



Pre-primary Early Number Fun Programme and Resource Kit: Discussion document

South African Numeracy Chair Project, Rhodes University

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The SANC Project Early Number Fun Programme

This programme is designed as a community of Grade R teachers from 10-12 local schools who meet on a monthly basis to engage with issues around developing number concepts in pre-school learners. The focus on the development of a well functioning and supportive teacher community is based on the assumption that teacher learning is greatly enhanced through active participation in ‘communities of practice’ and is informed by Wenger’s sociocultural theory of learning in communities of practice (Wenger, 1998). This aligns well with current SA teacher education policy that foregrounds the importance of localised teacher communities for enabling professional development (DBE, 2015).

The programme will be co-ordinated by the SANCP team, namely Prof Mellony Graven, Dr Debbie Stott and Ms Carolyn Stevenson-Milln and will emphasise relationships with teachers as partners in the endeavour to find ways to strengthen Grade R learning. The SANCP team will contribute research informed resources, ideas and access to professional networks while teachers will contribute critical contextual knowledge and experience of working with learners in local and diverse school contexts. Furthermore the programme will draw on expertise from a range of Grade R practitioners with experience in teaching, lecturing and/or researching early pre-school learning to lead and participate in sessions.

At the heart of the programme will be a research informed ‘*early number fun resource kit*’. This kit will be provided to all fully participating teachers for use in class. This kit will contain a wide range of resources such as dominoes, dice, flash cards, bead strings, number-story books, posters and so forth. Multiple sets of the resources will be provided for individual and/or paired learner use in classrooms.

In addition, the programme will pilot a parent/caregiver programme that focuses on use of a simplified resource kit at home. In this respect Grade R parents of a participating school will be invited to teacher-parent/caregiver sessions at which ways to use the resources at home will be shared. It is envisaged that two such sessions will occur in the pilot with the Grade R parents in 2016. The second is likely to be connected to a ‘family math’ event, which have already been piloted and used successfully in Grahamstown schools and after care centres. Depending on the success of the pilot programme this parent component would be extended to other willing participating schools. [In Wenger’s terms (1998) such a kit can serve as a powerful ‘boundary object’ that provides common ground for engagement between researchers/academics and teachers, and teachers and parents/caregivers.]

Early Number Fun Programme: theoretical and conceptual ideas informing the development programme

A number of theoretical, conceptual and curriculum informed ideas influenced the development of the programme. Each of these is described below.

Broad theoretical assumptions

Working with both Vygotskian theory and socio constructivism the programme is based on the following assumptions:

- Language is key to development and learning.
- Learners will learn number sense through actively constructing number knowledge through engaging with activities in social settings.
- Learning takes place in the Zone of proximal development (ZPD) defined as:

The distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky, 1978, p. 86)

Essentially this means that activities should be targeted to an appropriate level of learner development such that activities are neither too difficult nor too easy for the learners and activities should involve active engagement and encourage dialogue with learners. According to Wright, Martland, Stafford and Stanger (2006) activities should be at the ‘cutting edge’ of learner development. In this way learning leads development.



South African CAPS map for early numeracy

The Grade R CAPS document provides a map for emergent numeracy (numbers, operations and relationships) as follows. Within the context of everyday life, of note is the emphasis on the development of comparative language, counting - both forward and backwards as well as adding and subtracting to 10 orally.

	TERM 1	TERM 2	TERM 3	TERM 4
Number concepts CAPS p. 41-45	Count objects (up to 5); count in 1s; identify symbols (1) and names (one); ages; daily attendance register; comparative language (e.g. bigger, smallest; many); orders collections from smallest to biggest and vice versa; ordinal numbers (up to 3rd)	Count objects (up to 7); count in 1s; counting forwards & backwards (up to 4); identify symbols (up to 4) and names (up to four); house numbers & address; daily attendance register; comparative language (e.g. more than, equal to); ordinal numbers (up to 4th)	Count objects (up to 10); count in 1s; counting forwards & backwards (up to 7); identify symbols (up to 7) and names (up to seven); home telephone numbers; daily attendance register; comparative language (e.g. more than, most); ordinal numbers (up to 5th)	Count objects (up to 10); count in 1s; counting forwards & backwards (up to 10); identify symbols (up to 10) and names (up to ten); home numerical info; daily attendance register; comparative language (e.g. more than, most); ordinal numbers (up to 6th)
Adding and subtracting (CAPS p. 46-47)		Adding and subtracting to 4 (orally)	Adding and subtracting to 7 (orally)	Adding and subtracting to 10 (orally)

