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The Evolution of an Instrument for Researching Young Mathematical Dispositions

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In this paper, we share our experience of searching for ways in which to access learner dispositions and the evolution of an instrument that we have used as both a written and an interview instrument. We argue for the importance of understanding young learner mathematical learning dispositions in order to inform ways in which to support learning. As researchers, finding ways in which to access learner mathematical dispositions can be difficult, especially with young learners who struggle to articulate their stories. Mathematical learning dispositions are taken to include what learners say about learning and how they act when they learn. The focus of this paper is on gathering data in relation to the former. In order to illuminate what the instrument allows us to see we share some preliminary findings from our research. Our findings draw on evidence gathered, in interview form, from 16 learners in two grade 3 after school maths clubs and evidence gathered, in written form, from 614 grade 4 learners across 10 schools in the broader Grahamstown area. We interrogate the extent to which these articulated dispositions indicate constrained learning opportunities. The preliminary findings shared in this paper illuminate both what the instrument allows one to see as well as the limitations of the instrument.

Keywords: mathematics dispositions; productive disposition; mathematics proficiency; instrument development

Contextual Background

There is little doubt that South Africa is facing a numeracy crisis (Fleisch, 2008). Research relating to this crisis consistently shows poor performance on a range of mathematics assessments including international assessments such as TIMSS (Howie, 2001), regional assessments (e.g. Carnoy et al., 2011; SACMEQ, 2010) and national assessments such as the Annual National Assessments (e.g. DBE, 2012). While a common focus of the press relates to poor performance on matric mathematics examinations, the above studies point to the problem emerging much earlier in the schooling system. A range of factors have been identified as contributors to this crisis including for example, poverty, teaching time, opportunity to learn, homework frequency and teacher knowledge. However few studies have looked into the identities and dispositions of young mathematical learners as a way of understanding the crisis. The first author's earlier research within the field of Mathematical Literacy indicated that many learners have negative mathematical histories that resonate with experiences similar to those of emotional abuse (Graven & Buytenhuys, 2011). The research showed that where learners were given access to mathematical sense making and opportunity to negotiate and participate in that sense making learners were able to re-author their mathematical learning dispositions in ways that supported rather than impeded mathematical learning.

This earlier work explored the nature of shifting learners' mathematical identities in various Mathematical Literacy classrooms from 2006 to 2008. Mathematical Literacy (ML) was introduced as a

new senior secondary school subject (a compulsory alternative to mathematics) in the South African curriculum in 2006 and this research tracked several learners in the first cohort. Particularly of interest and concern in that research was the extent of many learners' negative experiences of mathematics as early as the first few years of primary school. Learners' stories regularly included the terms *failure, struggle, stress, nervous, hated maths, worry, extremely difficult, no confidence* and *hopeless* (Graven & Buytenhuis, 2011). The stories written by learners provided rich insights into student mathematics learning trajectories within the context of their schooling. The instrument used here was simple. Learners were asked to write their story of their mathematical learning from the start of their schooling up to the last day. No further guidelines were given. Learners tended to write between 2 and 3 pages. Of special concern was that many learners connected their negative mathematical experiences to their broader self-image. For example one learner wrote: 'My struggle with Maths also negatively impacted my self-confidence, and left me feeling like I was stupid and useless' (Graven & Buytenhuis, 2011, p. 498).

Without deliberate intervention these stories will likely continue into adulthood. Wright, Martland, and Stafford (2006) write of how a three year gap in the early years of schooling (e.g. a grade 4 learner operating at grade 1 level) expands to a seven year gap in later years. However they also argue that young learners' arithmetical difficulties are highly susceptible to intervention especially through more individualised work. Indeed many experiences of ML learners indicated the opportunity to create entirely different stories of their mathematical learning when given the opportunity for active participation, learner engagement and sense making (Venkat & Graven, 2008).

From this experience we chose to run clubs as a direct learner intervention of the SA Numeracy Chair project at Rhodes. For further motivation for such clubs and their potential to re-author leaner dispositions see Graven (2011). A key aim of our clubs is to support learners in the development of mathematical proficiency which across all our development work within our projects we take to be defined in terms of Kilpatrick, Swafford, and Findell's (2001) five interrelated strands of conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition. While we have several instruments to help us monitor learners evolving levels of proficiency in terms of the first four strands (including, Wright et al. (2006) assessment interviews), we did not have an instrument which specifically engaged with the fifth strand of proficiency, i.e. productive disposition.

