

Creating new mathematical stories: exploring opportunities within Maths clubs
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Introduction

In this paper I argue that many learners have negative mathematical histories that resonate with experiences similar to those of emotional abuse. Drawing on Sfard & Prusak's (2005) narrative definition of identity – as the reified, significant and endorsable stories we tell, this paper argues that it is critical that we provide the space for learners to develop new mathematical stories and thus identities. Earlier research into identity transformations of mathematical literacy learners paired with my recent experience of starting an FET Maths club in the Eastern Cape point towards the opportunity for the development of more participatory mathematical identities given the opportunity for learner engagement, negotiation and participation (Wenger, 1998).

These experiences lead me to explore, from a research and development perspective, the potential of extra curricula maths clubs, in providing supportive communities where learners can live out different stories. This is not to deny the need for mathematics classrooms to provide the opportunity for more participatory and positive learner identities but rather that the extra curricula nature of such clubs might provide increased freedom to *focus* on the deliberate construction of positive participatory mathematical identities intentionally at the expense of covering the range of skills and knowledge required to 'get through' the curriculum.

My story illuminates that where clubs are formed in such a way that the practice involves deliberate creation of more engaging, confidence building and participatory forms of practice and on the disruption of passive teacher-dependent 'ways of being' learners have an increased opportunity to re-author themselves (and be re-authored) as mathematical producers, mathematical questioners, and mathematical explorers.

Thus at the end of the paper I raise several research avenues for exploration in relation to what such clubs have to offer that is different or similar to the learning space available in many maths classrooms.

Are many learners mathematically 'abused'?

In earlier work with Prof Hamsa Venkatakrishnan I explored the nature of shifting learners' mathematical identities in various Mathematical Literacy classrooms from 2006 to 2008 (See Graven, 2009; Venkat and Graven, 2008, Graven and Venkatakrishnan, 2006). Mathematical Literacy was introduced as a new subject in the South African curriculum in 2006 and our research work tracked several learners in the first cohort from Grade 10 (2006) to Grade 12 (2008). In particular that work examined the way in which the new mathematical literacy curriculum enabled the formation of positive mathematical identities and enabled increased access and quality mathematics education particularly for learners with weak mathematical histories. Particularly fascinating in that research was

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the extent of many learners' negative experiences of mathematics as early as primary school. The experience of mathematics as something completely alien (and alienating) as if they were 'learning in Greek' (as one learner put it) pointed to experiences of an absence of opportunity for sense making and resultant feelings of hopelessness.

Learners' stories regularly included the terms *failure, struggle, stress, nervous, hated maths, worry, extremely difficult, no confidence* and *hopeless*. I include a few excerpts from learner stories of early mathematical experiences written on the last day of their schooling in 2008 in one teacher's (Esme Buytenhuys) mathematical literacy classroom (See Graven and Buytenhuys, 2011). These stories help to illuminate the argument that follows.

"Ever since Grade 1 I have always struggled in maths. Since I was younger I have refused to do maths homework not because I don't want to do my homework but because I simply did not understand the work that needed to be done."

"Mathematics for me was a daily struggle. I stressed and cried a lot because of my inability to fully grasp mathematical concepts"

"Ever since I started school in Grade 1 I have found maths to be one of my real weaknesses. I always struggled and never felt confident. As the years dragged on nothing changed. I felt left behind in every class. It's not fun knowing that there is no hope in the world that you can pass the test."

Many learners also connected their negative mathematical experiences to their broader self-image. For example one learner wrote: "I used to hate anything and everything that had to do with Maths. My struggle with Maths also negatively impacted my self-confidence, and left me feeling like I was stupid and useless".

The wide range of experiences shared by learners in interviews and in their writing led both the teacher and I to consider whether learner experiences of mathematical lessons resonated in any way to experiences of emotional abuse. Esme (the teacher of the class) in writing about the complete mathematical metamorphosis of her learners writes:

"The caterpillar stage: I clearly remember those first few months with my six Grade 10 Math Lit learners. They started out slinking into my class looking for a place to hide – to go unnoticed for 45 minutes. There was a tangible invisible barrier between the learners and me... I began to understand the nature of the learner who appears in the Math Lit class at the outset of Grade 10. These are precious young people who have been mathematically abused and for most as early as in Primary School." (Graven and Buytenhuys, 2011, 497 – 498).