Integrated curriculum

The integrated nature of teaching in pre-primary classrooms means that learning about number takes place alongside other learning in everyday contexts, with connections to the children's lives in meaningful ways and builds on a child's natural curiosity. Treffers (in van den Heuvel-Panhuizen, 2008) talks of watching out for "golden moments" of opportunity" (p. 42).

While the focus of this programme is on supporting learners in developing competence and confidence in working with numbers this focus is connected to the integrated learning curriculum and thus includes activities that support language and literacy development. The inclusion of 'number' story books and storytelling story boards further emphasises integration across the curriculum.

Number Sense

Dehaene (1997) defines "number sense" as a short-hand for our ability to quickly understand, approximate, and manipulate numerical quantities. According to Anghileri (2006) a child with number sense has the ability to work flexibly with numbers, observe patterns and relationships and make connections to what they already know, to make generalisations about patterns and processes. Number sense also includes a positive attitude and confidence (Anghileri, 2006)

The goal is to to begin the development of pre-primary learner's number sense – developing a feeling for numbers and to come to enjoy working with them, the ability to give meaning to numbers and numerical facts in everyday life and to deal with them appropriately (van den Heuvel-Panhuizen, 2008 p. 21).

In the context of early number sense in pre school learners the development of number sense primarily includes the ability to count both verbal number sequence (forwards and backwards) and sets of objects (up to ten), recognise numerals 1-10, and developing the capability to operate (adding and taking away) on small numbers (orally and through modelling).

Narrative approaches to working with number

The use of number stories for getting learners to actively engage with and imagine ways of working flexibly with numbers is a key part of the resource kit. Using stories is a widely promoted pedagogic strategy for language and literacy development across contexts. This programme emphasises a narrative (story) approach for developing number sense. Here we draw on Roberts & Stylianades (2013) work that uses 'narrative' as stories whereby several narratives (distinct stories) can be made up from a single story context. Thus in the resource kit there are therefore 'number' stories, which encourage learners to do imitative reading and provide resources for acting out and telling the stories (such as acting out with bundles of sticks or showing the story unfolding on a story board with moveable characters e.g. 5 people, 5 cows). Dialogic reading – 'a method of reading to children characterized by numerous opportunities for the child to engage in conversation with the reader' (Blair & Raver, 2014, 725) is promoted as well as and paired imitative reading (Bodrova & Leong, 2016). Both these forms of reading are shown to improve learner cognitive control discussed below.

Pattern, space, shape, measurement and data handling

Mel, perhaps this is where we should put in some info about these.. may need to find a ref or two. I will look..

Supporting Learner Cognitive Control

A wide range of neurocognitive research shows that learners' cognitive control (also referred to as executive functioning EF) is more strongly associated with school readiness and has greater influence on learners' school performance than their IQ score (e.g. Diamond et. al, 2007), especially in mathematics (Roebbers et al. 2012). Furthermore, particularly learners in poorer communities need early support to develop such cognitive control because many of these learners have had fewer opportunities for the development of such control. The ages 4-6 yrs have been identified as particularly important ages for focused support of EF as this is the window where marked improvements tend to occur (Rothlisberger et al., 2011).

