedness of the different types of teacher knowledge, and how this knowledge impacted on the way they taught mathematics. For example, one teacher commented:

> I have learnt so much about how children learn and how it all links together. My knowledge links to what the children learn and how they learn. The strategies and the mathematical content-it is all interlinked.

The following points from an evaluation of the Stage 2 (Years 3 and 4) implementation of CMIT (Bobis, 2003) are indicative of previous findings concerning the impact on teachers:

- Generally, teachers' responses towards the overall impact of CMIT were very positive.
- High proportions (69.5%) of teachers involved in CMIT reported improvements to their attitude both towards mathematics and towards the teaching of mathematics.

- High proportions of the sample indicated that their understanding of how children learn mathematics (71.6%) and the way they taught mathematics (77.9%) had changed as a result of their involvement in CMIT.
- A smaller proportion of teachers indicated an increase or improvement to their mathematical content knowledge (48.3%) as a result of their involvement in CMIT.
- The most commonly cited changes to the way teachers taught mathematics included: more use of hands-on activities, increased emphasis on thinking strategies, reduced use of textbooks, and an increased use of ability groups.

Sustaining the Project

A determining factor in the long-term success of any professional development program is how it links to more comprehensive change. In 2002, a new *Mathematics K-6 Syllabus* (Board of Studies NSW, 2002) was released. This reshaped syllabus is closely aligned to the CMIT program. Like CMIT, the new syllabus emphasises the significance of mental computation and focuses on the development of increasingly more efficient thinking strategies. The introduction of standard pencil and paper algorithms has been delayed by around two years to accommodate the increased attention to mental computational strategies. Additionally, the expected level of number knowledge and counting skills for the early grades has been increased in line with CMIT outcomes.

An obstacle facing the implementation of CMIT in the past has been the perceived mismatch between the program's content and that of the syllabus. Having achieved close alignment with the syllabus, such an obstacle no longer exists.

Despite the mathematical content and focus on strategy development for mental calculation from CMIT being embodied in the new mathematics syllabus, the initial aims of the program are as relevant today as they were in the beginning. The improvement of learning outcomes and increasing teachers' knowledge of content, pedagogy, and how children learn mathematics are recognised as an on-going journey. While institutionalising much of the focus on students' solution strategies emerging from CMIT assists in aligning the program with syllabus implementation, other challenges remain. Issues of sustained teacher change and the generative growth of knowledge are challenges inherent in all aspects of professional development. Given the experimental research design of the CMIT model, revelations about new areas of content knowledge, namely fractions, have begun emerging since the new syllabus was released. New areas of knowledge such as this reinforce the need for professional development programs, such as CMIT, and the wealth of teaching support documents emerging from it, to continue.

The Victorian Early Numeracy Research Project

Background

The Victorian Early Numeracy Research Project (ENRP)[2] ran from January 1999 to February 2002 in 35 project ("trial") schools and 35 control ("reference") schools in the first three years of school (Prep to Year 2). It differed from CMIT in that it was conceptualised as a project that would inform ongoing programs and policy rather than an ongoing and evolving initiative.

The aims of the project included:

- to work with teachers to explore their beliefs and understandings about how students develop their understanding of mathematics in the early years of schooling, and how this could be supported through the teaching program;
- to evaluate the effect of the professional development program on student mathematical outcomes; and
- to describe effective practice in mathematics in the early years of schooling.

There were four main components of the ENRP:

- a research-based framework of *growth points* provided a means for understanding young children's mathematical thinking in general;
- a one-to-one, task-based, assessment interview provided a tool for assessing this thinking for particular individuals and groups;
- a multi-level professional development program was geared towards developing further such thinking; and
- case studies of particularly effective teachers and schools were conducted in the final year of the project, seeking to describe effective classroom practice.

Key Features of ENRP

Learning and assessment framework. The impetus for the ENRP was a desire to improve mathematics learning and so it was necessary to quantify such improvement. It would not have been adequate to describe, for example, the effectiveness of the professional development in terms of teachers' professional growth, or the children's engagement, or even to produce some success stories. It was decided to create a framework of key growth points in numeracy learning. Students' movement through these growth points in trial schools could then be compared to that of students in the reference schools, using statistical processes adapted by the team (e.g., Horne & Rowley, 2001).

[2] The Early Numeracy Research Project was supported by grants from the Victorian Department of Employment, Education and Training, the Catholic Education Office (Melbourne), and the Association of Independent Schools Victoria.

