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Strengthening maths learning dispositions through 'math clubs'

Author:
Mellony Graven[1]

Affiliation:
[1]Education Department, Rhodes University, Grahamstown, South Africa

Corresponding author and email:
Mellony Graven
m.graven@ru.ac.za

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In this paper, I argue that the establishment of after-school mathematics clubs in early grades holds rich potential for supporting the development of increasingly participatory and sense-making maths learning dispositions. Within the South African Numeracy Chair project, lead by the author, multiple after-school mathematics clubs have been set up for learners in Grades 3–6 across Eastern Cape schools. These clubs are a complementary initiative to teacher development, aimed at improving low levels of numeracy learning across the majority of schools in the province. Two sources of data, learner interviews and teacher questionnaires, from one case study club, are shared in this article to illuminate the potential such clubs hold in developing increasingly participatory mathematics learning dispositions.

Introduction

South African mathematics education is widely acknowledged to be in crisis. Both performance on international assessments such as TIMSS (see Reddy 2006) and departmentally administered annual national assessments indicate poor performance that worsens as learners move up the grades. For example, the most recent Annual National Assessment (ANA) report reveals national averages for mathematics decreasing steadily from Grade 1 to Grade 3 (68%, 62% and 56%, respectively) followed by a sharp drop in Grade 4 (to 37%). By Grade 9, the average is 11% (Department of Basic Education 2014). Furthermore, these averages hide the bimodal nature of performance across schools with differing socio-economic status. South Africa has, arguably, two education systems, one largely functional servicing the wealthier 20%–25% of learners (where the results compare well internationally) and the other largely dysfunctional system for the majority of learners from poorer backgrounds (Fleisch 2008). The schools I work with, in the South African Numeracy Chair (SANC) Project, are from the latter system with learner performance largely below national averages. Thus, by Grade 4 the vast majority of learners are already considerably behind the level of the curriculum taught and the materials provided for their grade.

Whilst a range of complex systemic factors challenge mathematical learning (e.g. social disadvantage, language issues, teacher knowledge, and absence of teacher support), attention is increasingly being drawn to the limited opportunity to learn mathematics. Classroom-based research points to teaching that foregrounds ritual participation (including chanting), passive listening and little sense-making, resulting in many failing to progress beyond inefficient one-to-one counting methods, even by Grade 7 (Heyd-Metzuyanim & Graven 2015; Hoadley 2012; Schollar 2008; Venkat & Naidoo 2012). The research by Carnoy *et al*. (2012) reveals that South African learners in the region bordering Botswana have only an annual average of 52 lessons per year, compared with 78 in Botswana. Thus, both limited learning time and access to quality learning impact on mathematics learning. Additionally, learners tend to equate mathematical success with teacher dependence, compliance and careful listening rather than independent thinking, problem solving or sense-making (see Graven & Heyd-Metzuyanim 2014). The notion of dependence and compliance as a specific aspect of poverty, entrenched under apartheid, requires attention in relation to how it impacts mathematics learning of the new curriculum.

Adler argued in her presentation to the South African Mathematics Education Chairs' initiative in 2010 that we have to 'interrupt' the learning and teaching culture in schools, where learners are passive, learning is teacher-dependent and the focus of teaching is on compliance (compliance to national assessments and producing documentation for district officials). Because our recent apartheid history systematically disempowered people politically, economically, socially and educationally, I have argued (Graven 2014) that we need to focus our attention on redressing apartheid's legacy of compliant, passive and dependent learners that work counter to developing critical, creative and actively participating mathematics problem solvers as envisioned in our new curriculum (Department of Basic Education 2011).

Many learners have negative mathematical experiences, beginning in the early primary years, that impact on their mathematical learning trajectories throughout schooling. Earlier research I conducted with mathematical literacy learners revealed that many learners expressed helplessness and hopelessness in accessing mathematics (Graven & Buytenhuys 2011). However, this research also pointed to rich opportunities for repairing negative relationships with mathematics through foregrounding active learner participation and sense-making. Furthermore, Wright, Martland and Stafford (2006a) argue that young learners' arithmetic difficulties are highly susceptible to intervention especially through more individualised work. They caution that without this intervention, the gaps in primary school learning can expand to a 7-year gap later on. Indeed, in South Africa research points to our Grade 4 learners already being almost two grades behind expected levels of performance (Spaull & Kotze 2015), and by Grade 9, it seems most are lost to the opportunity of further mathematics learning as indicated by the 2014 ANA average of 11% for mathematics (Department of Basic Education 2014). With this in mind, designing early-grade learner interventions, in the form of after-school clubs, that enabled increased individualised learner attention facilitating increasing participatory and sense-making dispositions became a priority for my project development work as the SANC at Rhodes University (discussed below).