Learner executive functioning (or cognitive control) is used to assess school readiness. This involves 3 main components of:

- Working memory: ability to maintain and manipulate information over a brief period of time
- Inhibition (interference control): ability to suppress a dominant or automatic response
- Shifting attention (flexibility): ability to shift attention from one aspect or mental state to another (so for example from sorting shapes according to colour to sorting according to shape or size – this also involves inhibition as one must suppress earlier mental state to work flexibly with a different state (Garon et al., 2008; Diamond et al., 2007)

In our programme we will use a series of short sharp focused activities (many games) to help learners develop each of these. These have been shown by researchers to support EF and cognitive control if used regularly. Three key examples to illustrate are:

- Working memory - Objects on a plate memory game – cover how many can the learner recall
- Inhibition – Simon says game (only do it when Simon says do this not that)
- Shifting attention – sorting objects game in different ways (from colour, to size to shape).

Physical activity games such as Simon says and musical statues are shown have a particularly positive effect on the aspect of inhibition (Jager et al., 2015). Additionally imitative reading and dialogic reading support the development of these three EF aspects (Blair & Raver, 2014). The development of the above three executive functions however also depends on learner emotions, motivation and learning dispositions discussed below.

Growth mindsets, productive dispositions

A mindset is a belief about yourself and your most fundamental qualities like ability, faith, personality, political views, talents etc. People with *fixed mindsets* believe that fundamental qualities like intelligence are essentially stable: they don't change much over time. People with *growth mindsets* believe that these qualities are growable: they can change and flourish and wither in others (Hymer & Gershon, 2014).

Dweck (2006) states that if a belief that your qualities are carved in stone (a fixed mindset), creates an urgency to prove yourself over and over, where every situation calls for validation of your character, personality or ability. The growth mindset works from the basis that your basic qualities are the starting point for development, which can be cultivated through your efforts.

A fixed mindset makes you concerned with how you'll be judged; the growth mindset makes you concerned with improving (Dweck, 2006 p.13).

Kilpatrick et al. (2001) use the term productive disposition to describe a particular attitude towards learning mathematics:

Productive disposition refers to the tendency to see sense in mathematics, to perceive it as both useful and worthwhile, to believe that steady effort in learning mathematics pays off, and to see oneself as an effective learner and doer of mathematics (p. 131).

In our programme, our focus is on combing these ideas to help teachers develop growth mindsets and productive dispositions in their learners by encouraging effort, perseverance, persistence, sending messages about process and growth and that making mistakes are opportunities to learn. 'Mistakes are our friend because we learn from them!'

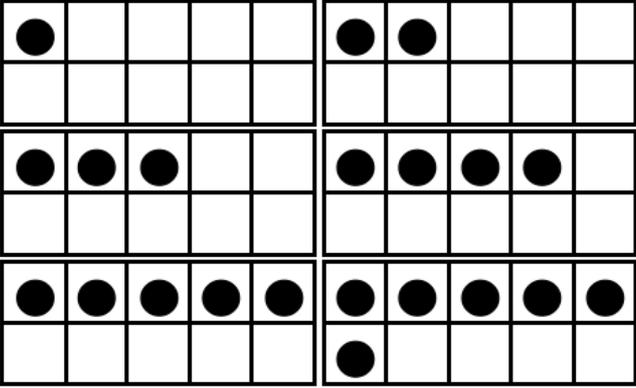
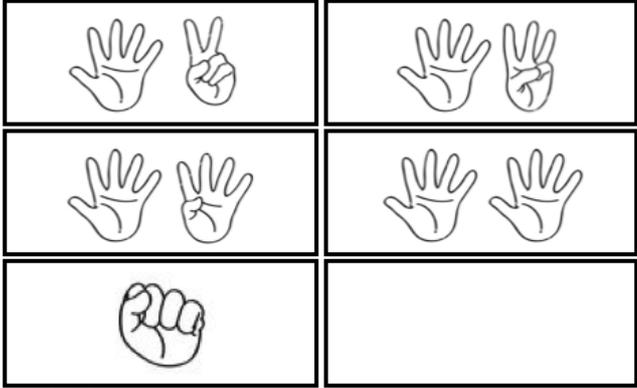
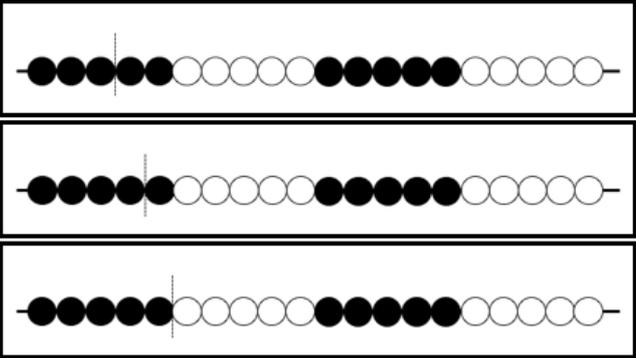
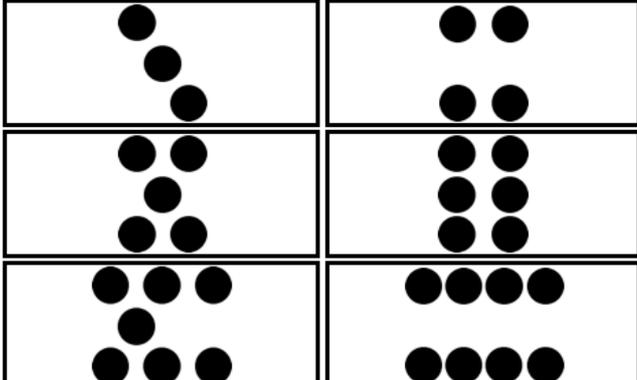
Emergent Numeracy and Growing Number Sense (trajectories & progression)