We thus needed to access learner dispositions in the clubs and the classrooms in order to assess this aspect of mathematical proficiency. The instrument discussed in this paper has been used as an interview instrument with our club learners as well as an orally administered but written response instrument given to all grade 3 and 4 learners across all the schools that we work with in the Rhodes University SA Numeracy Chair project. In this paper, we only report on the findings from our first two clubs (a pilot of 10 learners and another club of 6 learners) and on the findings gathered from 614 grade 4 learners from 10 schools in the broader Grahamstown area. These are all the grade 4 classes of schools participating in our Numeracy Inquiry Community of Leader Educators (NICLE) programme. Other data are still being processed.

Theoretical Framing of Learning Dispositions

Wenger's (1998) seminal work on communities of practice is particularly useful for thinking about student learning and the importance of developing positive participatory ways of being with learners. Wenger's (1998) work is based on the premise that people are social beings and knowing is about active engagement in the world. Since learning changes who we are, it is an experience of identity. Wenger explains that 'we define who we are through our participation and by the way we and others reify ourselves' (p. 149).

In our research we wish to explore the relationship between learners' mathematical histories and their evolving dispositions, forms of participation and changing ways of being in the clubs and in the classroom. Thus we draw on Wenger's notion of learning trajectories. According to Wenger (1998):

> As trajectories, our identities incorporate the past and the future in the very process of negotiating the present… Learning events and forms of participation are thus defined by the current engagement they afford, as well as by their location on a trajectory. (p. 155)

Wenger (1998) notes that identity formation involves a dual process of identification and negotiability. Identification provides 'experiences and material for building identities through an investment of the self in relations of association and differentiation' (p. 188), and, negotiability is 'the ability, facility, and legitimacy to contribute to, take responsibility for, and shape meanings that matter in a social configuration' (p. 197). Much recent research on learner dispositions explicitly locates itself within a socio cultural frame and connects dispostions to identities and particularly to Wenger's (1998) work on identity in different ways (see for example, Carr & Claxton, 2002; Deakin Crick, Broadfoot, & Claxtonn 2004; Gresalfi, 2009). While connections are made between dispositions and identities in these writings however, no clear distinctions are given for these concepts. This is likely to stem from an absence of an operationalised definition in most identity work. Thus Sfard and Prusak (2005) take issue with Wenger (1998) and others who equate identities as 'ways of being' for not having provided an operationalised definition of identity.

To research learner identities unfolding through participation in a community of practice such as math clubs or classrooms, an operational definition of identity becomes useful. In this respect Sfard and Prusak (2005, p. 16) define identities as 'collections of stories about persons or, more specifically, as those narratives about individuals that are reifying, endorsable, and significant'. Reification comes with verbs such as 'have' (e.g. 'she has strong maths ability') and we would add with declarations of one's being such as 'I am' (e.g. 'I am stupid'). Stories are considered endorsable if the identity builder can answer to them being a faithful reflection of a state of affairs. (e.g. 'I'm stupid because I always fail maths tests'). Stories are *significant* if a change in the story is likely to affect the storyteller's feelings about the identified person—e.g. a change in the story that 'he is a slow learner' to 'he thinks deeply about each problem' is likely to lead to a change in feeling by the storyteller about learners. Thus, within their definition identities are human made, collectively shaped by authors and recipients. This definition is helpful to researchers as this operational definition means we can access these identities through interacting with learners and teachers and paying attention to the stories told.

While much of the recent development in research on learning dispositions draws explicitly from a socio cultural perspective and Wenger's work on identities, the take-up of Sfard and Prusak's (2005) operationalised definition is yet to be explored. A great deal of theoretical work is required in order to examine the extent to which learning dispositions are a part of identities and where identities go beyond dispositions or ways of being and participating. This theoretical work is beyond the scope of this paper.

Here instead we focus on the notion of learner dispositions as the fifth strand of our working definition of mathematical proficiency taken from Kilpatrick et al. (2001). Productive disposition, as they 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)

This relatively simple and mathematically specific definition guided our initial search and design of our instrument and we thus explored dispositions *without* establishing the extent to which these were part of learner identities or the extent to which learner 'stories' or utterances about their dispositions were 'significant' or 'endorsable' for learners. The disposition data gathered from our instrument, however, serves as one aspect of a broader collection of stories of learners that we gather from a range of data sources, including observation of learner participation in clubs, classrooms, and eliciting learner stories from their teachers and/or care givers. This wider data gathering process should enable us to examine learner identities in an operationalised way as Sfard and Prusak (2005) suggest. Thus our aim here is limited to sharing an instrument designed to gather data from learners in terms of what they say about mathematical learning and not data we gather from observation of how learners act. As Lahire (2003, p. 337) notes, a distinction must be made between dispositions to act and dispositions to believe. In this paper, we report on the articulation of dispositions in relation to learner views on what maths is.