The project team studied available research on key *stages* or *levels* in young children's mathematics learning (e.g., Clements, Swaminathan, Hannibal, & Sarama, 1999; Fuson, 1992; Lehrer & Chazan, 1998; McIntosh, Bana, & Farrell, 1995; Wilson & Osborne, 1992), as well as frameworks developed by other authors and groups to describe learning. The Steffe and Wright work described earlier contributed significantly.

The decision was taken to focus upon the strands of Number (incorporating the domains of counting, place value, addition and subtraction strategies, and multiplication and division strategies), Measurement (incorporating the domains of length, mass and time), and Space (incorporating the domains of properties of shape, and visualisation and orientation).

Within each mathematical domain, growth points were stated with brief descriptors in each case. There are typically five or six growth points in each domain. To illustrate the notion of a growth point, consider the child who is asked to find the total of two collections of objects (with nine objects screened and another four objects). Many young children *count all* to find the total ("1, 2, 3, . . . , 11, 12, 13"), even once they are aware that there are nine objects in one set and four in the other. Other children realise that by starting at 9 and *counting on* ("10, 11, 12, 13"), they can solve the problem in an easier way. Counting all and counting on are therefore two important growth points in children's developing understanding of addition and exemplify the nature of the growth points. More information on the nature of the growth points and further examples are referenced elsewhere (Clarke, 2004; Clarke, Cheeseman, McDonough, & Clarke, 2003; Sullivan, Clarke, Cheeseman, & Mulligan, 2001).

One of the desired characteristics of the framework was that it needed to be in a form and language readily understood and, in time, retained by teachers. The aim was that teachers would use the framework as a kind of "lens" through which they could view interactions with children individually, in small group or whole class interactions, as well as during lesson planning.

In discussions with teachers, the team came to describe growth points as key "stepping stones" along paths to mathematical understanding. They provide collectively a kind of conceptual landscape (Fosnot & Dolk, 2001) or learning trajectory (Simon, 1995).

However, it is not claimed that all growth points are passed by every student along the way. For example, one of the growth points in addition and subtraction involves *count back*, *count down to* and *count up from* in subtraction situations, as appropriate. But there appears to be a number of children who view a subtraction situation (say, 12–9) as "What do I need to add to 9 to give 12?" and do not appear to use one of those three strategies in such contexts.

Also, the growth points should not be regarded as necessarily discrete. As with the CMIT framework, the extent of the overlap is likely to vary

widely across young children, and "it is insufficient to think that all children's early arithmetical knowledge develops along a common developmental path" (Wright, 1998, p. 702).

Task-based assessment interview. The one-to-one interview was used with every child in trial schools and a random sample of around 40 children in each reference school at the beginning and end of the school year (February/March and November respectively), over a 30- to 40-minute period. The disadvantages of pen and paper tests were well established by Clements and Ellerton (1995) and others, and these disadvantages are particularly evident with young children, where reading issues are of great significance. The face-to-face interview was an appropriate response to these concerns. The interviews were conducted by the regular classroom teacher in trial schools, and by a trained team of interviewers in reference schools. A range of procedures was developed to maximise consistency among the 70 schools.

Although the full text of the ENRP interview involved around 60 tasks (with several sub-tasks in many cases), no child was posed all of these. The interview was of the form of a "choose your own adventure" story, in that the interviewer made a decision after each task, as instructed in the interview schedule. Given success with the task, the interviewer continued with the next task in the given mathematical domain as far as the child could go with success. Given difficulty with the task, the interviewer either abandoned that section of the interview and moved on to the next domain, or moved into a detour designed to elaborate more clearly the difficulty a child might be having with a particular content area.

All tasks were piloted with children of ages five to eight in non-project schools, in order to gain a sense of their clarity and their capacity to reveal a wide range of levels of understanding in children. This was followed by a process of refining tasks, further piloting and refinement and, where necessary, adjusting the framework of growth points. The final interview was published by the Department of Education and Training (2001).

Professional development program. The professional development program occurred (formally) at three levels. The 250 or so teachers from trial schools met with the research team each year for around five full days, spread across the year. The focus of the meetings was on understanding the framework and interview, and on appropriate classroom strategies, content, and activities for meeting identified needs of their students. On four or five occasions each year, the teachers met in regional cluster groups for two hours, usually after school. Each cluster contained from three to five school teams. One member of the university research team was responsible for each cluster group. The focus of these meetings was to complement the central professional development. There was usually a time of sharing, during which teachers discussed readings or particular activities or approaches that they had tried since last meeting together. This was followed by the content focus for the day, and further tasks were set that needed to be

completed before the groups met again. The third level of professional development took place at the school and classroom level. School professional learning teams met every two weeks, and coordinators and members of the research team provided classroom support.