Theoretical perspective and analytical frameworks

A sociocultural and socioconstructivist perspective of learning informed the design of clubs and related research. Mathematics learning is considered a social activity in which learners actively construct meaning. Additionally, learning involves developing dispositions and ways of being (Gresalfi & Cobb 2006) and our intervention work assumes that learning to learn can be actively and deliberately supported by developing productive learning habits (Claxton & Carr 2004).

Because mathematics is a strongly hierarchical subject, learners build new knowledge on previously learnt knowledge as they progress towards increasingly abstract levels and stages of numerical strategies, conceptual place value and multiplicative reasoning. Wright *et al*. (2006a) Learning Framework in Number and the related Mathematics Recovery Program (Wright *et al*. 2006b) informs much of the assessments and learning activities used in the broader project and in clubs.

Additionally, the five-stranded definition of mathematical proficiency put forth by Kilpatrick, Swafford & Findell (2001) guides project work. That is, mathematical proficiency involves the development of five interconnected strands, namely, procedural fluency, conceptual understanding, adaptive reasoning, strategic competence and productive disposition. Productive disposition, as Kilpatrick (2001) *et al*. define it:

> 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).

Kilpatrick *et al*. (2001:131) note that developing a productive disposition requires 'frequent opportunity to make sense of mathematics, to recognise the benefit of perseverance and to experience the rewards of sense making in mathematics'. They argue that productive disposition develops when other strands develop. For example, as students build strategic competence in solving nonroutine problems, their attitudes and beliefs about themselves as mathematics learners become more positive.

This coheres with the South African Curriculum and Assessment Policy (Department of Basic Education 2011), which states that mathematics is a creative part of human activity and that learners should develop a deep conceptual understanding in order to make sense of mathematics. Furthermore, the five-stranded definition of mathematical proficiency described by Kilpatrick *et al*. is explicitly referred to as in explanations of what teachers should work towards in teacher support documents such as the *Numeracy Handbook for Foundation Phase Teachers: Grades R-3* (Department of Basic Education 2012:11), which writes:

Being mathematically proficient (numerate) means:

- Understanding what you are doing (conceptual understanding);
- Being able to apply what you have learnt (strategic competence);
- Being able to reason about what you have done (adaptive reasoning);
- Recognising that you need to engage (productive disposition) with a problem in order to solve it; and of course
- Being able to calculate/compute (procedural fluency) with confidence. (Emphasis in original.)

However, a willingness to engage *with others* about mathematics is absent from the definition given by Kilpatrick *et al*. Arguing that 'not all dispositions are equally relevant to learning power' Carr and Claxton (2002), working in the context of early childhood education, foreground three key learning dispositions, namely, playfulness, resilience and reciprocity. These are defined as:

> Resilience: 'the inclination to take on (at least some) learning challenges where the outcome is uncertain, to persist with learning despite temporary confusion or frustration and to recover from setbacks or failures and rededicate oneself to the learning task'. (p. 14)
>
> Playfulness: 'means being ready, willing and able to perceive or construct variations on learning situations and thus to be more creative in interpreting and reacting to problems. In our current conceptualisation we identify three different types of playfulness, which we refer to as mindfulness, imagination and experimentation'. (p. 14)

> Reciprocity: 'The most valuable learning resources, especially for the young, are, of course, other people. Those who lack the awareness to articulate their own learning processes and problems, the ability to communicate these to others or the inclination or the courage to do so are inevitably handicapped as learners'. (p. 15)

Whilst not included within the above definitions of productive learning dispositions, I consider developing enjoyment and passion for mathematical engagement and learning an essential part of our work with learners in clubs. This is an under-represented aspect in majority of mathematics education literature on both teaching and learning (Graven & Schafer 2014).

