Unexpected Outcomes of a Family Mathematics Story-Time Program

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Research suggests mathematical stories can support mathematical learning. We discuss an unexpected outcome caregivers of reception year learners (Gr R age 5-6yrs), participating in a mathematics story-time program, shared in interviews. The program, implemented with Gr R learners' caregivers in two South African schools, explained and demonstrated a dialogic approach to reading mathematical stories. While data indicated success in the intended specific mathematics outcomes (e.g. numeral and number word recognition; finding one more/less), we focus here on a broader learning outcome all parents shared. That is, children changed their way of being a learner participant in the family/community.

Background and Context

South African learners tend to perform poorly on both international and regional mathematics and literacy comparative measures (see Graven, 2014). Furthermore, the performance gaps according to socio-economic status are among the most extreme (Reddy et al., 2015). Redressing inequality in education has been a priority since South Africa's first democratic elections in 1994 and education is seen as a vehicle for redressing persistent economic inequality. The South African Numeracy Chair (SANC) at Rhodes University (the incumbent is the first author), is mandated to work at the research and development interface to address the challenges of primary mathematics learning in so called previously disadvantaged communities. Much research points to early childhood learning opportunities being particularly influential in setting the educational learning trajectories of learners and particularly important for closing educational gaps between the rich and the poor (see Atweh et al., 2014). Increasingly South African research is calling for early intervention, especially in mathematics, as by Grade 4 the majority of Grade 4 learners are already considered to be two grades behind grade level expectations, (Spaull and Kotze, 2015). In 2016 the SANC introduced the Early Number Fun (ENF) program that brought over 40 Grade R teachers, and district and provincial departmental officials, together on a monthly basis. In the program participants engaged with SANC project researchers on selected research-informed resources that were considered potentially useful in supporting Grade R (reception year age 5-6yrs) student mathematics learning. Participants provided feedback on their in-class use of resources and adaptations were made accordingly (resources are available on www.ru.ac.za/sanc/enf).

Building on emerging local research that points to the benefits of using a narrative approach in the teaching of mathematics to primary learners (Roberts, 2016; Takane, Tshesane & Askew, 2017) the first author designed a series of mathematics stories for Grade R teacher use with learners. While the ENF focus was on mathematics learning, it was considered important to find ways to blend this work with literacy that is a key part of teachers' daily work. Mathematics story-books provided a powerful resource for blending these two key learning areas. Following highly positive feedback on the use of mathematics storybooks and their related resources from teachers it was decided to extend the use of these

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books and activities to parents. The first author's experience of running family mathematics events across several local schools, communities and after-care centres, indicated strong parent willingness to support their children's learning but also that there was a need for provision of age appropriate resources and guidance in the use of these for strengthening mathematical learning, reasoning and communication.

Thus, the mathematics story-time program was introduced to caregivers of Grade R learners, that involved three one-hour sessions (spaced out weekly or monthly) in which four story books were provided along with related resources (e.g., paper finger puppets, laminated numeral and number word cards, dice, cards). To date the program has only been run in two South African schools and plans are underway to run the program with a school in Australia mid 2018. Research into the process of implementing, and the effects of, the program is ongoing and will feed into subsequent iterations of the program. In this paper, we draw predominantly on data to illustrate the impact of the program on families. It is not the intent here to provide a deep, or theoretical analysis of these data. Simply, our intent here is to establish the impact of the program from the data collected.