In the sense that productive disposition involves 'seeing oneself' as an effective learner and doer of mathematics, and, that dispositions commonly refer to a habitual tendency to act in a certain way, they relate to learner ways of participating in mathematical learning situations. In order to elicit learner stories about how they see and participate in mathematics required the development of some kind of instrument which asks learners questions to elicit responses.

Searching for Instruments which Access Learner Dispositions

Kilpatrick et al.'s (2001) strands of proficiency have been enormously influential in the field of mathematics education research. However, mathematics assessments tend to ignore this aspect. For example the nationally administered numeracy assessments for young learners such as the TIMMS studies (Howie, 2001) and SACMEQ (2010) studies tend to focus on assessing the first two strands of proficiency. They do not include any items which gather information on learner dispositions. Similarly, Deakin Crick et al. (2004) express a concern with 'the current dearth of assessment instruments concerned with something more than measuring performance and achievement' (p. 266).

Early numeracy assessment instruments, such as those developed by Wright et al. (2006) which assess progress of learners through various developmental stages according to their Learning Framework in Number (LFIN) are more comprehensive, and carefully document learner strategies rather than simply learner performance on items. These are conducted through one to one oral learner interviews and focus on assessment across the first four (but not the fifth) strands of proficiency. The Count Me In Too (CMIT) intervention program that used the LFIN framework across 1,700 schools in New South Wales similarly notes the absence of the instruments' documentation of the fifth proficiency strand. In order to document the growth of productive disposition they gathered reflective information from teachers which indicated for example: 'the development of a 'give it a go' mentality…, with greater overall persistence' (p. 41). However, this strategy has the disadvantage that it only provides secondary data.

Searching for instruments which gather information about learner mathematical dispositions with young learners tend to involve ticking or circling pre-given options. Mathematics attitudinal research of the seventies and eighties focused on the use of scales and the Fennema-Sherman Mathematics Attitude Scales published by Fennema and Sherman (1976) became widely used in the seventies, eighties and nineties (Mulhern & Rae, 1998). Attitudinal items such as 'I see mathematics as a subject that I will rarely use in daily life as an adult' (Mulhern & Ray, 1998, p. 302) which must be completed on a scale of 1–7, however, do not seem appropriate for young learners who are unlikely to be used to working with such instruments. We thus continued our search and found an instrument more appropriate for young learners which involved circling pictures. We adapted the instrument slightly and piloted it with 10 learners in our pilot club (August 2011). Since learners were young we thought perhaps an instrument with simple graphics and limited language might be a good starting point. Thus we gave learners 18 questions[1] (as in Figure 1) and asked them to circle a picture for each.

Perhaps unsurprisingly this yielded little insight into learner dispositions as we suspected that learners answered in terms of what they thought we considered the correct answer. So for example all learners circled the smiley face in the first and several circled the thumb up no matter what the question. Scaled instruments additionally have the drawback that they provide little space for hearing the unexpected from learners as learners simply tick or circle their response.

In November 2011, we also piloted with the same club learners a 'Learning Tree' instrument (Figure 2). This visual tool had been used by various Scottish organisations with children to help them explore their feelings. It was adapted for our clubs from these ideas[2] and was administered orally to each individual learner. We hoped that by using this instrument we could get the learners to talk about their own progression or learning growth (trajectory) in maths and through this we could talk about what they thought enabled them to progress mathematically.

While the interviews gave us a sense of how learners saw their progress we did not find that they told us much beyond that learners found it difficult to articulate reasons for their placement. We thus designed our own instrument (Figure 3) and piloted it with our pilot club of 10 learners. The instrument was administered as an interview and we recorded learner responses on the instrument.