This programme draws on a wide range of numeracy research particularly the work of both Buys and Treffers (in van den Heuvel-Panhuizen, 2008) in learning-teaching trajectories related to whole number and the following elements of number sense. Everyday life, and the world that the child lives in, provide meaningful contexts for learning. *Emergent numeracy* is the starting point with the anticipation that this will form the foundation knowledge for *growing number sense*.

Emergent Numeracy (p. 25) 	Growing Number Sense (p. 31)
Recognising “two-ness”, “three-ness” and “many-ness” as a property of a group of objects	Recognising different functions of number in everyday life and learn to distinguish and connect them. Magnitude, order, measure, label and calculate <i>Progressing from:</i> Learning to count To Learning to count-and-calculate To Context-bound counting-and-calculating To Object-bound counting-and-calculating To Pure counting-and-calculating via symbolisation
Learning to recall the number sequence	Counting: Know the counting sequence at least up to 10 (magnitude and label)
Imitating resultative counting	Arrange numbers in the correct order, make reasonable estimates and compare quantities as being more, less or equal (magnitude and order)
Symbolising by using fingers	Represent physical numbers up to 10 on their fingers and with lines and dots Elementary calculation: Select a suitable strategy for simple addition and subtraction situations for up to 10 objects using these skills (calculate)

Key Representations

Fingers, dot patterns, linear model (bead string), 10-frame, concrete items (counters, blocks etc.) These representations emerge from the broader research literature and are particularly prevalent in the work of Buys and Treffers and in Wright et al.'s work.

5 and 10-frames	Finger patterns
	
Bead strings	Dot patterns
	

Key user-friendly terms and phrases

Throughout sessions and in working with materials the ENF CoP we will develop commonly understood phrases that capture key concepts and aspects pertinent to reflecting on early number learning and ways to mediate this learning. Locally adapted phrases and terms will be encouraged to support common understanding. So for example the term ‘work off the decuple’ is used in research as a phrase to describe using 10 to help solve for example $8+5$ (by going first from 8 to 10 then $+3$) but has also been referred to as working with friendly numbers (e.g. where 10 and 20 are friendly numbers). The latter is likely to be preferred by teachers.

Ongoing research and monitoring of the effectiveness of the program

The SANC is tasked with searching for sustainable solutions to the challenges faced in primary mathematics education through quality research and monitoring of the effectiveness of programs implemented. It is thus within our funding imperative to research our own practice and teacher and learner experiences of our

programs. Thus teacher questionnaires, interviews, classroom observations/videos, and so forth will be part of the program. However, each teacher, or learner, will have the right to choose not to participate in this research. In this respect each participant will be asked if they are willing to participate in the research and individual signed permissions will be sought (in the case of learners, parent/caregiver permission will be sought).