Clubs as an intervention strategy

The South African Mathematics Education Chair initiative has established six chairs since 2010. I hold the SANC at Rhodes University in the Eastern Cape (one of the poorest and lowest performing provinces in South Africa). The Chairs differ and have the dual mandate of both research and development. All are involved in ongoing teacher development programmes with teachers from at least 10 schools (with learners from predominantly 'disadvantaged' backgrounds). It is beyond the scope of this paper to outline the work of the broader development project suffice it to say that the project has two interrelated professional learning communities. The first is our research community of master's and doctoral students (many of whom are also teachers) and the second community consists of more than 40 Grades R to 6 teachers from 12 schools participating in the Numeracy Inquiry Community of Leader Educators (NICLE) program. Both communities meet regularly and work together to find ways forward to the challenges of mathematics teaching and learning.

Whilst NICLE is the key intervention programme of the SANC project, I chose a complementary learner-focused strategy, in the form of the implementation of multiple after-school primary mathematics clubs in order to support both teachers and learners in our project schools. The rationale for implementing clubs (focused at Grade 3 and 4) as an intervention strategy emerged from the context discussed above. Because most of the learners were way below the expected level of performance for their grade, the district-provided schemes of work and workbooks would constrain opportunities for remediating learning in classrooms. Furthermore, large classes, with little space for teacher movement between desks, often work against opportunities for individualised learner attention. Thus, whilst the SANC project works with teachers in NICLE to enable the development of key foundational numeracy skills, I believed that much could be gained by working with learners in after-school spaces in which club facilitators (project team members and NICLE teachers) would be free to work with learners in smaller groups focusing on specific learner needs informed by his/her competence level and learning disposition. Additionally, it was hoped that these club learners might become catalysts for demonstrating new ways of engaging in their mathematics lessons. This was seen as important as some teachers noted that when they shift their practices towards more learner-centred pedagogies through, for example, asking learners to find and explain alternative solution methods, learners often do not know how to respond. Feedback from teachers about club learners indicated that club learners often modelled for others ways of responding to new forms of teacher questioning.

Furthermore, club sessions and the take-home activities, games and worksheets provided would extend the time learners engaged with mathematics and would promote continued mathematical learning outside of clubs and classrooms. The cross-border Botswana–South Africa study by Carnoy *et al*. (2012) indicates that insufficient time and opportunity to learn are key factors in South Africa's low performance in regional comparative assessments. Thus, clubs were defined as voluntary, informal, extra-curricular spaces where facilitators (teachers and/or researchers) work with between 6 and 15 learners in a particular grade in developing their mathematical proficiency (discussed below). The term 'informal' is used in contrast to the more 'formal' classroom environment within the official school timetable, which is bound by the curriculum guidelines for that grade.

Another advantage for the SANC project is that clubs provide important learning spaces for project researchers and NICLE teachers through providing access to engagement with learners in smaller groups and without concern for disruptions to school time. Clubs can serve as explorative spaces (or 'labs') to try out new activities and ways of teaching and recovering early numeracy concepts, testing theories, frameworks and assessments before sharing them with a whole class of learners or teachers in NICLE workshop sessions. Thus, the clubs provide a safe space for trying new pedagogical approaches for teachers and additionally provide researchers with an empirical field for their studies. For many postgraduate researchers in SANC project (which includes several teachers and two NICLE teachers), the clubs provide empirical fields for their research (Hewana 2013; Stott 2014).

Despite an absence of research (other than that generated by SANC project researchers) on *primary mathematics clubs* in South Africa or Africa, interest in our clubs (and related research) has grown rapidly since we (SANC project researchers and teachers) began presenting our clubs at conferences. At the request of teachers and district education officials, we have conducted several workshops with teachers and educators across the Eastern Cape and beyond on starting clubs. Workshops emphasise the importance of developing participatory sense-making dispositions and enabling learners to think independently and to develop both resilience and enjoyment of mathematical challenge. Additionally, workshops emphasise getting learners to extend their mathematical learning and practice through teaching simple games that can be used at home (e.g. dice, cards and oral calculation games).