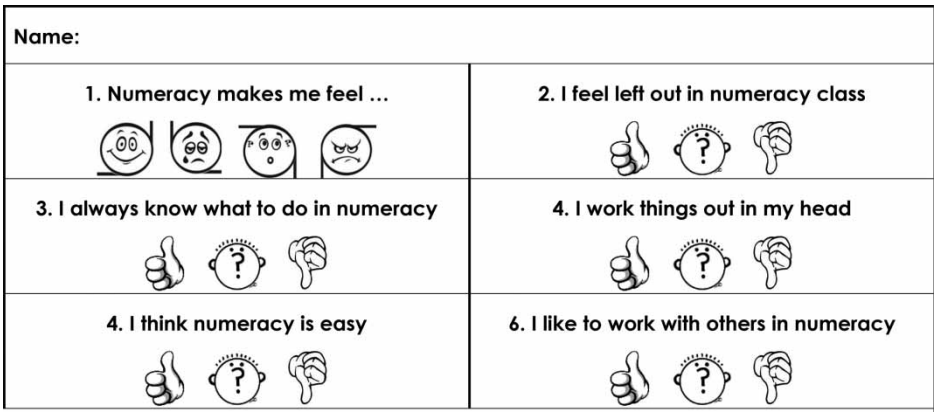

Figure 1: Initial simple graphic instrument

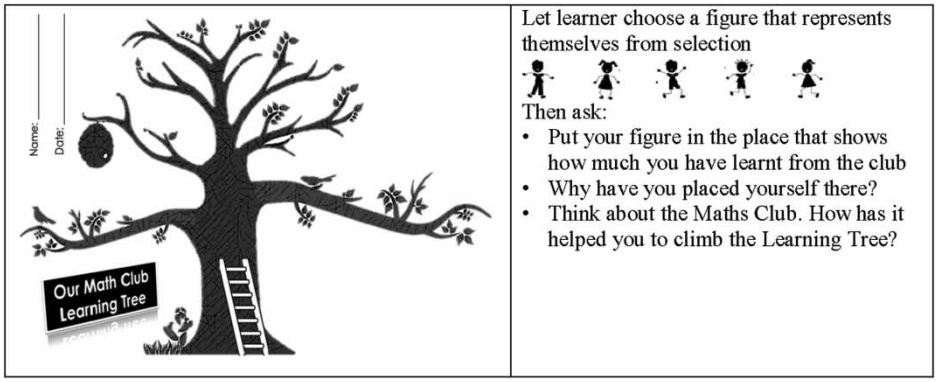

Figure 2: Learning Tree Interview Instrument

The instrument was purposefully open ended but allowed for key elements of a 'productive disposition' to emerge. Thus we asked learners, for example, open ended complete the sentence items such as, 'Maths is …' in order to see whether they see mathematics as a meaningful activity; we asked them to indicate where they saw themselves on a scale of one to nine learners, to see how they see themselves as a mathematics learner, and we asked them to describe a 'strong' mathematics student (with complete the sentence 'Mpho is…') in order to see whether they saw strength in mathematics as an innate ability, as teacher dependent or dependent on 'steady effort' and work. We also asked how learners respond to situations of 'not knowing an answer' in order to access how they say they would act in such situations. The instrument's referral to others (even while learners often followed descriptions of Sam or Mpho with 'I am…') aimed at enabling a 'safe' and less personal space where learners could articulate their views. The names Mpho and Sam were deliberately chosen to enable the interpretation of both male and female genders.

The findings of this instrument enabled us to see how learners positioned themselves within the class in relation to their perceived mathematical strength or weakness. Several learners responded by saying 'I am Mpho' or 'I am Sam' and thus when they described Sam and Mpho we were provided with windows into their stories about themselves as learners or non-learners. For example, Ray (pseudonym) said he was Mpho and described him as 'he's nice, he's playing, and talking and running around in class'. While it is beyond the scope of this paper to go into the findings from this instrument in depth the data provided rich-textured information on how learners perceived productive