The cluster coordinator visited each school approximately three times per year, spending time in classrooms team teaching or observing, participating in planning meetings, jointly leading parent evenings, and acting as a "sounding board" for teachers, coordinators and principals. In addition, the Early Numeracy Coordinator at each school conducted weekly or fortnightly meetings of the "professional learning team" to maintain continuity, communication, team cohesion, and purpose.

Key Outcomes of the ENRP

Student data. The interview was conducted over 36,000 times, including two years of follow-up data in Grades 3 & 4 for children who were interviewed six times during the main phase of the project. This extensive data set provided the quantity and quality of reliable data on Victorian children's mathematical thinking that was previously unavailable to systems to inform curricula decisions. Table 1 provides data for the domain of addition and subtraction strategies for a variety of cohorts.

As shown in Table 1, over half of the Prep children arrive at school able to count all. Most of the rest gain this skill during the year, with nearly two-fifths of the students in trial schools counting on by the end of the Prep

Table 1
Percentage of Students Achieving Addition and Subtraction Strategies Growth Points Over Time (Prep to Grade 2 for Trial Schools, Grade 2 for Reference Schools)

Growth Points	Prep Mar 2000 (n = 1485)	Prep Nov 2000 (n = 1483)	Grade 1 Nov 2000 (n = 1262)	Grade 2 Nov 2001 (n = 1262)	Ref Grade 2 Nov 2001 (n = 296)
0 Not apparent	48	10	1	0	2
1 Count all	44	42	18	3	10
2 Count on	7	28	41	22	33
3 Count back/ down/up	1	8	16	14	16
4 Basic strategies	0	3	17	29	21
5 Derived strategies	0	0	6	31	18
6 Extending and applying	0	0	0	2	1

year. By the end of Grade 2, there was a considerable spread of student performance on these strategies. Given the percentage of students who successfully used derived strategies (e.g., build to next ten, related doubles) by the end of Grade 2, particularly in reference schools, there are important implications for the appropriateness and timing of the teaching of formal algorithms in the early years (see Clarke, 2004, for a discussion of these issues).

Reference school data for Grade 2 children show a quite different distribution across the growth points with, for example, 19% of children demonstrating derived strategies or better, compared to 33% for trial school children. Students in trial schools outperformed significantly (at the .05 level) children in reference schools, at every grade level and in every mathematical domain. To examine this further, Figure 4 presents the percentage of the trial school students at each growth point on addition and subtraction strategies over the four interviews. For each point in time, by looking vertically, the reader can determine the approximate percentage of children who are at each growth point. By moving from the bottom left to the top right of the graph, the reader gains a sense of how much time is spent relatively at each growth point.

Figure 4 shows the way in which children progress over time, but also indicates that some children remain at the lower growth points at the end of

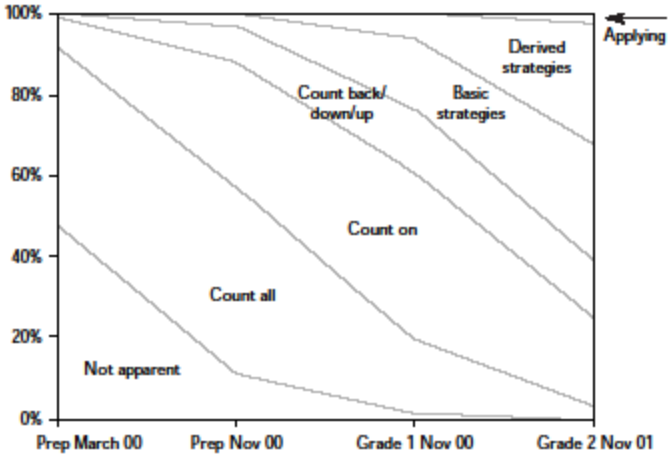

Figure 4. Trial school students (%) achieving Addition and Subtraction Strategies growth points over time.

Grade 2. The first three transitions all seem substantial. This is an important issue because it means that teacher awareness of such barriers or potential difficulties is an important prerequisite to facilitating student progress.