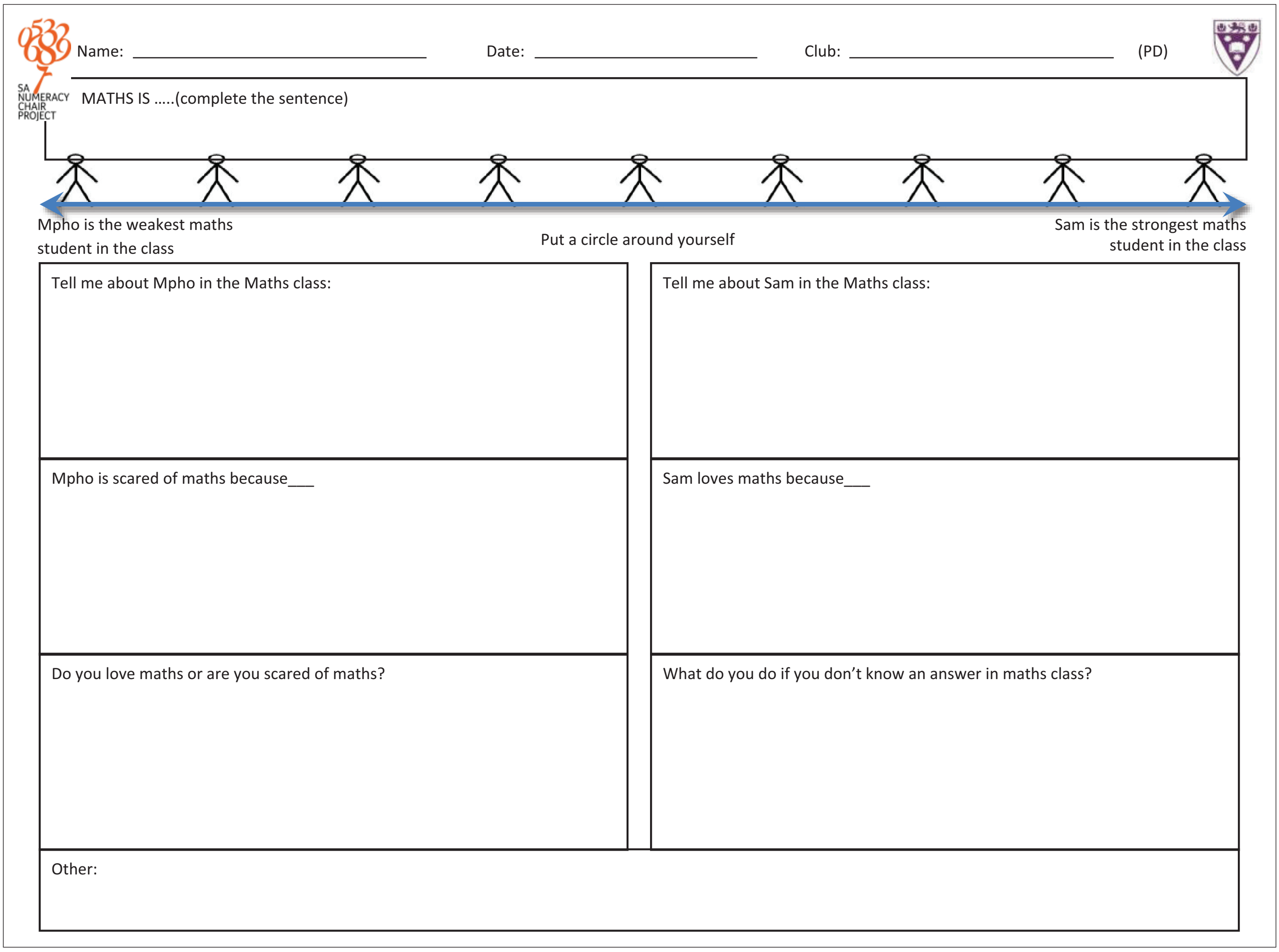
Research design

The methodology of the broader research combines qualitative and quantitative research methods across learners in clubs and schools. Qualitative methods include case study classroom observation, club observations (with transcriptions), individual club learner mathematics interviews and dispositional interviews (also video recorded and transcribed). Two sources of data are shared in this paper. Firstly, teacher questionnaire responses are shared that relate to possible influences of club participation on learner participation in mathematics class. Secondly, the responses of one learner to a learning dispositional questionnaire/interview instrument administered to the same learners three times over a 12-month period are shared. The dispositional instrument is given below. All data shared in this paper relate to one case study club of six learners in which I was the primary facilitator from May 2012 to November 2013 (Figure 1).