Framing Assumptions

All SANC programs are broadly informed by a Vygotskian perspective of learning where learning is considered socially mediated and historically and culturally situated (1930). For Vygotsky language is the critical socio-cultural tool that enables development of concepts and meaning making, first socially "between people (interpsychological)" then individually "inside the child (intrapsychological)" (Vygotsky 1930, p. 48). Thus, an assumption of the program was that for learners to develop rich mathematical understanding they needed to engage actively with mathematical ideas in social situations. The dialogic reading approach (see Whitehurst et al., 1988), with its interactive technique where the reader prompts children to discuss ideas and answer questions related to the stories read to them, coheres well with these assumptions. Encouraging learners to pretend read the stories, using the same dialogic approach with others, provided further opportunity for children to talk about mathematical and other ideas in the stories. Furthermore, a constructivist approach informed the development of the storybook program and resources were informed by literature around learner progression (e.g. Clements and Sarama, 2009) and what young learners can be expected to know and do mathematically by this age (5-6yrs). This aligns with the South African curriculum content and its progression for Grade R learners and is similar to the Australian curriculum.

The Family Mathematics Story-Time Program

The aim of the program is to involve parents in engaging with their children about mathematical ideas in the reading of picture book mathematics stories to strengthen their children's number sense, mathematical language and love of reading and enacting stories with mathematically-engaging content. In each session the first author modelled dialogic reading to parents of each story with 3-5 children and a child would then pretend read the story back. Thereafter demonstrations of children engaging with mathematical ideas using the accompanying resources (e.g. the puppets, the numeral and number word cards, the flash cards of 'more' and 'less') were done. In particular attention was focused on questions to ask children as one engaged with the resources. Parents were provided three sessions in which this dialogic approach to reading the stories was explained and demonstrated. Parents were encouraged to engage with learners about what was happening mathematically (and

otherwise) in the story; to encourage prediction of what would happen next and to have children similarly 'pretend' read the story.

The first three books each tell a basic number story of five or ten characters moving from one place to another, one or two at a time, and focuses on the changing quantities as this movement happens. For example, the first story begins with 5 monkeys in a small tree, no monkeys in a big tree and a moaning monkey who provides the stimulus for jumping to the big tree. See Graven and Coles (2017) discussion of teacher and learner engagement with the story in two classroom contexts. Below is an example of one page of the story:

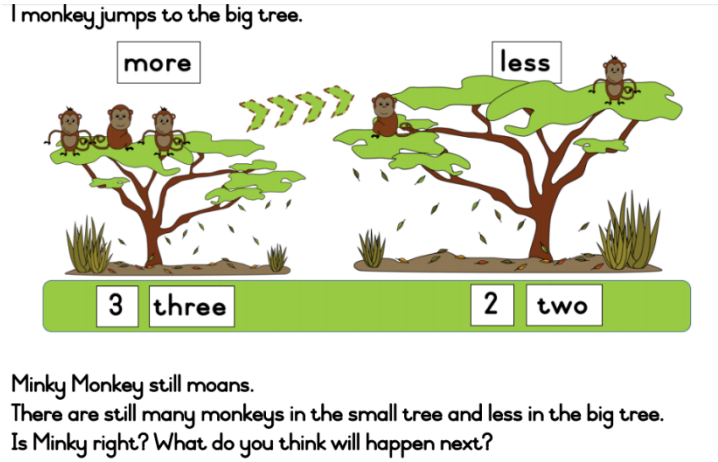

Figure 1: Page 4 of the 'Monkeys in the tree' book (SANCP, 2016)

In the demonstrated reading children were asked questions throughout like 'Okay so if another monkey jumped then how many will there be in each tree when I turn the page? Where are there more monkeys? Where are 'less' monkeys? How many monkeys are there altogether? The second book is similar with 5 children under a small umbrella at the start of the story. The third book (vastly adapted from its first version used in ENF) involved 10 frogs on a small lily pad and unfolds with the frogs jumping in pairs to a large Lily pad. A story-board page was provided at the end of each of the first three books which had only the pictures of the two trees/umbrellas/lily pads etc. Children were encouraged to use this page, with the finger puppets and flash cards (numerals, number words and the words 'more' 'less'), to retell the stories by moving the puppets from picture to picture. The final story involved two children collecting firewood for their 'Gogo' (granny) and carrying the sticks on their heads (as can be seen locally). The children in the story, Busi and Thabo, sometimes pick up one or more sticks and the sticks sometime fall. This story is not patterned in the same way as the other three stories but similar questions are asked such as 'how many sticks altogether?' 'now who will have more sticks?' and 'how many more sticks does Busi have?' While dice and cards were also provided and basic games demonstrated at the end of each session to families these were not a main focus of activities and instead were used to reinforce concepts, language and skills developed in the stories (numeral recognition; how many altogether? where are more? etc.).

