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ORIGINAL ARTICLE

Exploring grade 3 teachers' resistance to 'take up' progressive mathematics teaching roles

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Abstract This article addresses the question: Why teachers of mathematics have yet to 'take up' progressive roles? Drawing on the philosophy of critical realism and its methodological equivalent, social realism, we analyse interview and observation data of four grade 3 teachers, with the view to identifying the mechanisms conditioning the expression of teachers' identities. In so doing, we show how post-apartheid changes in systemic roles of teachers create contradictory tensions for teachers as these bring their own mathematical learning and teaching experiences into contradiction with the new post-apartheid roles they are mandated to enact. We examine how this contradiction, together with beliefs about mathematics, pedagogy and learners, is expressed in the teaching of grade 3 mathematics. We maintain that the complementarity between teachers' beliefs and old systemic roles provides an explanation for why teachers of grade 3 mathematics have yet to 'take-up' progressive roles. The implications point to the need for teacher development that creates enablers that lead to changes in classroom practices that align with policy-designated, progressive roles in teaching mathematics.

Keywords Teacher identity · Systemic teacher roles · Curriculum · Beliefs · Social realism

Introduction

Curriculum change toward more learner-centred forms of teaching has been an international phenomenon for the past few decades. South Africa's major curriculum change from the *teacher as transmitter of highly controlled knowledge* to the *teacher as mediator of learning* occurred following the end of formal apartheid in 1994. This curriculum change gave teachers far more agency in terms of decisions about curriculum content and pacing and placed the individual learner's needs as central to the decision-making process in teaching.

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Subsequent revisions have reduced teacher autonomy, but the promotion of learner-centred teaching practices has remained to date. Despite new roles for teachers (i.e. from transmitter of knowledge to mediator of learning), as articulated in the curriculum policy, teacher practices have remained mostly unchanged and there has been little improvement in learner performance.

We situate this article within the context of curriculum change and learner underperformance in South Africa. This is followed by a brief explanation of the theoretical framework—social realism—that we use to analyse and explain both interview and observation data of four teachers' practices while teaching grade 3 mathematics. Social realism, particularly Margaret Archer's (1995) morphogenetic approach, enabled us to identify the base mechanisms that condition the expression of teachers' identities, that is, the way in which they express their roles as teachers.

While rooted in the South African context, the paper is relevant to mathematics education researchers across the globe because concerns with learners' mathematics performance (e.g. Geiger et al. 2017) are seemingly universal. Furthermore, while research into mathematics teacher identity is a growing field (and of particular interest in Australasia) (e.g. Grootenboer and Ballantyne 2010), here, we draw on an under-represented theoretical framework (social realism) in mathematics education research to offer new insights into the roles that structure, culture and agency play in conditioning the manner in which teachers' identities are expressed in teaching grade 3 mathematics.

The purpose of this article is to further current debates as to possible explanations for why teachers' practices remain unchanged. We thus ask the question: Why have teachers of mathematics yet to 'take up' progressive roles?

Learner performance

The performance of South African learners in the international mathematics benchmarking tests, such as the Trends in Mathematics and Science Study and the Southern and Eastern African Consortium for Monitoring Education Quality, indicates that South African learners are underperforming when compared with their international counterparts (Reddy et al. 2015).

Concern about learner performance in mathematics is a worldwide phenomenon. In regions such as Australasia, this concern is directed toward marginalised communities (Hunter et al. 2016). Anthony (2017) suggests that this derives from an interest in equity, but regrets that despite policy initiatives and funding for intervention programmes for those underperforming communities, there appears to be negligible improvement in learner performance. Explanations for learner underperformance in Australasia include a focus on learning and teaching mathematics generally (Anthony 2017) and specifically the challenge of teachers' perceived reluctance to adopt progressive pedagogies (e.g. Groth 2007).

In South Africa, there is similar concern with educational underperformance, particularly in mathematics; in grade 4 many learners already lag two grades behind grade-level expectations (Spaull and Kotze 2014). A key difference in South Africa (compared with Australia) is that the majority of the learner population underperform in mathematics. There is a multitude of explanations for learner underperformance in South Africa. These explanations are usually systemic in orientation and offer a discourse that regards teachers and learners as products of the social, political and economic systems (e.g. Graven 2014), the schooling system (e.g. Reddy et al. 2015) and the teacher education system (e.g. Adler et al. 2009). Furthermore, research that offers explanations based on teachers' insufficient content knowledge (e.g. Carnoy et al. 2011 and Van der Berg et al. 2016) and poor teaching practices (e.g. Hoadley 2012) also proffers a systemic explanation as the latter research views teachers as products of inefficient schooling and teacher education systems.

