

Affordances and constraints in a Primary Maths Community of Practice in-service programme

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This study is broadly framed by the Communities of Practice perspective and specifically the situative concepts of constraints and affordances (Greeno, 1998). The paper draws from a broader ethnographic study and presents data gathered from interactive interviews, field work observation notes and collected documents. The study purposively sampled 10 teachers who were participants in a primary maths focused community of practice professional development initiative called the Numeracy Inquiry of Leader Educators (NICLE). The paper discusses activities within NICLE which constrained or enabled the evolving of the participants' numeracy teacher practices. Teachers offered attunements to most of the participation and learning constraints. The study indicates that teachers mostly take-up and appropriate innovative affordances presented by primary maths experts and fellow teachers that link theory and practice and especially when teachers collaboratively engage with concepts, tools, demonstrations and activities that relate to classroom practices. Such affordances deepen teachers' primary maths knowledge, enable teachers to engage learners in maths classes and afford opportunities to focus on student thinking.

Introduction

This paper draws from the first author's longitudinal PhD ethnographic study and focuses specifically on his third research question, which investigates: Activities and forms of participation within the Community of Practice which enable or constrain evolving teacher numeracy identities and practices and how these enable or constrain teacher evolving identities and practices? Because of space limitation this paper only focuses on numeracy teacher practices and not their identities. This study is theoretically informed by the Community of Practice perspective (Lave and Wenger, 1991, Wenger, 1998) and Greeno's (1998) situative concepts of 'constraints and affordances'. Attending to the aforementioned research question this paper discusses affordances and constraints of primary maths teacher practices of ten sampled educators participating in a professional development Community of Practice called the Numeracy Inquiry of Leader Educators (NICLE) designed and run by the second author.

The first author has been a participant observer in NICLE, which forms the empirical field of research to this study. The numeracy professional development programme was conceptualised as both a Community of Practice and Inquiry (Wenger, 1998, Jaworski, 2005) teacher development approach. The NICLE initiative focuses on numeracy (primary maths) teacher development within the Foundation and Intermediate Phases in 12 primary schools in the greater Grahamstown area and currently has 47 teachers who attend fortnightly seminars and inquiry sessions held at Rhodes University.

Most of the constraints and affordances outlined by the teachers resonate with maths teacher education literature (Garet et al, 2002, Graven, 2005, Adler and Reed, 2001, Farmer et al, 2003). The sampled teachers reveal different attunement 'strategies' to participation constraints that they experienced. Exceptional for this study is that the constraint concerning the 'size' of the teacher learning community needs further research on how to '*re-scale up*' maths professional development initiatives. Secondly teachers tend to learn and appropriate into their maths classes innovative NICLE affordances presented by primary maths experts and fellow teachers that connect with their maths classroom practices. We investigate the features of the NICLE activities that support teacher learning and what enables teachers' take-up of these tasks into their maths classes.

Research Methodology and Theoretical Framing

The data presented in this paper is mainly from interactive interviews with 10 purposively sampled teachers who are part of a broader educational ethnographic doctoral research study of the first author. The interactive interviews were carried out in November and December 2011. We supplement interactive interview data with field work observation notes and NICLE documents that were given to participating teachers in the first year of the maths community of practice teacher development initiative.

Teachers in the sample are from four different types of schools in the South Africa education system. Four teachers are from a farm school which had multi-grade classes (Mary, Belinda, Swallow, Everton), two are from a historically African township school (Pamela and Calvin), two are from historically coloured schools in a historically coloured area (Edna and Robert), and two are from an ex model C preparatory school in a formerly white area (Melania and Ruth). In this sample of teachers three are intermediate phase teachers, two of these are male (Calvin and Robert) and only taught maths classes. The other female intermediate phase educator was an all-subjects multigrade teacher (Everton). The other seven teachers in the sample are all female foundation phase teachers; one of whom is a multi-grade teacher of grades 2-3 (Willow) and two are grade R teachers (Edna and Mary).

The coding and exploration of raw data obtained from interactive interviews, field work observation notes and documents collected from NICLE was guided by the situative theoretical elements of affordances, constraints and attunements (Greeno, 1998). The outlined participationists' concepts will be used to analyse and interpret the sample data. To provide a rich thick description of activities that afford teacher learning we also link the teachers' response to interview utterances that illuminate how teachers' knowledge take-up is enabled in NICLE.