Searching Wikipedia (2/18/2011) and other definitions of emotional child abuse indicates abuse can include "excessive criticism, inappropriate or excessive demands, withholding communication, and routine labelling or humiliation" and that victims may react by "distancing themselves... internalizing the abusive words... a tendency for victims to

blame themselves (self-blame) for the abuse, learned helplessness, and overly passive behaviour”. The stories of learners above indicate self-labelling and blame (in terms of mathematical inability), a sense of helplessness, and a distancing and non-participatory stance to further learning. It was interesting to note the relative absence of reference to the teachers’ role in the stories although some learners did refer to not understanding their teachers. More commonly the experience of ‘excessive criticism’ and ‘abusive words’ came in the form of consistent failing results in work, tests and projects – for example “30% - Fail!”. Thus, no matter how unintentional, mathematical learning (or rather lack of learning and failing performance) is experienced by many learners as – ‘excessive criticism’, ‘excessive demands’, and ‘routine labelling’ which is then internalised by learners as ‘I am a mathematical failure’ or ‘I am stupid’.

So while emotional abuse is much broader and more complex than these characteristics of the definition that I have chosen to include here, there is a certain amount of resonance between learner stories and notions of emotional abuse that warrant exploration into the creation of opportunities to work with learners to create new relationships with mathematics and thus to help learners tell new stories about their experiences. Indeed each of the learners above told an entirely different story of their mathematical learning within Esme’s Mathematical Literacy class and as a result of active participation and engagement in the class spoke of mathematical competence and confidence to solve mathematical problems in and beyond the classroom.

Esme described their metamorphosis into the butterfly stage as becoming mathematical negotiators who no longer shy away from “maths” (See Graven and Buytenhuys, 2011).

What enabled learner transformations in Esme’s classroom?

Overwhelmingly learners’ reasons centre around the nature of participation and engagement afforded in these Mathematical Literacy classrooms. Learner comments primarily linked the reasons for this to their changing participation in the classroom in relation to two factors: ‘real’ collaboration and ‘real’ problem solving and through these the opportunity for sense making. Furthermore, in this engagement, their own methods and ideas were valued. For Esme (teacher) the slower pace of the curriculum and its explicit reference to getting each learner to ‘become a self-managing person’ (DoE, 2003, 10) enabled her to focus on developing learner confidence as a priority. She deliberately and consciously worked towards developing learner confidence through encouraging their contributions and following their thinking and methods. She explained to learners that many of the scenarios that were introduced (e.g. blood alcohol levels) were new to her too and she therefore did not have the answers. They would need to figure out how best to make sense of the mathematical thinking embedded in the scenarios together through active participation and discussion.

In addition the newness of the subject meant that there were no matric assessment precedents to drive the learning in class. Thus there was freedom for Esme to interpret the curriculum’s rhetoric of ‘maths for life’ and ‘developing confident mathematical ways of being’ according to the needs of the learners in her class without the

distraction of preparing for examinations. [This said her learners performed well in the final matric examinations – all passed and 85% achieved at the highest levels of ‘outstanding’ and ‘meritorious’].

Responding to a question in a seminar about how learning trajectories and identity relate to mathematics classrooms where trajectories tend to be outside of the classroom and generally away from Mathematics Wenger¹ posited that perhaps his theory ‘was not ready for prime time’ for school classrooms. He argued that schools tend to put skills and information before meaning and curricula focus on cognitive aspects of learning while within his theory identity should drive cognition. He writes:

“What makes information knowledge – what makes it empowering – is the way in which it can be integrated within an identity of participation. When information does not build up to an identity of participation, it remains alien, literal, fragmented, unnegotiable. It is not just that it is disconnected from other pieces of relevant information, but that it fails to translate into a way of being in the world coherent enough to be enacted in practice. Therefore to know in practice is to have a certain identity so that information gains coherence of a form of participation.” Wenger (1998, 220)

Esme’s learners’ early mathematical experiences included above illustrate Wenger’s point. On the one hand they reveal that an absence of opportunity to participate meaningfully in mathematical learning alienated learners from developing mathematical identities. Indeed in these learner stories previous knowledge gained was not empowering and remained literal and fragmented resulting in experiences of excessive demands and on-going failure. On the other hand the formation of a new form of mathematical collaboration focused on the joint enterprise of solving various problems (that were open to a multitude of learner generated approaches and solutions) led to more active forms of participation involving engagement and negotiation. This enabled the formation of positive identities of mathematical participation and the experience of mathematical knowledge as empowering, both in and beyond the classroom.