While we recognise the importance of research that provides a systemic explanation, such research tends to view teachers as epiphenomenon of systems with little agency. Thus, teachers and learners are regarded as 'passive agents'. Archer (2000) argues that people have the capacity to 'act back', an effect of their agency. For example, teachers have the capacity to actively respond to the mechanisms that constrain or enable their teaching of mathematics. This agency is expressed through their social identity. Agents 'acquire their social identity in the way in which they personify the roles they choose to occupy' (Archer 2000, p. 261). In this article, we suggest that how teachers express their roles as teachers *is* their social identity or teacher identity. Drawing on Archer, we posit that roles have autonomy in the sense that they endow various occupants with different dispositions and personal characteristics. As a result, teachers have 'different "performances" of the same role' (Archer 1995, p. 186). Systemic roles condition teacher identities, but no two teachers will express their (social) roles as teachers in the same way. It is in the process of teaching that both teachers' identities and the systemic roles are (re)defined. In order to analyse this change in teachers' identities, it is necessary to differentiate between the *systemic roles* and the occupants of those roles (Archer 2000). Put differently, it is necessary to delineate between systemic roles and social roles, that is, the roles that teachers' express when teaching grade 3 mathematics. The research on which this article is based argues that the way the teacher expresses her roles as a teacher of (in this case grade 3) mathematics is central to successful learner performance (Westaway 2017).

This article recognises the teacher as agent and seeks to examine the complex interplay between structure (systems) and agency in explaining learner underperformance. While there are numerous structural mechanisms that enable or constrain how teachers express their identities in teaching grade 3 mathematics, we examine two mechanisms in this paper: the systemic roles of teachers as expressed in a variety of policy documents and the related beliefs about mathematics, learners and pedagogy. We reflect on these systemic roles and contrast them with the way teachers of grade 3 mathematics express their teacher identities. Drawing on the beliefs teachers' hold, we consider why teachers tend to embrace beliefs and identities of the past.

Theoretical framework

The philosophy of critical realism underlaboured this research. Critical realism assumes a realist ontology and a relativist epistemology (Bhaskar 1978). It postulates the existence of reality irrespective of our knowledge of it, while simultaneously acknowledging that our knowledge of reality is fallible and thus open to review. Furthermore, critical realism suggests that reality is both stratified and differentiated in that it consists of three levels: the *empirical*, the *actual* and the *real*. As noted in Fig. 1a, b, the empirical is the level of experience and refers to persons' subjective understandings of what occurs in the world. The actual refers to events in the world, whether we experience them or not, while the real comprises social structures that condition events in the world and people's experiences thereof. For example, teaching mathematics is an event (at the level of the actual). This event is enabled or constrained by numerous structural and cultural mechanisms (at the level of the real), such as curriculum, beliefs, and the systemic roles of teachers. The experiences of learners as teachers teach mathematics are at the level of the empirical.

Archer's social realism (1995, 1996), in particular, her morphogenetic approach, provides useful tools to analyse and explain data. Drawing on these, we argue that teachers' identities are conditioned by, amongst other things, the systemic roles of teachers (i.e. structural mechanisms) as articulated in policy documents and beliefs (i.e. cultural mechanisms) underpinning the systemic roles of teachers. Beliefs, as with the systemic roles of teachers, are real and exist independently of the actions of teachers. However, they have the potential to enable or constrain the manner in which teachers, as agents, express their identities in teaching mathematics. For example, the widespread belief that grade 3 mathematics is about taught procedures exists independently of the teacher, but has the potential to condition teachers' identities. When this belief coheres with a systemic role that teachers are required to impart 'objective mathematical knowledge', as we illuminate later in the paper, teachers are less inclined to 'take up' more progressive teaching roles. As such, the choice not to alter the manner in which teachers express their identities in line with new systemic roles *is* an expression of their agency.

As highlighted in Fig. 2, two key assumptions relating to Archer's (1995) morphogenetic approach are that structural and cultural mechanisms (e.g. the systemic roles of teachers and beliefs) at the level of the real *predate* the actions of teachers, and that morphogenesis (change) or morphostasis (reproduction) *postdates* the actions of teachers. Put differently, there are structural and cultural mechanisms at the level of the real that