In sessions the likely progressions of children in the various intended mathematical skills and concepts were made explicit to caregivers so that they could assist in mediating children's progression. The intended skills that were built into the stories and demonstrated in the dialogic reading were: number and numeral recognitions (first to five then to ten);

counting objects and collections of objects accurately up to ten; subitising up to 6 (aided by dice); working out what one/two more/less of a quantity is; working with the comparative language of more and less and later saying how many more (noting the difference) in each collection. So for example for it was noted that children may move from counting the characters or objects in stories and dice by: sometimes making errors with one to one counting (e.g., touching one object more than once in a count or touching it once and counting more than one number); they should later count correctly with one to one correspondence; they should eventually subitise (know instantly there are three monkeys or 4 dots on a dice without counting); once subitising they can count on from how many in one place to get the total number in both places or on both dice.

Research Sample and Data Gathering

The interpretive research, drawing on aspects of design experiment research (Cobb, Confrey, Di Sessa, Lehrer and Schauble, 2003) that is highly interventionist in nature used qualitative data gathering methods aimed at understanding both caregiver and learner experiences as a result of their program participation. The primary data-gathering instrument was interviews. Two caregiver interviews were conducted - one at the start and another at the end of the three sessions. These interviews were a one-on-one interview and were audio recorded. All interviews were transcribed. Learner interviews were task-based where children were asked to: pretend read the monkey story, retell the story (using various props), and play with two dice – in each of these activities learners were asked a range of questions that provided data as to learner progress in relation to the various intended mathematical learning outcomes. Video recordings were made of each of the sessions. These have not been transcribed as their primary purpose was to enable revisiting what was communicated and discussed in sessions.

The data used in this paper are derived from the transcribed post-session interviews with the caregivers who participated in the mathematics story time program at one of the two schools it has been implemented in to date (as described below). The interview questions included for example: Can you tell us about your and your child's experiences of reading these story books together? Could you please tell us about your and your child's experiences of these activities? Has the way in which your child interacts with the stories changed at all after reading the books a few times? Explain. Do you think there have been any social/emotional advantages to reading these number stories with your child? Explain.

Unexpected Outcome

Across the post session interviews in both schools there were multiple comments from caregivers about the ways children engaged with others in their extended families and in their local communities had changed. While a key aim of the program was to encourage primary caregivers to spend time engaging with children around mathematical ideas we had not expected the extent to which mathematical engagement spread, initiated by the children, to other members of the family and community. We chose to focus on this rather unexpected outcome for this paper. While a similar story could be told drawing on the data of caregiver interviews in the other school, we have chosen this school because the second author attended the final session at this school and observed several of the post-session parent and learner interviews.

Both schools serve predominantly learners who under apartheid were classified non-white. In both classes the medium of instruction is English even while the vast majority of learners speak either isi-Xhosa (the language of indigenous people in the Eastern Cape area)

or Afrikaans (a language of Dutch origin spoken extensively by those of mixed race classified under apartheid as 'Coloured'). The school we focus on here draws learners from predominantly poor, working-class or unemployed backgrounds.

The parents/caregivers of nine children in the Grade R class of the chosen school participated in three sessions run weekly at the school in the evenings from 5:30 to 6:30 pm. All nine parents or caregivers participated in interviews at the start and end of the sessions. In some cases different caregivers came to the different sessions (such as a different parent, an aunt or a grandmother). The interviews were conducted on a one to one basis by the first author and a research assistant who attended all sessions and assisted with the distribution of resources and video recording the sessions. The second author attended and assisted with the recording of five of the interviews following her attendance of the third session in this school. All names used below are pseudonyms. Responses to interview questions were coded according to themes. The theme we share here of increased and child-led mathematical engagement emerged in all nine sets of caregiver interviews.