In coherence with the NICLE design, this research is framed and informed by the Community of Practice perspective (Wenger, 1998, Lave and Wenger, 1991). This theory regards learning as active participation in the practices of communities and constructing identities in relation to these communities. The situated learning theory has been recontextualised to create maths communities of practice from which teachers learn through active participation. The potentials, teacher learning opportunities and many benefits of maths teacher communities of practice are well noted in the literature (Borko, 2004, Graven, 2005, Farmer et al, 2003, Matos, 2009). To help us interpret and understand activities, relations and forms of participation within the Community of Practice which enable or constrain evolving teacher numeracy practices are the 'concepts of attunement to *constraints* and *affordances* of social practice' (Greeno, 1998, p. 11). Greeno (1998, p. 9) defines affordances as 'resources, characteristics... and qualities of systems that can support interactions and... participation'. In other words affordances are 'opportunities for engagement in practice' (Lave and Wenger, 1991, p. 93). Borrowing from Greeno (1998) we use the term *constraints* to imply regularities, systems or materials of social practice that inhibit interaction or participation.

Constraints and attunement to constraints in NICLE

This section of the paper presents and discusses constraints that the sampled teachers experienced during their participation in NICLE. The data presented here was gathered from responses to the question, '*What do you think are some of the disadvantages of participating in NICLE?*' Some teachers articulated that they faced more than a single challenge and thus they appear in the different constraints categories discussed in the paper. Furthermore we present some teachers' attunements to the participation constraints.

The most appearing challenge described by five of the ten teachers was that they were inconvenienced by having to travel long distances from their schools to participate in NICLE fortnightly sessions. Willows and Everton who both taught at a 'transport school'² and had to travel a total of 160km to and from their school to attend NICLE disclosed how challenging it was to attend NICLE. On this challenge Everton said,

‘it’s the travelling for us, its heavy going, it makes a very long day we get up early, we ride buses, we ride children and we get back here at 7 ‘O’ clock some nights’.

Robert had also disclosed that they were being constrained by ‘travelling to Grahamstown’. Robert, Calvin and Elvira had to travel a total return trip of 170km to attend NICLE sessions. Maths teacher education literature presents this challenge as the dilemma pertaining to the site from which staff development can take place (Garet et al, 2002, Graven, 2005, Adler and Reed, 2005). As an attunement to this constraint the Chair encouraged teachers from the same school to travel together so as to share driving responsibilities, secondly the teachers were also given money to cater for their travelling expenses. The travelling challenges closely relate to time constraints, which we discuss below, all these concern the aspect of convenience.

Five teachers reported that they faced ‘time constraints’ in attending and participating in NICLE sessions. Melissa who taught at a ‘transport school’ felt that NICLE should start 30 minutes later to allow for time to take the ‘children to the bus stop’. Ruth and Melania also felt constrained to find ‘time’ to attend NICLE from their teaching preparation schedules. Ruth disclosed that her,

‘duties at school continue to be the same so we are not relived off. I just happened to have Monday duties at school and Tuesday, so I often find that when I get to Wednesday I haven’t had one solid afternoon of preparation time’.

Calvin also felt that the NICLE’s contact time was itself inadequate, for him ‘two hours is not enough’. Arising from the interviews is the fact that the *set*, *engagement* and *contact* times can all inhibit teacher engagement in professional development initiatives. The literature also points that the greatest challenge to successful staff development programmes is the unavailability of time to engage in professional work (Farmer et al, 2003, Abdal-Haqq, 1996, Graven, 2005, Adler and Reed, 2003). As an attunement to this constraint Ruth had indirectly suggested that they be ‘relived off’ their school duties when they participate in NICLE and this concurs with one of Abdal-Haqq’s (1996) strategies of creating time for teacher development.

The two Grade R teachers participating in NICLE where frustrated with their participation in NICLE for they could hardly practice what they learned in NICLE in their elementary numeracy classes¹. Mary succinctly captured this when she said ‘the things that I have learned at NICLE I haven’t been able to put into practice’ Edna also felt the same as she disclosed that ‘with the Grade R’s there is not much you can really do with them...because sometimes you get a lot of ideas and you must sit with everything inside and it gets bottled up because I can’t do it with the Grade Rs’. Edna had attuned to this constraint by requesting an opportunity to offer the Grade 3 classes ‘extra maths time’. Her colleague had put a similar request at her school. The two Grade R teachers felt constrained by the classes they were teaching for they could not appropriate what they learnt from NICLE into their elementary maths classes.