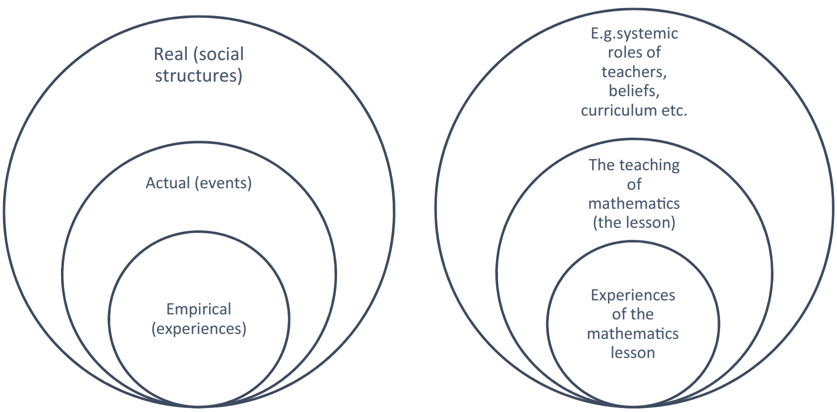

Fig. 1 **a** A stratified and differentiated reality (adapted from Bhaskar 1978) **b** A contextualised example of Bhaskar's (1978) stratified and differentiated reality

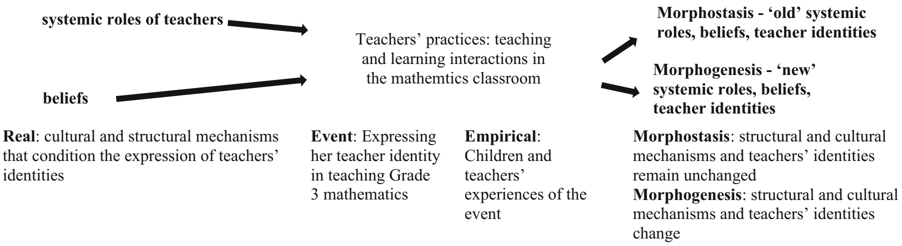

Fig. 2 Archer's (1995) morphogenetic approach (adapted for interpreting mathematics teaching)

condition the manner in which teachers express their identities in teaching mathematics. Change or reproduction of these structural and cultural mechanisms, and teachers' identities, postdates the expression of their roles as teachers of grade 3 mathematics. The manner in which teachers express their identities has the potential to promote change or reproduction of their identities and the structural and cultural mechanisms conditioning the expression of their identities in teaching grade 3 mathematics.

In this article, we focus particularly on the interplay between the systemic roles (structural mechanisms) and the beliefs about mathematics, learners and pedagogy (cultural mechanisms) that condition the expression of teacher identities in teaching grade 3 mathematics. As such, we delineate between the systemic roles of teachers and their expressed roles (or teacher identity) and show how the systemic roles of teachers as expressed through policy documents are part of the real, and condition the actions of teachers at the level of the actual. Archer (1996) maintains that 'to uphold ideas which are embroiled in a contradiction or enmeshed in complementarities places those who do so in different action contexts where they are confronted with different situational logics' (p. xxii). When the systemic roles of teachers and beliefs do not correspond, this creates a *situational logic of contradiction* for the teachers. It is this situational logic of contradiction that leads teachers to 'act back' on the structural and cultural mechanisms, resulting in morphostasis or morphogenesis. Teachers are able 'to mediate structural and cultural properties of society, and thus to contribute to societal reproduction or transformation' (Archer 2007). It is through the expression of teachers' identities that structural and cultural mechanisms, and their identities as agents, are elaborated or reproduced.

The systemic roles of teachers of primary school mathematics

1994 marked the end of formal apartheid in South Africa and provided an opportunity to redress inequalities of the past. Three years later, the first post-democracy curriculum was implemented in all South African schools. The new curriculum brought about new systemic roles for teachers, which have remained stable throughout the three subsequent curriculum iterations.

Prior to 1994, the systemic role of teachers was to discipline both the mind and body of ill-disciplined and ignorant children (Woods 1996). Teachers transmitted 'objective mathematical knowledge' to disciplined children (regarded as passive recipients of knowledge) who were required to recite and chorus answers, memorise facts and regurgitate knowledge taught by the teacher. Quick correct answers and taught procedures were valued. Teachers were viewed as implementers of a fixed and prescribed curriculum that was viewed as non-negotiable and based on rigid time frames. The curriculum was based on the objectives model that defined education as 'changing of behaviour' and sought to make learning measurable and teachers accountable (Woods 1996). Teachers were thus positioned as passive transmitters of knowledge and expected to comply with education polices and all forms of authority. Three of the four teachers (Nokhaya, Veliswa and Buhle) who participated in the broader research from which this article emerges were subjected to this view of the roles of teachers and learners during their schooling and initial teacher education. One teacher (Nomsa) completed her initial teacher education qualification post-1994. All four teachers have 'upgraded' their qualifications post-1994.