Early Number Fun Programme: development programme overview

Participants

Grade R teachers from participating SANC project schools (maximum 13 schools)

Timescale

In 2016, the programme will run monthly over a six-month period from April 2016 to September 2016. In 2017 the program will similarly run monthly from February/March 2017 to September 2017.

Sessions will run from about 1pm to 4pm at Rhodes University.

See the detailed schedules on the pages below.

Resources

Teacher resources (and following the pilot possibly family resources) will be provided at the sessions in a kit format. These are detailed on the following pages.

Teacher support for travel

Teachers will be reimbursed for their travel to and from sessions.

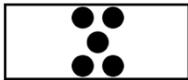
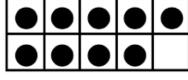
Snacks and refreshments

Snacks and refreshments will be provided at each session.

Teacher Resources

Pedagogic / dispositional resource	Activity-based	Physical games and verbal activities	Assessment	Other
Teachers handbook Growth mind set – classroom posters Listening and concentration activities	Dice sets Domino sets 5 & 10-frames ¹ Bead strings * Various laminated activities Various laminated flash and learner cards [#] Unifix blocks Laminated number line Popsicle sticks Counters Various illustrated maths story books and activities	Rhymes Songs Hopscotch Etc.	Assessment tasks Assessment checklist	Egg box (5 x 1) Egg box (5 x 2) Paper plates Prestick White board markers Cleaning cloth

Teachers laminated cards

Flash cards	Cards with illustrated books and story boards	Wall cards
0 to 10 for each representation: Dot patterns  Finger patterns  10-frame  Bead string  Numeral and number word	More / less Big / small Number words 0 – 10 Numerals 0 – 10 Cows Fish Dragonflies Flies Chickens People Ducks	0 to 10 with: Dot pattern, numeral and number word 

¹ Teacher and learner versions

[#] See table below

Family Resources in giant ziploc x 25 packs

3 dice (1 big / 2 small)	5 toilet rolls	Flash cards: Dot patterns Fingers
1 pack cards	Strip 5 monkeys	
1 set plastic dominoes	Cheap box wax crayons	
2 books (Monkeys / Sticks) 1 set more/less cards	Little sellotape / strip of prestik	
1 bead string		
20 popsicle sticks		