Another constraint that is theoretically and practically important cited by Brenda was that the NICLE was a ‘big group’. Brenda would have preferred a small group for it is quite difficult in a big group for a ‘person to actually understand... so that you can transfer it to the children’, secondly in big groups not all individuals will have the opportunity to talk as ‘there is always someone else who will answer questions’. Brenda’s insight on the limitations inherent in large groups is quite true of NICLE which at times had 50 teachers in attendance thus inhibiting closer teachers – facilitator interaction. NICLE thus face this constraint of the ‘large size’ of the initiative. Communities of practice are often by their nature small if we consider the Liberian tailors and midwifery exemplars cited in Lave and Wenger. Most maths teacher Community of Practice professional development models have generally been small.

Another disadvantage cited by Calvin, a school Deputy Principal, that relates both to the Grade R teachers and Brenda’s constraints was that NICLE catered mainly for grades 3 and 4 teachers, thus some of their primary maths teachers who were not part of the targeted teacher audience were ‘missing out’. Calvin’s school had 13 foundation phase teachers who were willing to voluntarily join

NICLE, unfortunately the primary maths teacher initiative could not ‘accommodate all of’ these teachers. As a result only five - Grade 3 and 4 teachers from Calvin’s school were participating in NICLE. However an attunement to this constrain that needs research is how to ensure that teacher communities of practices can be *re-scaled up* (reformulated) into bigger professional learning communities yet retain their teacher learning benefits.

Affordances in NICLE

In this part of the paper we present part of our research findings that focuses on the affordances that teachers experienced during their participation in NICLE. These activities teachers claimed, enabled them to take-up and appropriate what they learned in the professional development programme into their maths classroom. The data presented here is from response to the questions, *Has NICLE supported your understanding of mathematics teaching at all so far, If so explain?* and *What do you think are some of the advantages of participating in NICLE?* We also enrich our data by presenting the teachers’ utterances about their knowledge-take up within NICLE across a range of other interview questions where relevant. We discuss the features of the appropriated NICLE activities and explain how these enabled knowledge uptake amongst the sampled teachers.

Four of the sampled teachers indicated that they had appropriated into their classes what they had learned in Tom’s Mental Maths’ NICLE sessions. In his sessions teachers were actively involved in mental maths activities with Tom encouraging teachers to use flash cards when doing mental arithmetic as this ensures that learners know their ‘number bonds’. Tom, an experienced maths teacher educator stationed at RUMEP encouraged teachers to have 10-15 minutes of mental maths daily in their classes and emphasised that educators must ‘focus on the thinking process of how to reach an answer’ as this improves the learners’ ‘number sense’. Melania had described how the mental maths sessions had impacted and improved her maths teaching,

‘they have been very very good ideas, mental maths and the way that he did that mental maths at the beginning of the morning and with those flash cards and children working in groups I really liked those ideas... you think immediately I would like to implement those in my class, very good ideas’

Pamela had also indicated that Tom’s session had helped her with ‘questions that you may ask in the mental maths’. Calvin and Mary had also alluded to appropriating into their maths classes some aspects of Tom’s mental maths.

Four of the sampled teachers also indicated that they had appropriated what they learned from Zonia’s sessions on the concept of zero into their maths classes. Zonia a former primary school teacher and primary maths textbooks author was the NICLE teacher development co-ordinator. Zonia’s session on the concept of zero had drawn more attention to this concept, thus Ruth said,

‘I mean I know about zero, it’s not that I am learning zero for the first time, for instance, *what I took along from it*, was asking the children to define it, *so that is learning for me*, how to allow for discovering things instead’

Mary and Edna had also reiterated that this session had given them more information on a concept that they had took ‘for granted’, only to find out that its ‘not just zero anymore, there are other things to it’. Calvin also noted some aspects of this concept into his maths classroom.

Melania one of the sampled teachers in this study had done a Flard card (place value cards) practical demonstration activity with six of her Grade 3 learners in a NICLE session. The demonstration lesson emphasised the importance of place value with learners using flard card boxes to solve maths tasks and freely explaining how they had worked their solutions (Fieldwork notes, 11 October, 2011). During the interview Calvin acknowledged the influence of NICLE and Melania’s session on his practice as he said,

‘...you learn a lot of things. You learn new stuff, you meet new people, you share experiences with other people and you hear what their class practices are. Like (Melania) you can see that those learners weren’t coached it’s what is happening in the classroom’

Willow, Mary and Calvin had explained that this session had helped them ‘to see other people’s methodologies’, the ‘equipment’ that can be used to teach place values and had given them a glimpse of what happens in other maths classes. According to Willow, Melania’s practical session had given the teachers ‘fantastic ideas’ and encouraged them to improvise resources ‘using every day things which educators would not have thought of to teach the children’.