In 2000, teachers were also asked to comment on aspects of children's growth that they had observed which were not necessarily reflected in movement through the growth points. Although the research team had a great interest in cognitive growth as demonstrated by the response to interview tasks, growth can take other forms (e.g., productive disposition, as identified by Kilpatrick, Swafford, & Findell, 2001). It is important to document these other forms of growth.

Data from the 210 responses were categorised into themes. The five most common themes (in decreasing order of frequency) were the following:

- children are better at explaining their reasoning and strategies;
- children enjoy mathematics more, look forward to mathematics time, and expect to be challenged;
- the development of a "give it a go" mentality is evident, with greater overall persistence;
- children are thinking more about what they have learned and are learning; and
- all children are experiencing a level of success.

Teacher data. Given the clearly successful efforts of trial school teachers in developing children's mathematical skills and understandings in 1999 and 2000, it became important for the research project to study successful teachers' practice to try to discern those aspects of "what the teacher does" that make a difference.

All teachers facilitated growth in student learning over time, but the data for some teachers are particularly impressive. In 2001, the research team conducted detailed case studies of some of these teachers, as well as those school professional learning teams whose overall data are impressive (Clarke & Clarke, 2004). It should be emphasised that growth in student understanding was the main measure of success, not achievement at a given time. Although leadership and other school factors were of interest, the major focus of these studies was on what the teacher does in the classroom.

The ENRP had a significant impact on teachers' beliefs and understandings, in relation to their teaching of mathematics. In the final professional development session, teachers were asked to comment on how their teaching had changed due to their involvement in the ENRP. Two hundred and twenty teachers responded to the final questionnaire. These open responses were then grouped in themes. Six of the top ten themes or categories related to aspects of teachers' knowledge and beliefs. According to the teachers, as a result of their involvement in the ENRP they were more likely to:

- use growth points to inform planning (63 responses);
- use knowledge of individual understanding/better assess needs (49);
- challenge and extend children, and have higher expectations (42);
- have more confidence in teaching mathematics (28);
- enjoy mathematics more, have fun and make mathematics more interesting (27); and
- have greater knowledge of how children learn (24).

Teachers' specific responses reflected the importance placed on the knowledge and understandings that they had developed, and on how their beliefs, attitudes, and practices had changed. The growth points provided not only a way to discuss what the children already know but also the direction to move. The notions of trajectories of learning, or learning landscapes, are helpful here.

> Knowledge of mathematics must also be linked to knowledge of students' thinking, so that teachers have conceptions of typical trajectories of student learning and can use this knowledge to recognise landmarks of understanding in individuals. (Carpenter & Lehrer, 1999, p. 31)

Teachers in the ENRP gained the kinds of knowledge described above, and therefore developed a clearer picture of the typical trajectories of student learning, and a recognition of landmarks of understanding in individuals. Such a picture guided the decisions they made, in planning and in classroom interactions, as their knowledge of the understanding of individuals informed their practice.

In addition to these aspects of teachers' knowledge, a range of teaching strategies provided additional pedagogical tools, and it was the combination of these that appeared to empower the teachers. One teacher commented:

> [My teaching] hasn't changed that much but … I give children more time to think. I ask more relevant, thought-provoking questions. Some are even open-ended! Concrete materials are more prominent in my teaching. Most of all, the scenarios (through rich learning activities provided through ENRP PD) offered to children are more real and more interesting. Growth points and the interview have been great in identifying needs.

Some Concluding Comments

The requirement of teachers to participate in the assessment interviews meant that they were involved deeply in researching the understanding of their children, as individuals and as a group. Having access to data from a much larger group of students also enabled them to consider patterns or trends and to start to consider reasons for them. Ongoing assessment, and interviews in the latter part of each year provided an opportunity to evaluate the effectiveness of their teaching across different domains. This process

proved very powerful in teachers' own professional development. They increased their knowledge of how children learn mathematics in general, they had a much clearer picture of their own children's understanding, and they had a repertoire of teaching approaches to enhance this understanding.

The research team noted with considerable pleasure, particularly in the third year of the project, the increasing fluency of trial school teachers with mathematics education research terminology, and the willingness to engage in complex ideas over extended periods. It appears that the "shared language" about young children's learning, so evident among teachers in the context of literacy in Victoria, was becoming a reality in mathematics as well.

The Early Numeracy Interview and the framework of growth points now provide the basis of much of the professional development in mathematics in the early years in Victoria, both in pre-service (e.g., McDonough, Clarke, & Clarke, 2002) and in-service settings.