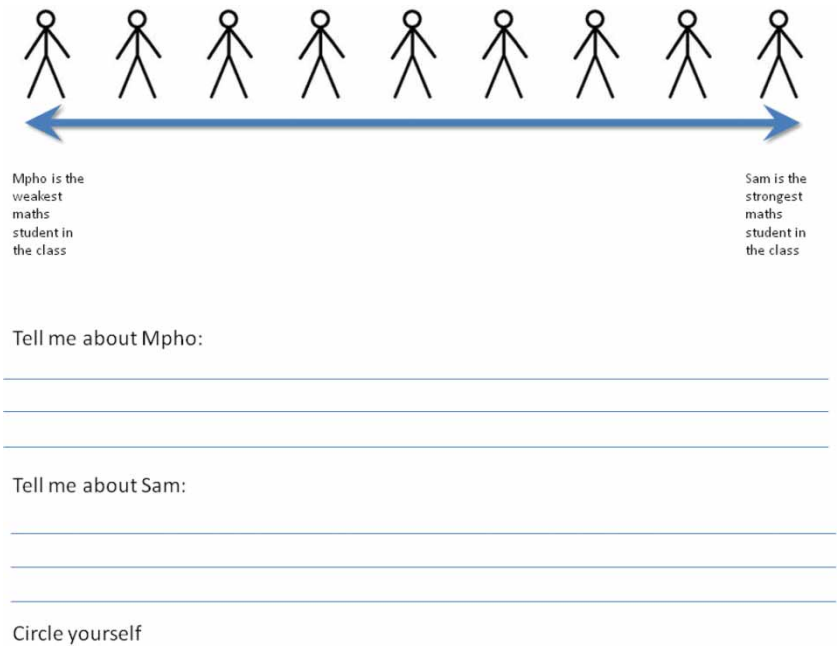

Figure 3: November—Pilot Interview

(and unproductive) learning dispositions. The dominant descriptor of learners for Sam was that s/he was someone who: listens to the teacher (6/10 learners; behaves or doesn't play (2/10); likes maths or a part of maths (3/10). On the other hand doing the work and working hard only received one reference across the responses. While not all learners provided responses for Mpho those who did described him/her in opposite terms to Sam, i.e. as not listening (4/10), playing or talking (3/10), doesn't like maths (1/10). These data provided us with insight into learner stories of the dispositions and ways of being in the mathematics class that they perceive as required for success. Of concern was that it seemed that compliance and passive listening dominated over active participation, challenging one's thinking and negotiated sense making. We were thus convinced that this type of instrument could be usefully used and extended to gather rich dispositional data for learners and we thus expanded it as in Figure 4.

POST PILOT: Interview

The complete the sentence items relate to being scared of and loving mathematics respectively. Learner completed sentences from our first 2012 club suggested 'because s/he gets everything wrong' and 'because s/he gets everything right respectively' as the dominant response with only one learner varying with 'because 'he's stupid' and 'he's clever' respectively. Another question on this instrument that we added which is providing rich and varied data is the question about what learners *do* if they don't know an answer in class. In this respect the question is different from the other questions in that it is the only question that aims to get at learner dispositions in terms of learner stated actions. While we acknowledge that one cannot simply assume that how learners *say* they act in class is the same as how they act it nevertheless does give us a sense of how they think they 'should' or are expected to act. Overwhelmingly learners in our first 2012 club interviewed in February 2012 answered with a variation of: 'ask your teacher' (5/6) or 'ask a friend' (1/6). While one might expect such answers one might equally expect answers that indicate thinking, developing a new strategy, or trying a different approach (see Graven, 2012, for examples from another club).