The club ran at an after-school development centre that supported learners who were most in need of after-school care because of circumstances at their homes. All Grade 3 learners at the centre were invited to participate in the club and parental permission was sought for both their participation and the related research. Six learners participated regularly in the club. All six club learners were in Grade 3 in 2012 and Grade 4 in 2013. There were three girls, Jaya, Bernie and Agnes, and three boys, Leonard, Thato and Sonny (these are all pseudonyms). In 2013, Agnes and Leonard moved to another town and were no longer in the club.

Data analysis

At the end of 2012 (after I had run the club on a weekly basis for 5 months), a questionnaire was provided to the teachers of each of the learners asking them whether they noted any influence of participation in after-school clubs on the learners in their class. The questions asked whether teachers thought the club had any influence on learners' ways of participating in class, learners' mathematical understanding and learners' performance on assessments. All teachers, except Agnes's, stated that the clubs improved learners' performance on written assessments (and I have other data indicating improved performance shifts across other mathematics assessments). However, because some improvement in mathematics performance on assessments over time would be expected irrespective of learner club participation, here I include


SA NUMERACY CHAIR PROJECT

Name: ______________ Date: ______________ Club: ______________ (PD)

MATHS IS .....(complete the sentence)

Mpho is the weakest maths student in the class

Put a circle around yourself

Sam is the strongest maths student in the class

Tell me about Mpho in the Maths class:

Tell me about Sam in the Maths class:

Mpho is scared of maths because___

Sam loves maths because___

Do you love maths or are you scared of maths?

What do you do if you don't know an answer in maths class?

Other:

Source: Graven, M., 2012, 'Accessing and assessing young learner's mathematical dispositions', *South African Journal of Childhood Education* 2(1), 49–62.

FIGURE 1: The dispositional instrument.

TABLE 1: Teacher responses to questionnaire on club learners in their class.

Teacher	Ways of participating/understanding
Leonard and Bernie's teacher	- Leonard's maths improved a lot. He is enjoying every lesson. - He (Leonard) likes to solve the problems on his own. Even his reading skills improved. He likes to draw in order to illustrate his problem. - Yes, Leonard understands how to solve problems. He can work on his own and likes to explain how he got an answer and is proud to help others - Bernie's confidence and group participation improved. She loves maths and likes group work and to discuss while solving problems.
Jaya's teacher	- Jaya and the other learners definitely benefit from club. Although she struggles, I can see she is doing her best to participate. - The other learners (referring to 8 other learners in her class in another club run by the project) recognise the maths they do in (club) and are excited to attend (club).' - Their problem solving methods improved. They are very confident.
Thato and Sonny's teacher	- Yes, they were very quiet. Ever since they joined the club they are lively.
Agnes's teacher	- Yes, Agnes has become confident in answering questions verbally. The fear of giving a wrong answer (hesitating) has decreased. She starts to take chances. - She (Agnes) is still struggling with certain concepts but at least now she tries to find solutions for answers and not leave it hanging.

only responses in relation to learners' ways of participating and understanding. Table 1 provides a summary of the comments of the four teachers (across three schools) who taught the learners in 2012.

The teachers' comments point to learners shifting ways of participating and understanding. They refer to increased enjoyment (three of the four teachers refer to this), increased willingness to verbalise/discuss and engage mathematically (three of the four teachers) and increased willingness to try without fear of being wrong (two of the four teachers), which was also accompanied by use of the term increased 'confidence' (three of the four teachers). Each of these relates, respectively, to the following aspects of productive disposition discussed above and derived from the literature: enjoyment/excitement, reciprocity (Carr & Claxton 2002), resilience and steady effort (Carr & Claxton 2002; Kilpatrick *et al*. 2001), and self-efficacy (Kilpatrick *et al*. 2001). The increased risk taking or willingness to take chances as noted by Agnes' teacher, 'Yes Agnes has become confident in answering questions verbally. The fear of giving a wrong answer (hesitating) has decreased. She starts to take chances', connects clearly with confidence and is an important aspect of mathematical experimentation/playfulness as well as resilience (Carr & Claxton 2002).

Below, I present data from one club learner (Jaya) to illustrate shifts in ways of talking about mathematical disposition that were captured through administering a dispositional interview/questionnaire instrument. Similar shifts were noted for other learners in the club, although only Jaya admitted to not liking mathematics in the May 2012 questionnaire. Thus, her increasing love of mathematics was more visible over time.