The New Zealand Numeracy Development Project

Background

The New Zealand Numeracy Development Project (NDP)[3] is a major government initiative in mathematics education. Much of the impetus for this initiative came from the results of the Third International Mathematics and Science Study [TIMSS] which showed that New Zealand students performed poorly in mathematics compared to those of other education systems (National Center for Educational Statistics, n.d.). New Zealand, like other western countries, responded to its poor TIMSS results by focusing attention on mathematics teaching and learning in schools, with a particular emphasis on numeracy. Teachers' pedagogical content knowledge as well as teaching quality and confidence were recognised as being important for ensuring optimal mathematics learning. *Understanding* mathematics (instead of the mindless application of rote procedures) was seen as a key aspect in the preparation of students to participate fully within a democratic society.

The NDP came about as a result of extensive work by the Ministry of Education, which included the development of a comprehensive numeracy policy and strategy, and several pilot projects that provided teachers with professional development in mathematics (Ministry of Education, 2001). The NDP sits within the context of the New Zealand Ministry of Education's Literacy and Numeracy Strategy and reflects the key themes of that strategy: clarifying expectations, improving professional capability and involving the community (Ministry of Education, 2002). The focus of the project has been on improving student achievement in mathematics by improving the professional capability of teachers.

[3] The Numeracy Development Project was funded by the New Zealand Ministry of Education. The views expressed in this paper do not necessarily represent the views of the New Zealand Ministry of Education.

The NDP was first implemented in New Zealand schools in 2001. Since then, approximately 300,000 students and 11,500 teachers in approximately 1450 schools have participated in the project. It is intended that by 2007, almost every teacher of Year 1 to 6 students, and most teachers of Year 7 and 8 students, will have had the opportunity to participate in the project.

The project has been informed by annual evaluation reports that have examined the impact of the project on students' mathematics learning, as well as exploring the experiences of numeracy facilitators/consultants, classroom teachers, and school principals. Findings from the evaluations indicate that the project has had a significant impact on the quality of teaching and learning in mathematics (Christensen, 2003; Higgins, 2003; Irwin, 2003; Irwin & Niederer, 2002; Thomas, Tagg, & Ward, 2003; Thomas & Ward, 2001, 2002).

Key Features of the Numeracy Development Project

The Number Framework. At the core of the NDP is the Number Framework which consists of a sequence of global stages describing the mental processes students use to solve problems with numbers (Strategies), as well as the key pieces of knowledge that students need to learn in order to be able to use strategies effectively (Knowledge). The Number Framework has been informed by research showing that there are identifiable progressions in how children develop number concepts (Cobb, Gravemeijer, Yackel, McClain, & Whitenack, 1997; Jones et al., 1996; Steffe, 1992; Wright, 1998; Young-Loveridge & Wright, 2002). The framework has evolved since the 2001 implementation of the project, in response to student achievement information and feedback from project personnel and teachers. The Number Framework gives teachers "direction for responding effectively to children's learning needs" (Higgins, Parsons, & Hyland, 2003, p.166).

The Strategy section of the Framework consists of nine stages. The first five stages (0 to 4) focus on counting, with each stage involving increasingly sophisticated counting skills. The Framework begins with the Emergent stage (0), at which there is no counting, and progresses through counting a single collection (1), counting from one to join two collections of objects (2), counting from one mentally to solve addition/subtraction problems (3), to counting on to solve addition/subtraction problems (4). The four upper stages of the framework involve the use of increasingly complex *part-whole* strategies. These strategies are based on using knowledge of number properties to break numbers apart (partitioning) and recombine them in ways that make the problem solution easier. The first of the part-whole stages is Early Additive (5) involving a limited number of partitioning and recombining strategies, whereas the Advanced Additive stage (6) involves choosing from a wide range of strategies for solving addition and subtraction problems. The Additive part-whole stages are followed by the Advanced Multiplicative stage (7), in which the strategies chosen are for solving multiplication and division problems, and the Advanced Proportional stage

(8) for solving problems involving fractions, proportions, and ratios. Each of the nine stages contains three operational domains: addition and subtraction, multiplication and division, and proportions and ratios.

The Knowledge section describes the key items of knowledge that students need to learn, including numeral identification, number sequence and order, grouping and place value, basic facts, and written recording. The two sections are viewed as interdependent with "strategy creating new knowledge through use, and knowledge providing the foundation upon which new strategies are built" (Young-Loveridge & Wright, 2002, p. 722). It is considered important that students make progress in both sections concurrently:

> Strong knowledge is essential for students to broaden their strategies across a full range of numbers, and knowledge is often an essential prerequisite for the development of more advanced strategies (Ministry of Education, 2004, p 1).