Findings

In all interviews comments were made about how the children increasingly initiated mathematical learning activities, even beyond with their caregiver/s who attended the sessions and beyond the stories. Below we provide examples of utterances from all nine interviews of this changing engagement with different family/community members. We begin with exemplar comments of changing engagement with parents, then with siblings or cousins and finally with others in their community such as neighbours and friends. Thereafter we provide a fuller vignette of one child's changing engagement and way of being to illuminate this in a richer more holistic way. In sharing the data we have ensured that we have provided at least one quote from each of the nine caregivers interviewed.

Examples of utterances about changing ways of being with parents

> Jaya's mother: "She would be shy because she doesn't always read to her father. But now with this project she always reads to him."
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> Zandi's father: "She was not interested in reading, but now she asks what we are reading, and then tomorrow she wants to act what you were reading yesterday for her… I don't have much time, only on weekends. I sit with them and we take all the books, and from Saturday to Sunday we go through all the stories… I have learned to also teach the young ones because I used to say to them I didn't have time."
>
> Cal's father: "Like I said to my wife, for us reading the book, and to help him read as well, it is eye-opening for us as well to let him start at a young age. It's like a new seed for a tree to come out, shall we say."
>
> Leanne's mother explained that she was more confident reading to her daughter and that now it is "routine for them every night…They will come with the book, even though I think, 'I want to watch this movie' I would rather sacrifice that."
>
> Saide's mother: "I don't want to lie. I didn't even remember taking a book before my baby went to bed and read it. But after I got those books, when I come home at 5 o'clock, 'mommy can we read a story?' I don't get bored, I read the story and he also reads the story for himself, and when we go to bed again we read the story."

Examples of utterances about changing ways of being with siblings/cousins/aunts

> Nathi's mother: "He is telling the big sisters the stories…He used to fight with other people, but now it has brought them together with the games and the stories…"

> Jaya's mother: "We did it [reading and re-enacting] together, me and the eldest and Jaya. Even the baby was sitting there. Always enjoying [inaudible] that one…because now in this project we have time to read together as a family."
>
> Lee-Ann's mother: "she explains to her brother how the books work…So she is telling him 'Listen here, do you know that six and four is ten?' with that attitude. But I am glad. I am not going to interfere because she is in the learning process. Then she says, 'let me show you how I got ten.'"
>
> Jean's mother: "She asks you to help her with the sticks and the cards, and the monkeys. It's very exciting for her… She likes to play on her own, but she also asks me to play with her, and my sister also."

Examples of utterances about changing ways of being with neighbours/friends

> Eli's granny: "He goes to his friends. Like yesterday he showed them the book, and they asked questions, and then Eli told them what the story was about."
>
> Sade's mother: "In class she was very quiet I think, but because she has those books now, whenever we go to other people's houses she will tell them about [them and] these interesting games, and the numbers and then she is the teacher. Which she really is."
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> Leanne's mother: "Yeah because in the class she is very quiet, I think, but because she has these books now, whenever we go to other people's houses, she will tell them about these interesting games, and the numbers, and then she is the teacher."

Elsa's changing way of being and engaging with others as told by her Aunt

In order to provide a more holistic picture we now provide a fuller story of one child (Elsa) as told by her aunt. Elsa's aunt looks after her in the afternoons as her mother works in a city about 160 km away. Elsa's aunt attended the sessions in place of Elsa's mother who was only able to attend one session. We selected this interview because it captures multiple changing way of engaging with others in learning activities that were noted across interviews. While not all interviews tell the story of such oppositional change from 'quiet and shy' to 'talkative and open', as is shared below, they all indicated increased engagement with others around mathematical ideas mathematical engagement and all provided instances of their children initiating or taking the lead in such engagement.