Brenda, Calvin and Melania explained that Aarnout Brombacher’s NICLE session on how to support the development of learners’ ‘number sense’ had influenced their practices. Brombacher is a primary maths specialist, teacher trainer, materials developer and researcher. Brombacher’s session had learners’ video clips with the presenter emphasising how ‘critical’ it was for learners to ‘explain what they are doing in maths classes’ (Fieldwork notes, 12 April, 2011). Whilst Brenda liked the session for explaining ‘a practical situation in the classroom’ Calvin and Melania emphasised how the session had improved their maths teaching practices. Melania clearly outlined how Brombacher’s session had ‘sharpened her awareness’ about,

‘interacting more with children and having them to explain to you how they are thinking how they are working out problems from that perspective...I have communicated more with the children about how they are doing things and why they are doing things’

Everton and Calvin also reported how they had appropriated the ‘Singapore maths’ ideas into their intermediate phase maths classes. Mrs Bev Keth, a Rhodes masters student had done a NICLE presentation on her research into the use of Singapore maths in schools in the Eastern Cape (NICLE documents, 27 September 2011). Her session included engaging activities in which teachers used pictorial models to solve mathematical problems. Everton had started using Singapore maths in her classes and said,

‘I was very taken with that Singapore Maths you know and I would like to work with my group I am sure. Next year I am planning on introducing that method *more* with most of the things that I do...’

Calvin also admitted taking-up this notion into his maths classes and said, ‘Singapore maths. I tried it in the class. I am doing it with the kids’.

Five foundation phase teachers in the sample had reported using NICLE’s resources, equipments and games in their maths classes. Melania and Ruth had used some of the NICLE games in their classes with Ruth specifically pinpointing that the alphabet maths game was ‘very interesting’ as it had,

‘supported what can sometimes become tedious. It has freshened it up and everybody in the class love that, they just loved that game, so I think the NICLE programme has given me ideas, it has you know...’

Melania also mentioned that she had used Flash cards in his maths lessons. Though Edna, Pamela and Willows did not specifically mention the NICLE ‘artifacts’ they had used in their classes they admitted incorporating ‘resources’ and ‘equipments’ from NICLE into their maths classes. Thus Edna acknowledged that the,

‘colourful things thing they give us, it makes it much easier instead of just standing there in the front of the class explaining something, where you have the actual resource that you can use and give to them’.

In its first year running teachers had been exposed to flard cards, brace maps and dices and had been given different resources that included, for example laminated number lines, flash cards, alphabet maths cards and Number Sense workbooks (Fieldwork notes and NICLE documents, 2011). The teachers had used some of these resources in teaching their maths classes. Artifacts are part of a community’s shared resources and these are produced or adopted in the course of its existence and become part of its practice (Wenger, 1998). Garet et al (2001) and Borko (2004) have also argued that maths teachers’ communities of practice’s artefacts and tools strengthen and deepen teachers’ understanding of important mathematical ideas and allow them to explore pedagogical possibilities when teaching.

Forms of participation that enables take-up

In this part of the paper we focus on forms of participation that enabled teachers to take-up the described NICLE activities into their maths classes. In doing this we discuss the features of the appropriated activities and what the teachers suggested as enabling their learning alongside teacher education literature.

Six teachers explained that participation in NICLE enabled them to share classroom experiences and practices with other teachers and this facilitated maths knowledge take-up amongst them. The sharing of maths teaching experiences was through group work discussions, informal talk or when a participating teacher presented a session. Thus Everton and Melissa emphasised that they learnt through engaging with other teachers with the latter saying,

‘I love the sharing when I do my group work the things that come up, um, you know with the other teachers, sharing experiences it is a huge advantage because we learn from one another’

Calvin also disclosed that through participating in NICLE they could ‘share experiences with other people and you hear what their class practices are, like that (session by Melania)’. The latter statement refers to Melania’s mat work demonstration on using flard card boxes. Robert, Belinda and Willow also stated that sharing experiences with other teachers improved their understanding of maths practices. Effective professional development programmes allow for collaborative participation and peer interaction on activities, concepts and practices linked to the context of teaching amongst teachers who teach the same grade levels (Abdal-Haqq, 1996, Garet et al, 2001, Matos, 2009). Teacher comments also show that sessions presented by a fellow teacher, as was the case with Melania’s presentation, have a great impact on teachers’ learning of maths practices an argument supported by Borko (2004).