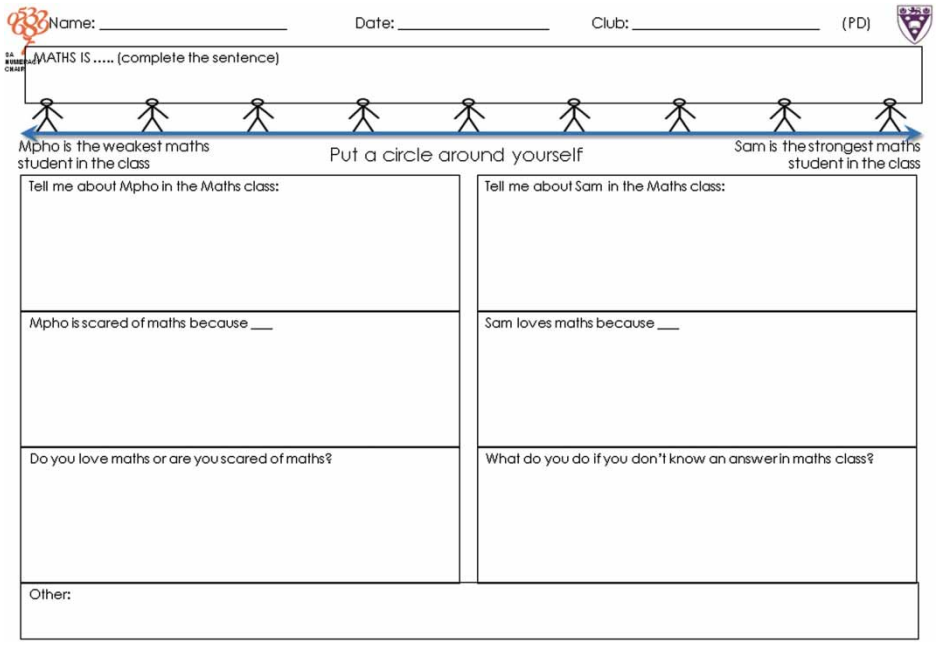

Figure 4: Post Pilot Interview

The addition of this question about what students do when they don't know an answer thus gives rich data into learner ways of being as mathematics learners and a sense of the extent to which they have developed a 'productive disposition'. While it gives insight into this for each learner it also provides insight into the way in which certain dispositions are promoted across classrooms and schools. While one cannot argue that the less teacher-dependent dispositions result in stronger mathematical performance there is much evidence that suggests that mathematical sense making and mathematical proficiency requires learners to construct their own knowledge and to think independently.

Contrasting Interview Data with Written Data

Contrasting written responses (administered in whole class) with use of the instrument as the basis for a semi structured interview enables us to note both the advantages and disadvantages of each. Administering the instrument as a written test allows for large numbers of responses to be gathered in a short amount of time. Thus in about 5 to 10 minutes one is able to gather 30 to 40 response sheets from a class of learners. The disadvantage of this method is, as indicated below, that a large portion (between a quarter and a third depending on the question) of the learner responses are illegible or un-interpretable. Thus, even while key themes and patterns are still visible from the remaining (about 70%) data, the dispositions of those learners with serious writing difficulties are largely absent from the data.

On the other hand to administer the instrument as a one to one interview takes between 5 and 15 minutes per learner and while the interviewer can make notes of learner responses on the recording sheet, in order to ensure that learner responses are correctly captured for analysis, transcriptions of audio recorded data become necessary. However the benefit of the interview form of this instrument is clear especially when wanting to explore in depth the possible evolution of learner dispositions over time. Gresalfi (2009, p. 333) notes that 'dispositions are not fixed but rather can shift over the course of the school year'. In order to illuminate what the interview allows us to see in comparison with the written interview we share the data of one of our learners in our smaller club, namely 'Jen' (pseudonym) who we interviewed over time (Nov 2012 and May 2013).

In her written response to the orally administered whole class assessment (May 2012) Jen responded that Maths is 'phonics'. The origin of this answer is unclear but perhaps this was written on the board at the time. She circled herself as the second weakest learner. She simply described Sam as good in Maths which is what the class was told when asked to describe Sam. She answered 'I don't like maths' to the question of 'do you love or are you scared of maths?' and simply wrote: 'I ask the teacher' in response to the final question.

In contrast her response to the oral interview several months later (May 2013) indicates that for Jen Maths is about learning lots of sums, listening to the teacher, concentrating on what the teacher tells her, learning times tables and sums like multiply and divide. Jen identifies herself with the top learner on the continuum and when asked why she explains 'because I learn a lot of maths and our teacher tells me Mellony's teaching you nice mathematics and now you understand it properly'. She describes Sam as listening and being able to remember what the teacher tells him and that he is working every-day in his book and that he then shows the teacher his work and does corrections if it is wrong. She says she loves maths because it is nice which is similar to her November 2012 interview where she explained: I'm loving maths. It's so nice to be in maths class. It's my favorite thing. I have a sticker in my book (good work sticker). 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 then maths problems. It's lovely to do maths'. In response to what do you do if you don't know an answer her response no longer indicates teacher dependence but instead she explains in her November 2012 interview that she draws sums on paper and draws some children to represent sharing. She expands on this in her later interview in May 2013 indicating that how she responds differs depending on the context and the teacher. So she explains that currently she would be 'getting scared' because the teacher would say she wasn't listening but that the previous year she would tell the teacher and then the teacher would give her the counting card. In the Maths club she said she would 'ask Mellony' (first author and mentor of the club) and that she would then try to figure it out and that in class she also does this (works it out on paper) and works with a friend.

The interview responses provide much richer data and indicate possible shifts in disposition from the first interview and the written test in May (2012). She is now able to articulate a range of dispositions required to be good at maths which go beyond listening to also working consistently (which relates to seeing that steady effort pays off—Kilpatrick et al.'s definition). Her response to not knowing an answer reveals both the situatedness of dispositions (Carr & Claxton, 2002; Gresalfi, 2009) and her evolving disposition which now includes more agency in terms of taking out paper and figuring it out and thus indicating a belief in one's ability to make sense of mathematics. Thus for Jen repeating the interview over time allowed us to explore the nature of her mathematical learning disposition better as well as the evolving nature of this disposition.