Elsa's aunt explained how Elsa had become someone who asked lots of questions and initiated regular engagement with her and her mother about mathematical ideas:

> She asks lots of questions…She says 'Mummy please can you come and sit here I want to ask you something. Tell me how many plates are in the cupboard…' and then when she comes home from school she says, 'Can you please read the book? Can we please do the cards and dice?' She wants to choose what she wants to do…I read to her then she mentions how she reads to me. 'I am the mom you are the child'.

Later she explained that this engagement 'even' extended to her father. Comments about engagement with fathers came up in several interviews across both schools as can be seen in some of the examples above. Elsa's aunt commented that "Even with her father. 'Daddy how many wheels on the car?' and he says 'It's four. You can count. If I take one away, how many are there?'" Elsa's aunt further explained how Elsa would get her to act out the story pretending spoons were monkeys and cups were the trees and would use blankets for umbrellas. They would then move spoons around and Elsa would ask questions such as 'how many are under each umbrella?' She explained how Elsa asked for a pen because she wanted to write the numbers (1-5). She then explained how Elsa engaged with "her big cousin in Grade 7" and argued with him mathematically:

> The big cousin in Grade 7 now. He says (to her) 'What is this nonsense you are doing? I don't understand.' I say, 'Come Barry, come and sit here.' And she (Elsa) argues with him when he says 'it is five more'. And she says, 'no it is two more'.

This relates to a page in the "Busi, Thabo Sticks and the fire" storybook where on Busi has 5 sticks on her head and Thabo has 3 sticks on his head. So while Barry is right that Busi has 5 sticks and this is more than Thabo's - Elsa is arguing that Busi only has 3 more than Thabo and not 5 more. This distinction was made explicit to parents in the sessions. In South Africa it is common in national assessments for students throughout primary grades to answer questions of 'how many more' by simply stating the quantity that is more as Elsa's cousin is reported to have done. Elsa's Aunt went on to explain how much Elsa was enjoying engaging with mathematics ideas and 'helping' others with these ideas:

> She wants to do so much and you can see she is enjoying it. She is experiencing more about numbers. She tells her brother she will help him with maths. She says 'Come and sit, you are also going to get clever'.

Elsa's Aunt further stated that Elsa was talking and 'opening up' to the family more:

> She is not actually my daughter but my sister's daughter. My sister works in (city). She was quiet before but now she is talking. Her mother was here for the last session, but she could not make it today because she was working a bit late…. because of the things she does now she is opening up to us. She speaks more now, then she asks all of us to tell her something.

She added how Elsa was now more willing to play with other children:

> She did not want to play with the neighbours before, but now she wants to go out and play with the other children, but we don't want her to go because it's not safe in the street. So when the children ask if she can play, we tell them they must play in the yard. She calls them to come play… When they play she goes and fetches paper and the pencils… she wants to read the book about the monkeys to those children. They are all in Grade R. She says 'come I am going to read to you'…. She never had friends calling, but now she is more interested in teaching them how to count…. She was a shy girl but now she has more friends, talks and does stuff.

'Playing teacher' or 'playing school' with the resources given with other children was noted in several other interviews. At the end of the interview Elsa's aunt re-iterated: "Our child was very quiet, but now when you came, its like you took her out of that quiet corner. She opens up to everyone."