6-month development schedule 2016

Session timetable	Session One (2016)	Session Two (2016)	Session Three (2016)	Session Four (2016)	Session Five (2016)	Session Six (2016)
Event	Teacher workshop, once a month 1pm-4pm (19th April, 17th May, 14th June, 19th July, 23rd August, and 20th September)					
Overview	Orientation <ul style="list-style-type: none"> • Programme overview • Resource box • Concentration and calming activities • Growth mindset and ways to praise • Assessment for progression • Wolfie time game 	Based on assessment feedback: <ul style="list-style-type: none"> • activities and resources for: <ul style="list-style-type: none"> ◦ 2-ness; 3-ness and many-ness ◦ counting progression Story books <ul style="list-style-type: none"> • general aims and rationale • how to use storybooks • extensions for storybooks • learner story boards and how to use them 	<ul style="list-style-type: none"> • Working with 5 frames • Numeral recognition • More less and ordering amounts least to most 	<ul style="list-style-type: none"> • Working with dot patterns (dice and dominoes) • Numeral recognition 	<ul style="list-style-type: none"> • Working with linear models – bead strings and unifix blocks • Numeral recognition 	<ul style="list-style-type: none"> • Connecting linear models with measurement of everyday items • Water and sand play
Concentration and calming activities	<ul style="list-style-type: none"> • Simon says please 	<ul style="list-style-type: none"> • Memory game with children's objects 	<ul style="list-style-type: none"> • TBA 	<ul style="list-style-type: none"> • TBA 	<ul style="list-style-type: none"> • TBA 	<ul style="list-style-type: none"> • TBA
Executive function activities		<ul style="list-style-type: none"> • Freeze game 	<ul style="list-style-type: none"> • Shape sorting 	<ul style="list-style-type: none"> • TBA 	<ul style="list-style-type: none"> • TBA 	<ul style="list-style-type: none"> • TBA
Resources	<ul style="list-style-type: none"> • File, plastic folder & handbook • Assessment checklists • Coloured plates • Pegs • Big dice • Pencil bag and pens • Mindset poster: 1 • Executive functioning activities • Resources for making masks 	<ul style="list-style-type: none"> • Plastic folder & handbook • 2 x story books, cards & handbook • 1 x story board • Popsicle stick bundles • Flash cards • Mindset poster: 2 • Executive functioning activities • Resources for making puppets 	<ul style="list-style-type: none"> • Plastic folder & handbook • 2 x story books, cards & handbook • 1 x story board • 5-frame resources • Counters • Mindset poster: 3 • Executive functioning activities 	<ul style="list-style-type: none"> • Plastic folder & handbook • Dot pattern resources • Dice sets • Dominoes • Mindset poster: 4 • Executive functioning activities 	<ul style="list-style-type: none"> • Plastic folder & handbook • Bead strings • Unifix blocks 	<ul style="list-style-type: none"> • TBA
Parent programme	<ul style="list-style-type: none"> • Only pilot with one school in 2016 		<ul style="list-style-type: none"> • First pilot parent session after this workshop 		<ul style="list-style-type: none"> • Second pilot parent session after this workshop 	<ul style="list-style-type: none"> • 'family math event' at end of year and to gather parent feedback

6-month development schedule 2017

Session timetable	Session One (2017)	Session Two (2017)	Session Three (2017)	Session Four (2017)	Session Five (2017)	Session Six (2017)
Event	Teacher workshop, once a month 1pm-4pm					
Overview	<ul style="list-style-type: none"> • Recapping 2016 use of resources and reflection on adaptations needed. • Re-issuing assessments • Introduction workbook activities 	<ul style="list-style-type: none"> • Assessment analysis • Preparing for parent sessions – parent resource kit – what and how to work with parents. 	<ul style="list-style-type: none"> • Extension of use of key representations 5-10 range 	<ul style="list-style-type: none"> • Using touch screen in the Grade R classroom and arranging for use of SANCP set • Preparing for 2nd parent session with ‘family math’ event 	<ul style="list-style-type: none"> • Guest speaker 	<ul style="list-style-type: none"> • Guest speaker and reflection of program • Reflection on learner progression against assessment • Reflection on parent program • Reflection on learner workbooks and adaptations needed.
Resources	<ul style="list-style-type: none"> • Assessments • Workbooks per learner 	<ul style="list-style-type: none"> • Parent resource kits • Calendar dates for each 	<ul style="list-style-type: none"> • Laminated extension ideas 	<ul style="list-style-type: none"> • Key activities on touch screen with smart phone versions listed where available • Parent kit additions and ‘family math’ activities 	<ul style="list-style-type: none"> • Speaker handouts 	<ul style="list-style-type: none"> • Reflective questionnaires • Speaker handouts
Parent programme						

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Key Grade R specialists to be consulted in the development of this programme

The following people will be consulted in the development of this programme for which this discussion document forms a base.

- Rhodes University CSD: Director and SARAECE president: Giulietta Harrison and the CSD team
- Ex-Foundation Phase Grahamstown district advisor and current Grade R CPUT pre-service lecturer – Elna Barnard
- Local Grade R teachers (who have also participated in NICLE programme): Elvira Milborrow; Melissa Tweedie
- Researcher, teacher and occasional lecturer in pre-school at Rhodes University– Jean Schafer
- UNISA lecturer and researcher (in pre-school): Nosisi Feza
- Curriculum FP subject specialist for the Eastern Cape: Zanele Mofu (also a doctoral researcher in numeracy education)
- Grahamstown FP district advisor: Zukiswa Sohena