Professor Jill Adler at the FirstRand Mathematics Education Chair Community of Practice forum held in Cape town (30/11/2010) argued in her presentation 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’ – i.e. passing assessments handed down by the Department of Education (DoE) and producing documentation that can be checked and approved by the DoE. Of course this is a challenge for all teachers and the pressure teachers are under to ‘comply’ with departmental demands and to meet ‘performance standards’ is enormous. The rollout of the Annual National Assessments (ANA) in various grades across the country (January/February 2011) and the pressure on schools to perform well in these

¹ On the 8th June 2007 Etienne Wenger visited Wits University, Education Department where he presented a seminar on “Social Learning Theory and communities of practice”. This part of the story refers to Wenger’s response to a question by Erna Lampen.

assessments might of course lead to teaching towards assessment as early as in the Foundation phase. We must indeed find ways within the maths classroom for identity to drive cognition and for increasing learner engagement and participation in mathematical sense making.

However the focus of this paper is on examining the potential of mathematics clubs in supporting the development of positive learner identities outside of the boundaries of curriculum compliance and assessment preparation. Drawing on my own experience of starting a Maths club, I argue that clubs are an opportunity for disrupting passive learning culture and deliberately working with learners to become confident mathematical participators. There is no need in these clubs to 'comply' because they are by definition 'extra-curricular'. This said, I do acknowledge that there might be a tendency for such clubs to comply and to simply be an extension of mathematics classes in after school time. I also acknowledge that there is nothing inherent in an after school maths club (just as there is nothing inherent in mathematical literacy classrooms), that will enable the formation of positive learner identities, only that they hold the potential for providing an enabling space. Perhaps then such clubs can enable the mathematical metamorphosis of learners into mathematical negotiators and producers as we have seen in Esme's class. In order to illuminate the potential of such clubs I share my own story of starting a maths club.

My story of starting a Maths Club

My story is based on a maths club that I started in February 2009. The club ran from the Mathematics Centre of a private school in South Africa and involved 22 Grade 10 and 11 Mathematics learners (in 2010 they were in Grade 11 and 12) from three 'traditionally disadvantaged' schools that were within 7km of the school. The invitation to learners was through an existing program of Saturday classes that ran with learners in these three schools. The Saturday classes predominantly took the form of whole class teaching that summarised key concepts in relation to various topics in the curriculum. These Saturday classes ended in 2009.

The Maths club ran every Thursday afternoon from 3pm to 4:30pm during term time. In the second year I drew in an additional 'mentor' to support discussion and engagement with learners. Learners tended to arrive at 2pm in order to work together in groups or to use the computers and internet access for research into projects, math games or use of math support programs. Participation in the Maths club was voluntary. Many of the learners had experienced severe disruptions in their mathematical learning at their schools as a result of not having a teacher for substantial periods of time as well as other disruptions such as school specific and nation-wide strikes. The aim of this club was to provide learners a space where they could ask their own questions, produce their own mathematics, talk mathematics, explain mathematics and enjoy mathematics! There would be no 'on the board' whole class teaching and learners needed to arrive with their mathematical productions and ideas about what they wanted to work on. I positioned myself as a mentor rather than the teacher - this was made easier by the fact that I was not an FET mathematics teacher. They had to show and explain to me what they had

produced and engage me on where they felt they were confused. They needed to take the lead in asking me questions related to their mathematical activity over the past week. No activity plan, lesson plan or homework plan was given for the club. Each session was entirely based on what learners brought to the session and what they chose to engage about. A range of resources were provided including some text books on newer curriculum topics and a set of past examinations with solutions. New calculators were also provided thanks to a donation by Casio. Learners were provided with the “Ask Archie” computer learning program that ran through key concepts in each of the topics covered in Grade 11 and Grade 12. Learners were able to use these at their schools, in community centres or in the Mathematics Centre before and after the club session.