Data Gathered from Written Responses on the First Item

We were eager to gather dispositional data across all grade 3 and 4 learners in our participating schools, however conducting these as one-to-one interviews was just not feasible. We thus decided to use the instrument as a written instrument administered simultaneously to whole classes of learners. The instrument was orally administered in the sense that we read questions and explained to learners where they should write their responses. The instrument was translated into English, Afrikaans and IsiXhosa and translations were given where necessary in class to explain to learners what was being asked. Learners were asked to write their answers in any language, however, learners tended to answer in the Language of Learning and Teaching (LOLT) of their class at their school. Thus for two of our schools where isiXhosa as the language of instruction in grades 1 to 3 shifts to English in grade 4 learners answered mainly in English even while they could have answered in isiX-hosa. In the data capture words were translated into English for categorisation purposes. Both language and writing difficulties have thus impacted on what the instrument allows us to access in relation to learner dispositions. As will be seen in the data below 28% of learners did not provide a response to the item 'Maths is….', 5% provided responses that were incomprehensible

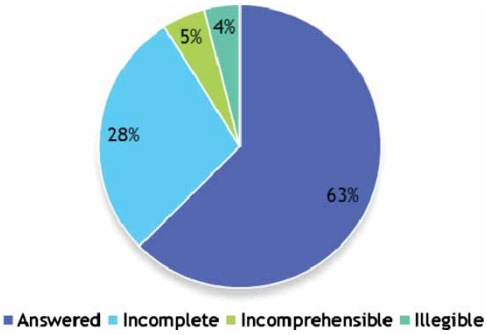

Figure 5: Types of responses obtained from learners

(for example, 'Mishhnoeiekk') and another 4% of answers were illegible (letters could not be made out). See Figure 5 below for graphical representation of this. Similar stats are emerging as our data are inputted for the other items on the instrument.

In order to give a sense of how the data point towards the presence or absence of 'productive dispositions' we share our findings in relation to what we saw across our 10 schools of 614 grade 4 learners in terms of the first item on the instrument—how learners see mathematics. These data enable us to gauge the extent to which learners describe maths in terms of a sense making, worthwhile activity.

All grade 4 response sheets were transcribed and coded using the program textalyser (where relevant) by the second author and about 10% of these were checked by the first author. If a word only appeared once in the entire sample it was classified under 'other'. Examples of this were: Maths is: 'phonics'; 'school work', etc. An exception was made for the response 'thinking' which only appeared once because this response speaks to individual mathematical sense making and we would wish to see more responses of this nature in the future. Across all schools the vast majority of learners provided only one word responses to the item. A small number of learners provided more than one word and so their responses are recorded in two categories in the table. For example: Maths is: 'sums and good'.

Our categorisation grid for the item 'Maths is…' from the instrument is shown in Table 1 below. Only totals across schools and classes are shown as the size of some of our classes may compromise anonymity within our project schools.

Figure 6 summarises the key responses that emerged from the 63% of learners who answered this question with a response that was recordable. It shows that the majority of these learners (31.6%) provide 'positive' attitudinal responses such as fun, good, nice, pleasant, likeable, lovely and even for a small percentage (3.9%) 'cool'. Another 7.5% of learners describe maths as easy while almost half of that (4.4%) indicate that it is hard or difficult. About a fifth of the learners (20.7%) see maths as sums or one or a combination of the four operations while another 10.1% see it as counting or simply describe it as numbers (3.4%). While the predominance of learners who see mathematics as fun, nice, good, and so forth, is pleasing the virtual absence of responses that indicate mathematics as involving thinking (0.3%) or solving problems (0%) is cause for concern and could indicate constrained or limited learning dispositions as argued from the smaller case study interview data on this same item. Additionally the data allows us to get a sense of similarities and differences across our 10 participating schools. So for example Maths is: 'cool' appeared in only two classrooms and thus could be related to a phrase promoted by those teachers or to a poster in the classroom.