For Calvin, Pamela and Edna participation in NICLE enabled the teachers to engage with experts in the field of primary maths and these enabled the participants to understand maths concepts better, rectify misconceptions and teach maths effectively. Thus for Pamela NICLE had provided her access to,

‘...specialists who are helping to answer the questions we had before. We are having specialists they do address our fears. Sometimes as mathematics teachers we do have fears of how we are going to do this in my class’

Similarly Edna also said, ‘what I like about NICLE uh, they invite a lot of guest speakers to introduce certain things to us’. Calvin had also pointed how he had ‘learnt a lot of things’ and ‘new stuff’ in NICLE as he had ‘meet new people’. These three teachers had appropriated maths practices through engaging with primary maths experts in NICLE. In Communities of practice participants learn from ‘masters’ and ‘old-timers’ as they generate identities and ‘move towards full participation’ (Lave and Wenger, 1991, p. 91). Recontextualising this aspect, learning and understanding for some teachers participating in NICLE was enabled through access to and engaging with invited specialists/experts (masters) in primary maths education.

Willow had articulated that participation in NICLE was giving her ‘the most up-to-date and best possible teaching methods’ and similarly for Everton engaging in NICLE had exposed her to the ‘modern thinking of how maths should be approached. I was very taken with the Singapore maths you know’. Reading from Everton’s utterance the Maths Singapore’s NICLE session reflected contemporary maths practices. Also falling in the category of innovative maths practices and having been part of the NICLE sessions is Deborah Ball’s video (shown and analysed in a session by Graven) and Brombacher’s number sense presentation. Teachers are thus likely to take-up into their classes modern and innovative maths practices that they engage with in professional development programmes.

Robert, Brenda and Melania expressed that NICLE enabled their maths learning because it involved practical demonstrations and experiences marked with active participation and avoided of theoretical

rhetoric. In instances where theory was emphasised it related to practical issues. Robert's interview utterance is illustrative of this,

'people come with different ideas with sessions and it demonstrate it is not just a talk show it is active participation, that keeps it lively and the interaction is not, it is on a level ground where the lecturer is on the same path as you. The interaction is not where you have to just be absorbing theoretical knowledge of someone else.'

For Brenda NICLE's sessions enabled learning for her as it paired theoretical and practical knowledge. Of this she said, 'you get to kind of have practical and theory all in one almost'. Two examples of NICLE sessions that connected theory and practice mentioned by the teachers included Brombacher's presentation that connected the notion of developing learners' 'number senses' and the theory of the five strands of mathematical proficiency as well as Bev's Singapore maths presentation which linked problem-solving and the heuristic drawing model. Teachers' comments indicate that connecting theory and classroom practices enables and influences primary maths teacher learning.

Conclusion

Whilst professional development programmes have some constraints, the sampled teachers had provided some attunements to these constraints. The teachers' attunements to some of the participation constraints concur with Kennedy's (1998) postulation that structural challenges have little effect on in-service teacher education. The two theoretically related constraints raised by Brenda and Calvin need further research pertaining to how teacher professional development communities of practice can be *re-scaled up* to cater for larger teacher audience while at the same time not compromising the benefits of smaller and more intimate maths teacher learning communities.

Participating in professional teacher learning communities presented by fellow teachers and primary maths experts whose work is grounded in innovative and modern practices that link theory and practice with teachers collaboratively engaging in concepts, tools, demonstrations and activities that replicate classroom practices deepens primary teachers' mathematical knowledge, enables teachers' to engage learners in their maths classes and affords them opportunities to focus on student thinking. All the sampled teachers expressed that participating in NICLE had enabled them to engage learners in their maths classes. This pedagogical element was highly emphasised in NICLE and also in local primary maths curriculum documents. Besides encouraging learner centred approaches NICLE also aims at improving teachers' understanding of primary maths content and a focus on the learner's thinking processes, knowledge dimensions which some of the sampled teachers indicated taking up from NICLE. However what is worth noting is that teachers participating in NICLE take-up and appropriate into their maths classes different knowledge aspects of the teacher professional development initiative. Also quite illuminating is that teachers from the same school tend to take-up from NICLE similar knowledge dimensions. Further research into the reasons for such teacher knowledge take-up trends need to be fully investigated?

Endnotes

¹ NICLE's focus is on Grades 3 and 4 primary maths teachers, it bridges the Foundation and Intermediate phases and these two grade R teachers had voluntarily participated in NICLE.

²A Transport school is a school in which teachers bus in learners in the morning and drops them at bus stops/homes when school finishes off.

Acknowledgements

This work is supported by the South African Numeracy Chair Initiative of the FirstRand Foundation (with RMB), Anglo American Chairman's fund, Department of Science and Technology and the National Research Foundation. However the opinions, findings and conclusions expressed here are the authors' and do not necessarily reflect the views of the funders.

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