The learner disposition interview was designed as both a written response (though orally administered) questionnaire and an interview schedule. The instrument involved several 'complete the sentence' items. The items included in this paper involved completing the sentence 'Maths is …' locating oneself on a spectrum of nine learners (the first indicating the weakest learner and the ninth the strongest in a class); completing the sentence 'Sam is …' after being told Sam is a strong learner who does well at maths. Another item asked learners how they felt about mathematics and a final question asked learners about what they do if they do not know an answer in maths class. (Sam was deliberately chosen as a gender-neutral name, although Jaya assigns male gender to this name in her responses.)

The dispositional instrument was administered to learners three times over a 1-year period (although two learners moved to a different town in 2013). All learner responses were transcribed. (Whilst there is much more data, including transcriptions of learners' shifting mathematical participation and proficiency in club sessions and mathematical task–based interviews, it is beyond the scope of this paper to share these data.) This is a clear limitation of these data, and as Lahire (2003:337) notes, 'a distinction must be made between dispositions to act and dispositions to believe'. In this paper, I have focused on dispositions in terms of what learners say, thus focusing on their beliefs rather than their actions even whilst the last question explicitly asked them about how they act in response to a particular situation of 'not knowing'. For shifting ways of participating for four of these six learners, as observed through video-recorded and transcribed club sessions in 2012, see Hewana (2013).

Table 2 shows shifts in Jaya's responses from May 2012 to May 2013 to four items that probed various aspects of her mathematical learning disposition.

Jaya's initial responses in May 2012 indicate a dislike of mathematics and a lack of confidence in her ability. She identifies herself as second from the bottom of nine performance-ranked learners in a class. Her description of Sam reflects the dominant finding in the data of 1208 Grade 3 and 4 learners in project schools where the same instrument was administered in May 2012 (including to Jaya as a learner in one of these schools) orally to a whole class, but learners provided individually written responses on the questionnaire. In this larger data set, most learners described Sam in terms of either innate cleverness or as someone who listens and/or is well behaved in class. Only 1% of learners described Sam as hard working and only 2% described Sam as someone who thinks or makes sense of mathematics (Graven & Heyd-Metzuyanim 2014). Similarly, Jaya's response that she will 'ask the teacher' if she does not know an answer was a common response (33%) of the 1208 learners. Whilst asking the teacher can be a useful learning strategy in some situations, especially if the aim is to enter into mathematical discussion aimed at learner sense-making, it can be equally problematic if these questions basically

TABLE 2: Jaya's responses to mathematics dispositional questions.

Question	May 2012	Nov 2012	May 2013
Maths is …	Phonics	When you are learning and the teacher tells you more things to learn. Tells you times tables, minus and divide sums.	Learning a lot of sums and you have to listen because the next day she (teacher) comes. (You must) concentrate on what the teacher tells you. Learning lots of fun maths games, cards to play, times table, division sums and multiply.
Self-evaluation	2	9	9
Sam is …	Good at maths	Is very good in the class. His teacher is very proud of him. He always does the things the teacher tells him to do.	Listens a lot and can remember what the teacher tells him. He is working everyday in his book. If he has done everything he shows the teacher and then fixes mistakes.
Feelings about maths	I don't like maths	I'm loving maths. It's so nice to be in maths class. It's my favourite thing. I have a (good work) sticker in my book. When I am big I will study it, maybe become a teacher, it will be fun for me to do maths with children. With other children we play school in class and I give them maths problems. Its lovely to do maths.	I love maths because its nice to do it and we learn more (in club) than what we do at school. Other: In maths club we do harder activities. Its nice we have fun.
What do you do if you don't know answer?	I ask the teacher	I write down the sums on the paper then I halve this … I draw some children when we do problems. Share the remainder in pieces.	Then I'm getting scared because the teacher says you didn't listen but last year the teacher said we must tell her and she would give a green counting card. In maths club I ask you and then I will try figure out the answer and use a paper. In class my friend explains and I ask for a piece of paper.

involve 'tell me what you want me to do so I can write what you want'. In such cases, learner questions work to obstruct learners from thinking for themselves in an attempt to avoid risking doing something that possibly the teacher did not want. In this respect, in Sfard's (2008) terms, ritual participation (participation aimed at connecting with others or, in this case, pleasing the teacher) would be foregrounded in such questions, reducing the opportunity for explorative participation (aimed at producing mathematical narratives so as to communicate mathematically). When administering the disposition instrument as a written response questionnaire across classrooms in 2012, I noted that many learners were fearful of answering these open-ended questions. Much encouragement and prompting was required accompanied by explanation that there was no one right answer and that I really wanted to know what they thought.