The club also became a space for negotiating future possible mathematical trajectories through discussing and investigating career options. Learners were provided access to resources such as the UNISA College of Science, Engineering and Technology MathEdge CD and website www.MathsEdge.org.za which provides access to critical information on mathematical careers, local university mathematical courses, access to entrance requirements and stories of inspirational achievements of South Africans working in mathematical fields. One of the learners, Vuyile, drew on the club to explore post school mathematics that he had come across. He had heard about a topic taught at University and wanted to know how to do it. We researched some of it over the internet (as my memory of some University maths was shaky) and he went off with my first year varsity mathematics textbooks. He dived into Olympiad type questions and tended to use the time in the club to find more challenging work. He showed little interest in the core maths curriculum taught at his school. He also used the club as a space where he could show his alternative methods to solving a problem and seemingly enjoyed convincing us ‘mentors’ of the logic of his methods as well as the beauty and sometimes superiority of his approach. His focus was to use the club to extend and challenge himself and to share findings and methods that were not in the textbook. His novel ways of approaching problems were interesting and created learning opportunities for me as I began to understand some mathematical topics in new ways. While he showed little interest in exam preparation he nevertheless achieved 100% for his 2010 matric national mathematics examination and has gone on to study a B Sc with a specialisation in Mathematics with a full bursary. While this student is of course somewhat exceptional the other three participating Grade 12s achieved two Bs and a D in their matric examination. The remaining students in the club will complete their Grade 12 this year in 2011.

The point for me about this club was that rather than teaching ‘catch up’ lessons in whole class style to learners (as in the previous Saturday classes) the club enabled learners to take responsibility for their own learning and for mentors to support their mathematical journeys. For Vuyile it was about extending himself way beyond what was in the curriculum and the opportunity for being challenged and sharing/communicating his discoveries of how to solve something in a new way and having to defend and argue these methods. For others it was about engaging support for understanding work they had been given at school and had tried themselves, often with other members of the club. As

with Vuyile they would lead the learning with their questions that emerged from their individual or small group mathematical workings and productions.

While I have no doubt that Vuyile would have succeeded at Mathematics irrespective of this club, (Vuyile obtained the top result, a B, for an assessment conducted by the teacher of the Saturday classes program in early 2009), the club enabled a strengthened identity as an excellent mathematical thinker and someone who produced his own mathematics. It supported him in achieving exceptional results which resulted in his identification as a top mathematical achiever both locally and regionally thus strengthening the development of a future mathematical trajectory. (He is majoring in Mathematics in his B Sc with his eye on possibly going into actuarial science). Similarly the results of the other participating students showed improvement. The improving performance, however, is less an indicator of the success of the club than the more active, sense making and participatory mathematical ways of working that learners adopted.

What frames are useful in reflecting on my story?

I have found Wenger's (1998) seminal work on communities of practice particularly useful for thinking about the learning community of a maths club and the importance of identities of participation (and non-participation). However to research learner identities unfolding through participation in a community of practice such as math clubs I need an operational definition of identity. In order to provide an operational definition for identity Sfard and Prusak (2005, 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. 'I have a mathematical brain') and I would add with declarations of one's being such as 'I am' (e.g. 'I am mathematically 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 mathematically stupid because I always fail 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. Their definition differs from Wenger's (1998) notion of identity in the sense that Wenger sees these discursive counterparts as only part of "the full, lived experience of engagement in practice". Despite this divergence Wenger's perspective on identity is particularly useful in considering the *process* of the formation of identity through his three modes of belonging within a community of practice: engagement, alignment and imagination. These modes of belonging in conjunction with identification and negotiability (as the mechanisms by which modes of belonging become part of our identities) enable us to explore how learner identities are shaped within the broader framework of learning within a community of practice where learning as

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belonging, learning as doing, learning as experience and learning as becoming are all interconnected.

Freedman and Combs (1996) in their book *Narrative therapy: the social construction of preferred realities*, argue that the metaphor of stories helps one to see how stories circulate in society and how these realities are socially constructed, constituted through language and organized and maintained through narrative:

“When life narratives carry hurtful meanings or seem to offer only unpleasant choices, they can be changed by highlighting different previously un-storied events, thereby constructing new narratives. Or when dominant cultures carry stories that are oppressive, people can resist their dictates and find support in subcultures that are living different stories” (p32-33).

In this sense supportive communities such as maths clubs hold the potential for enabling learners to live different stories. These maths clubs should open up these alternatives because as we have seen in many of the learner stories included in this paper these stories ‘carry hurtful meanings’, undermine mathematical identities and impede learning. The stories of learners in Esme’s class and in the math club indicate a willingness and capability of learners to re-author their mathematical identities given the opportunity for mathematical sense making and active participation, engagement and negotiability. It is hoped that the future research and development work into learner clubs will provide a fruitful space for engagement leading to shifts in the deficit discourse of numeracy education by highlighting opportunities available within the current landscape of educational constraints.

Where to from here?