Concluding Remarks

All caregivers interviewed indicated a willingness to attend future programs as they reported that they had gained so much from participating in the workshops. In all the interviews an increase in children's confidence to initiate engagement with others about mathematical ideas is indicated. Indeed, confidence to engage mathematically is likely to increase the more one has opportunities to speak the language of mathematics. From the interview data it seems that the provision of these storybook resources and the demonstration of a dialogic reading approach provided opportunities for engaging mathematical ideas that went beyond the intended caregiver-child reading scenario. Data showed that children regularly played with the resources and books both by themselves and with other family members and other children. Perhaps a key enabler in this was that the resources, while handed to parents, were to be given to their children providing for a sense of ownership of them. Leanne's mother explained that she saw this as important in enabling the independence and agency her daughter had developed in guiding her own learning. She explained "She doesn't have to depend on the other person. 'Come and play with me'. She can do it on her own and can be in charge of the games. It could be a factor why she likes it so much." Later

she added “But the thing is, because they are her books, she wants to be the main actor in reading the books. So she want to tell you, she want to show you how it works… she wants to be in charge”. In concluding the interview Leanne’s mom explained the learning opportunity enabled by this home based versus classroom-based story time program as:

> ‘What is nice about it, is, if ever they have difficulties in understanding in these sessions they are shy and they won’t ask questions. But in their own space at home, they are more confident. I think kids learn more when things are informal and not as formal as in the classroom.

What we need to do from the work reported here is to frame this within a model of parental engagement and learning for the children. It is clear from the data presented here that the project has built the intellectual capital of both parents and learners both in terms of literacy and mathematics. We now need to undertake a deeper analysis of the data to build this theoretical case. We are also keen to see how the same project is realised in the Australian context and to test the viability of a theoretical model across the two diverse contexts.

References:

Atweh, B.; Bose, A.; Graven, M.; Subramanian, J. & Venkat, H. (2014). *Teaching Numeracy in pre-school and early grades in low-income countries*. Berlin: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

Clements, D. H., & Sarama, J. (2009). *Learning and teaching early math: The learning trajectories approach*. New York: Routledge.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher, 32*(1), 9-13.

Doyle, B. & Bramwell, W. (2006). Promoting emergent literacy and social–emotional learning through dialogic reading. *The Reading Teacher*, 59(6), 554–564.

Graven, M. (2014). Poverty, inequality and mathematics performance: the case of South Africa’s post-apartheid context. *ZDM Mathematics Education*, 46, 1039–1049.

Graven, M. & Coles, A. (2017) Resisting the desire for the unambiguous: productive gaps in researcher, teacher and student interpretations of a number story task. *ZDM Mathematics Education*, 49: 881-893. https://doi.org/10.1007/s11858-017-0863-7

Roberts, N. (2016). *Telling and illustrating additive relation stories*. Unpublished doctoral dissertation. Johannesburg: University of the Witwatersrand.

Robertson, S-A. & Graven, M. (2015) Exploring South African mathematics teachers’ experiences of learner migration. *Intercultural Education*, 26(4), 278-295.

Reddy, V., Zuze, T., Visser, M., Winnaar, L., Juan, A., Prinsloo, C., Arends, F. & Rogers, S. (2015) Beyond Benchmarks: What Twenty Years of TIMSS Data Tell Us About South African Education. Cape Town, South Africa: HSRC Press.

Spaull, N. & Kotze, J. (2015) Starting behind and staying behind in South Africa. *International Journal of Educational Development*, 41, 13–24.

SANCP (2016) Monkeys in a tree: An early numeracy fun book. Downloaded from http://www.ru.ac.za/media/rhodesuniversity/content/sanc/documents/Monkeys%20in%20the%20tree-English-families.pdf

Takane, T., Tshesane, H., & Askew, M. (2017). From Theory to practice: challenges in adopting pedagogies of mathematizing in South Africa. In M. Graven & H. Venkat (Eds.), *Improving primary mathematics education, teaching and learning: Research for development in resource constrained contexts* (pp. 179–197). Hampshire: Palgrave Macmillan.

Vygotsky, L. S. (1930). *Mind and society.* (Transcribed by A.Blunden & N.Schmolze. Published by Harvard University Press).

Whitehurst, G.J., Falco, F.L., Lonigan, C.J., Fischel, J.E., DeBaryshe, B.D., Valdez-Menchaca, M.C., et al. (1988). Accelerating language development through picture book reading. *Developmental Psychology*, 24, 552–559.