Whilst there are clear limitations to the instrument, especially when orally administered with written learner responses (as in the May 2012 responses), it does reveal some shifts in terms of Jaya's stated relationship with mathematics. Her first written response to what maths is indicates a difficulty with providing a written description of it and was assumed to have been copied from the word phonics that was written on the board at the time. Whilst her description of what maths is continued in 2013 to emphasise the importance of the teacher and listening and complying with what she 'tells you', she is able to describe a range of activities of the mathematics class including some fun maths games. Whilst Jaya's self-evaluation is overstated in relation to her performance positioning in the class, it coheres with her own improvement in mathematical proficiency (which in our task-based interview assessments showed improvement from 65% to 83% over 2012). Additionally, it shows Jaya's increasing confidence and sense of self-efficacy (a key aspect of a productive disposition in the definition provided by Kilpatrick *et al.*).

Similarly, Jaya's description of what behaviours constitute being a good math learner (i.e. Sam is …) shifted from simply being 'good at maths' or being compliant and pleasing the teacher (always doing what 'the thing the teacher tells him') to listening and 'working every day in his book' (steady effort) as well as a focus on correcting his errors (pointing to both steady effort and resilience). In terms of Jaya's relationship to mathematics, she shifts from saying she does not like maths to loving it and elaborates on how 'loving it' plays out with her friends. She indicates that she 'plays school' with other children by giving them maths problems and has additionally developed an imagined trajectory of studying it when 'she is big'. In relation to the discussion made above, one could argue that, at least in terms of what Jaya says, her mathematical participation and relationship with mathematics in terms of key dispositional traits has shifted.

Of interest, in 2014, she mentions that in clubs she does harder activities but adds that this is fun, indicating some resilience in relation to mathematical challenge. Similarly, her response in November 2012 indicates a wider range of options that draw on her own resources rather than only asking the teacher (May 2012) (e.g. writing and using drawings), when not knowing an answer. However, her May 2013 response shows that her disposition in class is strongly influenced by the teacher. Thus, with her Grade 4 teacher, she says she is 'scared' if she does not know an answer as she will be in trouble for 'not listening', whilst she says that her Grade 3 teacher would provide her with support resources such as counting cards if she did not know an answer. In maths club, she adds that whilst she will ask me, she will also try to 'figure it out'. That one's learning disposition is affected by one's teachers is unsurprising and indeed an assumption of this development and research work is that dispositions can be proactively shaped.

Conclusion

In this paper, I shared a sample of data to illustrate that after-school mathematics clubs can provide rich opportunities for developing increasingly productive learning dispositions. The data, exemplified by one learner, point to several indicators of shifting disposition. These indicators, as drawn from the Kilpatrick *et al*. (2001) definition of a productive disposition and the Carr and Claxton (2002) three key learning dispositions, included shifts towards increased: (1) sense-making; (2) steady effort, (3) self-efficacy; (4) experimentation/playfulness; (5) resilience, (6) reciprocity (willingness to engage) and supplemented with (7) love and passion for mathematics. Whilst these are captured in several of Jaya's responses, they are exemplified, respectively, by the following: (1) 'I figure it out'; (2) 'working every day in his book'; (3) '9' (4) 'I draw some children'; (5) 'fixes mistakes' 'we do harder activities, it's nice, we have fun'; (6) 'with other children we play school. I like to give them problems'; and (7) 'I'm loving maths. It's my favourite thing'.

Whilst I have argued that the after-school club I ran enabled shifting dispositions, this is not to imply that there is anything inherent in an after-school club that will ensure increasingly productive dispositions, nor that mathematics classrooms cannot and should not provide these opportunities. Indeed, supporting teachers to strengthen their student learning dispositions is critical, and within our broader work with teachers (in the NICLE project), we work towards promoting teacher practices that enable increasingly productive mathematics learning dispositions. However, I have argued that after-school clubs, because of their extra-curricular freedom, hold rich potential for explicit focus on strengthening learning dispositions. Club learners might then become catalysts in their mathematics classrooms for modelling increasingly active, participatory, sense-making, hardworking and resilient ways of engaging mathematically (as was indicated to some extent in the teacher data on shifting classroom participation of the six learners in this case study club).

Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

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