The diagnostic interview. Another key factor in the success of the NDP is the diagnostic interview, an individual task-based interview designed to provide teachers with valuable information about their students' knowledge and mental strategies, and aligned with the Number Framework (Higgins et al., 2003).

The most recent version of the diagnostic interview (the Numeracy Project Assessment tool, or NumPA) has three overlapping forms at different difficulty levels. The teacher determines the appropriate form to use for each student, following his/her response to the "strategy window questions". Using the NumPA tool, teachers can develop for each student a number profile that has two main components: operational strategies (addition & subtraction, multiplication & division, proportions & ratios), and number knowledge (forwards & backwards number-word sequences, numeral identification, knowledge of fractions, decimals, percentages & basic facts, and understanding of place value).

Teachers participating in the project are expected to assess their students using the diagnostic interview on two occasions. The first is near the beginning of the project (after completing the professional development workshop on the use of the NumPA tool), and the second is at the conclusion of the project (after at least 15-20 weeks of the teaching program). Teachers are shown how to use information from assessments such as the diagnostic interview to make decisions regarding learning experiences necessary for students, both individually and in groups. Copies of the interview are available on the New Zealand Mathematics website (Ministry of Education, n.d.).

The professional development program. A third key factor in the success of the project is the professional development program, which requires the participation of the whole school over a one to three year period, and is predominantly situated in the classroom. The professional development approach adopted was informed by research that identified key elements of

effective programs (e.g., Clarke & Cheeseman, 2000; Fullan & Hargreaves, 1992; Stephens, 2000). The recommended teaching model builds on a simplification of the theoretical models for the growth of students' understanding developed by Pirie and Kieran (1989) and the research of Fraivillig, Murphy, and Fuson (1999) which describes a framework for extending students' mathematical thinking. The project is delivered by a team of expert numeracy facilitators/consultants who have demonstrated expertise in mathematics curriculum, assessment, and pedagogy. Each full-time facilitator/consultant works with approximately 90 teachers, tailoring a series of workshops and in-class visits to meet the needs of individual schools and teachers in a particular cluster. The in-class visits by the facilitator/consultant provide feedback and support to the teacher in their implementation of the project.

Key Outcomes of the NDP

The impact of the project has been closely monitored through tightly focused evaluations conducted annually with each version of the professional development program for a particular age-group of students and medium of instruction (Christensen, 2003; Higgins, 2003; Irwin, 2003; Irwin & Niederer, 2002; Thomas, Tagg and Ward, 2003; Thomas & Ward, 2001, 2002). The outcomes of the project include quantitative data on student achievement, and qualitative data on teacher capability.

Student achievement. Data from the NumPA interview have been collected for more than 300,000 students since 2000. This extensive data set provides valuable information about what constitutes reasonable expectations for student achievement and progress at particular year levels. The following overview reports data from over 73,000 Year 0 to 3 students. Table 2 presents the percentage of students at each stage on the strategy section of the Framework, at the initial and final interviews. A comparison of the initial and final data for each year level shows significant improvement. For example, the percentage of Year 2 students at the advanced counting stage or higher increased from 23% to 55%. The percentage of Year 3 students at the early additive part-whole stage or higher increased from 14% to 39%.

Other findings related to the student achievement data include:

- All students benefited from participation in the NDP, regardless of ethnicity, gender, and socio-economic status.
- Asian and European/Pakeha students began the project at higher stages on the Number Framework, and benefited more from participation in the project, than did students of Maori and Pacific Islands descent.
- Girls who began the project at lower framework stages appeared to make slightly better progress than boys who began at the same stage, but the opposite pattern was found at higher framework stages, with more boys progressing to a higher stage than girls.

- Students at schools in high socio-economic areas started the project at higher framework stages, and made larger gains over the course of the project, than did students at schools in low and medium socio-economic areas.
- Ethnicity, gender and socio-economic status had a combined effect on students' performance and progress. For example, being of Maori or Pasifika descent, being a girl, and attending a school in a low socio-economic area, was more disadvantageous than any one of those factors on its own.
- Analysis of the patterns of progress showed that even when starting point was taken into account, European/Pakeha and Asian students made greater progress on the Number Framework over the course of the project than did Maori or Pasifika students. Hence the project did not narrow the "achievement gap" as hoped but, instead, widened the gap slightly.