The high percentage of unanswered, incomprehensible or illegible answers, particularly in some schools is cause for concern and also indicates an enormous limitation of this instrument when not used on a one-to-one interview basis. The result is that the instrument has only managed to gather data on dispositions from learners who have language and literacy levels that enable them to respond and thus cannot be generalised as data across all grade 3 and 4 learners in our project schools. However the recurrent themes which emerge from those learners who were able to

Table 1: Categorisation grid for data on 'Maths is…'

School	Teacher	No. of learners	No. answered	'Maths is …' Categories														
				Hard/ difficult	Easy	Counting	Numbers	sums or + - x ÷	Cool	Good/ pleasant/ fine/ likeable/ lovely/ fun/ nice	The best/ best thing/ right thing/ subject	Thinking/ you think	Reading	Tests	Other	Incomplete	Incomprehensible	Illegible
Totals		614	386	17	29	39	13	80	15	122	10	1	2	4	54	174	30	25
% out of 614			63%													*28%*	*5%*	*4%*
% of total No. answered				4.4%	7.5%	10.1%	3.4%	20.7%	3.9%	31.6%	2.6%	0.3%	0.5%	1.0%	14.0%	N/A		

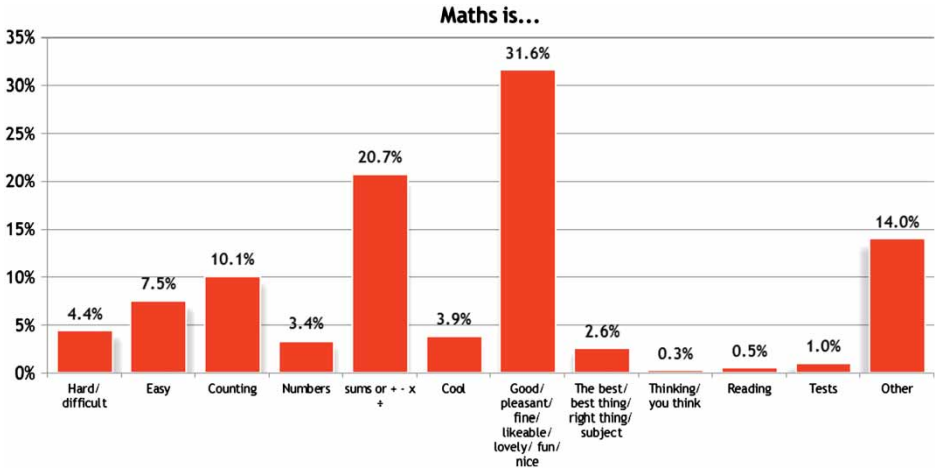

Figure 6: 'Maths is..' results

respond provide us with interesting information about learner dispositions which can help inform our work with learners and schools. For example the absence of learners who indicate that maths is about thinking, problem solving or sense making is cause for concern. If the 'tendency to see sense in maths' is absent across responses of learners then this indicates perhaps that our learners' mathematical dispositions are restricted. Similarly themes emerging from other questions indicate restricted dispositions in terms of belief in 'steady effort'. The administration of the instrument as an interview with a smaller number of learners provides richer insight into the themes emerging from the written assessments and furthermore enables learners with low literacy levels to contribute verbally. We would thus argue that researchers who wish to use it should consider supplementing it with a sample of interviewed responses.

Concluding Remarks

In this paper, we have shared the evolution of an instrument we designed to gather data on learner dispositions in terms of what learners say. While this instrument is generating rich data and our ongoing data coding and analysis is enabling us to explore the notion of learning dispositions further we have elaborated on the limitations of this instrument. This is particularly the case when

administered as a written instrument in contexts where literacy levels are low. We have also acknowledged that the instrument does not gather dispositional data in terms of learner actions in context (whether in maths clubs or classrooms) as this requires recording observational data. In our broader research work we are working to develop frameworks and instruments for recording learner dispositional data from video observations drawing particularly on Carr and Claxton's (2002) dispositional categories of resilience, playfulness and reciprocity.

Freedman and Combs (1996) in their book *Narrative therapy: the social construction of preferred realities*, argue that the metaphor of stories helps us to see how stories circulate in society and how these realities are socially constructed, constituted through language and maintained through narrative. Our data indicate that this instrument provides a start at accessing learners' mathematical stories and that access to these provide us, as teacher educators and math club facilitators, with a starting point for planning our future interventions. Preliminary analysis of the data shared in this paper indicates relatively constrained mathematical dispositions since sense making and critical, creative thinking are largely absent from learner stories of what maths is, despite their being foregrounded in recent Curriculum and Assessment Policy documents for both foundation and intermediate phase (DBE, 2011a, 2011b). We hope this instrument will enable us to continue to explore possible evolving mathematical learning dispositions in the context of our longitudinal research in our various projects.

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Notes

1. Adapted from the Kentucky Centre: http://www.kentuckymathematics.org/intervention/iResources.asp#Teacher
2. http://www.evaluationsupportscotland.org.uk/resources/227 and http://www.inspiringscotland.org.uk/UserFiles/Documents/GoPlayOEF.pdf (p. 29)

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