What has been described above is my story about stories (Sfard and Prusak, 2005). I have told my story of my experience in this club with the view to informing my own trajectory of working with clubs in primary schools within the FirstRand Foundation Chair in Numeracy Education. I believe that this story indicates the potential for what mathematical clubs might offer given the creation of learner opportunities for active engagement, negotiation and participation. Furthermore, since negative non-participatory learner identities seem to appear in many learner stories quite early in their mathematical learning it would make sense to explore the opportunity clubs might offer in ‘interrupting’ these negative relationships and re-authoring new positive experiences, stories and thus identities. The danger of negative stories (negative labeling) is they become self-fulfilling prophecies (Sfard and Prusak, 2005) and hence shut down the space for future learning and create cul de sacs along potentially exciting mathematical learning trajectories.

In beginning my learning trajectory into maths clubs I define, for our purposes here, maths clubs as extra curricula clubs focused on developing a supportive learning community where learners active mathematical participation, engagement and sense making are the focus. Individual, pair and small group interactions with mentors are the

dominant practices with few whole class interactions. From this point of departure the following questions emerge as potentially useful in mapping a future research trajectory:

Can Maths clubs interrupt passive teacher dependent learning identities of primary learners? If so what are the mechanisms that allow for this?

How might opportunities for learner independence, argumentation and listening to others perspectives (negotiability) differ for differing educational bands (Foundation phase, intermediate phase, senior phase and the Further Education and Training band)?

How might opportunities for learner independence, argumentation and listening to others perspectives (negotiability) differ for learners with differing mathematical confidence² levels?

Can maths clubs provide the space for mathematical support directed at help for learners to overcome their fear, shame and helplessness? If so how can clubs enable this? What norms and practices are needed in clubs to allow space for such support? What activities are needed? What forms of mediation are needed?

What are the roles of mentors in such clubs and how might mentors be prepared for their role in such clubs? Who might be drawn on as mentors for such clubs? What resources are required for such clubs?

What research lenses, analytical tools and related methodological approaches might be useful in researching these questions?

A general scan of the literature in the field of mathematics education seems to indicate an absence of literature pertaining to learning within math clubs especially as relates to early learners. We thus hope that we will be able to collaborate with other running mathematics clubs in South Africa in order to enter into dialogue in relation to the above questions and beyond.

References:

- Department of Education. (2003). National Curriculum Statement Grades 10-12 (General): Mathematical Literacy. Department of Education, Pretoria.
- Freedman and Combs (1996) *Narrative Therapy: the social construction of preferred realities*. W.W. Norton & Company, New York.
- Graven, M. (2009). Wenger's (1998) perspective on learning is 'ready for prime time' in some Mathematical Literacy classrooms. *Proceedings of the 17th Annual meeting of the Southern African Association for Research in Mathematics, Science and Technology Education*, Rhodes University, 1, 71-81.
- Graven and Buytenhuys(2011). Mathematical Literacy in South Africa: Increasing Access and Quality in learners' Mathematical Participation both in and beyond the classroom. In Atweh, B.; Graven, M.; Secada, W.; and Valero, P. (Eds)

² Within the perspective taken in this paper I replace the much used term 'ability groups' with the term confidence groups as especially in the early years and with labels resulting in self-fulfilling prophecies I believe it is more useful to think about and characterize learners in terms of their confidence levels demonstrated through their levels of engagement and participation than referring to some reified ability that is considered to reside inside of learners.

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- Mapping Equity and Quality in Mathematics Education*. Springer: Heidelberg, 493-509.
- Graven, M. and Venkat, H. (2007). Emerging pedagogic agendas in the teaching of Mathematical Literacy. *African Journal of Research in SMT Education*, 11(2) 67-84.
- Graven, M. and Venkatakrishnan, H. (2006). Emerging successes and tensions in the implementation of Mathematical Literacy. *Learning and Teaching Mathematics*, 4, 5-9
- Sfard, A. and Prusak, A. (2005). Telling Identities: In Search of an Analytic Tool for Investigating Learning as a Culturally Shaped Activity. *Educational Researcher* 34 (4) 14-22.
- Venkat, H. and Graven, M. (2008). Opening up spaces for learning: Learners' perceptions of Mathematical Literacy in Grade 10. *Education as Change*, 12, 29-44.
- Wenger, E. (1998). *Communities of Practice: Learning, Meaning, and Identity*. Cambridge University Press: New York, USA.