The NDP appears to have had a positive impact on students' mathematics achievement generally, not just on their number skills. This was evident in students' performance on tasks from the TIMSS study, which was better than that of their same-age peers in 1995, indicating that the project is doing more than simply accelerating students on the Number Framework.

Table 2
Percentage of Students at Each Stage on the Number Framework as a Function of Project Status (Initial or Final) and Year Level over 2002 and 2003.

Year level	0-1 (n = 20,207)		2 (n = 25,435)		3 (n = 27,908)	
Project Status	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
0 Emergent	20.1	4.0	4.7	1.1	2.0	0.6
1 One-to-one counting	28.8	10.9	12.8	2.7	5.0	1.0
2 Counting from one on materials	40.7	44.4	44.6	21.7	21.6	7.1
3 Counting from one by imaging	7.0	20.3	14.6	18.4	11.6	8.5
4 Advanced counting	3.2	18.5	21.0	43.1	46.2	43.5
5 Early additive part-whole	0.1	1.9	2.2	12.4	12.7	34.7
6 Advanced additive part-whole	0.0	0.0	0.0	0.6	0.9	4.6

Teacher data. The professional development program was positively received by participating teachers, principals and facilitators in each year of the project since 2001. The teachers have reported developments in their professional knowledge as a result of their involvement in the project, and have noted changes in their classroom practices to accommodate their new knowledge and understandings (Thomas & Ward, 2001, 2002). They also noted increases in confidence and enthusiasm for mathematics teaching (Higgins, 2003; Thomas & Ward, 2001, 2002).

Sustaining the Project

The project is now focused on investigating issues related to the consolidation and maintenance of gains made within the project since its initial implementation. Aspects that are now being incorporated into the project include:

- the establishment of Numeracy Lead Teachers in each school;
- building communities of professional practice both within and outside the school context;
- aligning school management and classroom practice; and
- providing ongoing access to support from outside the school through, for example, facilitators' visits and access to online resources.

Concern about meeting the needs of teachers and students in remote and rural schools, as well as the issue of teacher mobility led to the development of a new (web-based) version of the professional development program which was trialed in 2003. The success of this web-based facilitation model led to its expansion in 2004 as a strategy for addressing a range of issues. In addition to this web-based resource, a web-based program for developing the professional practice of Numeracy Lead Teachers is to be trialed in 2004.

Common Themes and Implications

In this article, key components of three innovative and successful research and professional development programs in New Zealand and Australia have been outlined. The background contexts of the programs have been described, as have their key components.

It could be argued that most research in children's mathematical learning until the 1990s could be categorised as either large *n* and small *d* or small *n* and large *d*. By this, we mean that either the research involved large numbers of subjects, but the information gained on them was not particularly deep, or alternatively a considerable amount of information was gained about a small number of subjects. A feature of these three programs is that large numbers of students and teachers were involved, and yet the depth of the information on student learning and teacher growth was considerable. We now know so much more about what young children know

and can do, and this information is already informing curriculum documents and classroom practices in New Zealand and Australia.

Although there are subtle but important differences between the programs in the grade level focus, the number of schools involved, the advocacy or otherwise of ability grouping, and the level of implementation across the three programs, several common features will be evident to the reader. These commonalities will now be discussed, as will the implications of these programs for other states, countries, and school systems that are considering implementing professional development and research programs in mathematics in the early years of schooling and beyond.

The Development and Use of Research-based Frameworks

The programs drew upon research in young children's mathematical learning to describe key stages or growth points in such development. Initially, the focus tended to be on the number domains, possibly for two reasons: the perceived importance of number in the curriculum, and the extent of the research base in this area (Kilpatrick, Swafford, & Findell, 2001).

In the case of number learning, the seminal work of Steffe and his colleagues provided a basis for these programs, and this has been complemented by the work of key researchers in Australia and New Zealand, such as Mulligan, Wright, and Young-Loveridge. In each program, the learning frameworks focus on a progression of increasingly sophisticated strategies in the particular mathematical domains. It is clear that, over time, teachers internalised and "owned" these frameworks, which provided a "lens" by which interactions with individuals, small groups and the whole class could be viewed.

The Use of Task-based, One-to-one Assessment Interviews

In New Zealand and Australia, the teaching of literacy in the early years of schooling has been characterised for a number of years by teachers working with individuals to assess their progress in reading. Count Me In Too in NSW was the first major systemic approach in Australia to provide an emphasis on the power of the assessment interview in numeracy. Increasingly widespread agreement on the limitations of pencil and paper testing in mathematics (e.g., Clements & Ellerton, 1995), particularly in the early years when issues of reading are particularly important, provided part of the impetus for the use of interviews with young children in mathematics.

Projects elsewhere, such as Cognitively Guided Instruction (Carpenter, Fennema, Franke, Levi, & Empson, 1999), also emphasised the benefits of sharing research with teachers, in a form that could be readily related to their classroom practices. Although one-to-one interviews are clearly demanding of teacher time, and therefore financially expensive, the experiences of teachers in these three programs have indicated that the benefits are considerable in terms of creating an understanding of what children know

and can do in mathematics in general terms and for the teacher's own students, and in informing planning. The frameworks and interviews have also assisted to move the focus of professional development from the notion of children carefully reproducing taught procedures to an emphasis on children's thinking, with teachers as researchers.

Ongoing, Reflective Professional Development

We have known for a long time that the "one-shot" professional development program has little long-term effects (e.g., Clarke, 1994; Owen, Johnson, Clarke, Lovitt, & Morony, 1988). All three programs are based on a longer-term view of teacher growth and a view of teachers as reflective practitioners (Doyle, 1990; Schon, 1983) who can take research information from external sources and from their own children, reflect on it with colleagues, and make adjustments to planning for individuals and groups, with this iterative process continuing over an extended period of time. In this way teachers are viewed as "sense makers" constructing meaning in a social context, in the same way as their students do in their classrooms (Hiebert et al., 1997).

Another important feature of the professional development in these initiatives is the focus on whole school professional development, where the whole staff, at least for the relevant grade levels, is involved. Of course, it is not always the case that a program developed on a relatively small scale retains all of its key features when implemented more broadly. For example the Victorian ENRP (involving 70 schools) had this whole school focus, with all teachers involved in five days of central professional development each year. The implementation of the Victorian Early Numeracy Program by the Department of Education and Training, however, subsequently involved a "train-the-trainers" model, in which numeracy coordinators participated in a professional development program and were then expected to train the staff back at their schools. Such train the trainers programs can lead to a watering down of the professional development received by initial participants, with likely impacts on teacher professional growth and student learning.

Changes in Student Achievement

In each program, there are clear data showing that the knowledge and understanding of young children have been enhanced by the involvement of teachers and schools in the programs, and that such changes have persisted over time. These changes also have implications for curriculum and teaching in the middle and upper primary school. One such aspect is the traditional emphasis on the teaching of algorithms, which can have a negative impact on young children's thinking and number sense (e.g., Narode, Board, & Davenport, 1993).

Changes in Teacher Knowledge and Practice

For each program, evaluation data show that teachers identify considerable personal professional growth in their knowledge of children's learning in mathematics, and an understanding of how such growth can be facilitated. Teachers also commented on the growth in their personal mathematics understanding, and a greater sense of the connectedness of this understanding (Hiebert & Carpenter, 1992). Shulman (1986) claims that thinking properly about content knowledge "requires understanding the variety of ways in which the basic concepts and principles of the discipline are organized to incorporate its facts" (p. 9). This organization is important, for as Brophy (1991) indicated:

> Where (teacher) knowledge is more explicit, better connected, and more integrated, they will tend to teach the subject more dynamically, represent it in more varied ways, and encourage and respond fully to student comments and questions. Where their knowledge is limited, they will tend to depend on the text for content, de-emphasize interactive discourse in favor of seatwork assignments, and in general, portray the subject as a collection of static, factual knowledge. (p. 352)

Increased confidence in teaching mathematics and an enthusiasm for doing so are other important consequences of these projects. In terms of teaching practice, common themes include a greater focus on children's thinking, the greater use of hands-on approaches, and a capacity to cater more appropriately for the range of understanding evident in their children.

Conclusion

The experiences of these three Australian and New Zealand projects indicate that research-based learning frameworks, together with carefully-constructed interview tasks, embedded in whole-school professional development programs that view teachers as researchers who reflect on the results of their teaching actions and their observations of children, provide important ingredients in developing confident and capable mathematics learners in the early years of schooling.

> The teacher's role will no longer be to dispense "truth" but rather to guide the student in the conceptual organization of certain areas of experience. Two things are required for the teacher to do this: on the one hand, an adequate idea of where the student is and, on the other, an adequate idea of the destination. (von Glaserfeld, 1987, p. 16)

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