1994 marked the onset of a dramatic shift in curriculum and pedagogy in South Africa. Two key curriculum policies were the first post-Apartheid curriculum, referred to as Curriculum 2005 (C2005) (SA.DoE 1997), and the current Curriculum and Assessment Policy Statement (CAPS) (SA.DBE 2011a, b). C2005 was a social reconstructionist curriculum aimed to right the injustices of the past through education (Graven 2002). The intention was to develop a society based on social, economic, political and environmental justice, creating equitable access to high levels of knowledge and skills for all learners, thereby disrupting the unequal relations of power and control (Naidoo and Parker 2005). As such, school mathematics as expressed in the curriculum had both epistemological and social justice aims. This marked a significant shift to the systemic roles and, thus, identities of teachers, as they were expected to prepare children through mathematics for democratic citizenship and become social agents (Naidoo and Parker 2005).

Graven (2002) argued that C2005 promoted four different orientations to school mathematics: critical democratic citizenship, utilitarian value, induction of children into the work of mathematicians, and development of the mathematical knowledge, conventions and skills required to learn further mathematics. New teacher roles were required to ensure that these four orientations to school mathematics occurred. Teachers needed to ensure that the mathematics children learned enabled problem-solving, related to their everyday lives, and demonstrated connectedness to their knowledge in the world (Pausigere and Graven 2013). Furthermore, teachers were expected not only to select the mathematical content to be learned but also to sequence and pace it based on the diverse needs of the children in their class (SA.DoE 2000). Instead of simply adhering to a prescribed curriculum, teachers were required to make decisions about *what*, *when* and *how to teach* (SA.DoE 2000).

Teacher support for the implementation of this curriculum was widely criticised. The use of a cascade model by the national Department of Education in preparing teachers for the implementation of C2005 proved ineffective. In this model, officials from each province were trained as 'master trainers' who presented the knowledge to district officials who then, in turn, shared the information with teachers in their districts. Problems identified with this model include the 'watering down' and/or misinterpretation of crucial information exacerbated by the lack of confidence, knowledge and understanding of the trainers (Chisholm et al. 2000). Teachers received at most 2–3 days of training and no follow-up support was provided for dealing with classroom implementation. Furthermore, such teacher development, while speaking the rhetoric of new forms of learner-centred practice, was largely presented through traditional information dissemination means, thus, ironically, further reinforcing the existing practices it was seeking to change. Despite the ineffectiveness of such courses, this is still the dominant training model used in South Africa (e.g. Venkat 2013). Following widespread concerns as to the effectiveness of the implementation of the curriculum and a thorough curriculum review (Chisholm et al. 2000), C2005 was replaced by the Revised National Curriculum Statement (RNCS) and later CAPS.

While the principles informing CAPS have remained consistent, there is far more emphasis placed on inclusivity, progression and quality in education. Inclusivity is viewed in CAPS as the driver of planning and teaching. To remove the prominence of knowers and knowing in C2005, CAPS sought to deliberately define the content to be taught and the organisation and pacing thereof (Hoadley 2011). While the emphasis on teaching specified content was a noteworthy shift from C2005 to CAPS, the pedagogy remained the same. CAPS continued to endorse learner-centred pedagogies and social constructivism but with limited integration of mathematics across other learning areas. While whole-class teaching continues to be a worldwide phenomenon, learning collaboratively in small groups is encouraged and children are required to demonstrate, record and share their thinking (SA.DBE 2011a, b). The Norms and Standards for Educators, a policy specifying the systemic roles of teachers (SA.DoE 2000), and CAPS portray 'a primary mathematics teacher who supports learners, to master fundamental mathematics concepts, and assess and test learners' understanding of these' (Pausigere and Graven 2013, p. 22). Teachers are regarded as mediators of learning, who facilitate rather than transmit knowledge to children. In addition, they are expected to mediate learning 'in a manner which is sensitive to the diverse needs of learners'; teaching should be contextually relevant, motivating, and effectively communicated (SA.DoE 2000, p. 13).

As highlighted above, the systemic roles of teachers pre- and post-1994 differ substantially. This radical change in systemic roles has created a *situational logic of contradiction* (Archer 1996, p. 190) for the four teachers who participated in the broader research. In other words, these teachers were not only confronted with two significantly different sets of roles, but were expected to 'take on' the new post-1994 systemic roles. These were teachers whose own schooling and, for three of them, their initial teacher education experiences were subject to apartheid ideologies such as Fundamental Pedagogics. The pre- and post-1994 systemic roles articulated through curricula and other policy documents have placed the teachers in a situation where the two 'sets' of systemic roles seem incompatible (Westaway and Graven 2017). In presenting and analysing selected extracts from lesson observations and interviews of the aforementioned teachers, we elucidate how teachers mediate this situational logic of contradiction.

Methodology

The first author spent four consecutive weeks in the classrooms of four grade 3 teachers in the Eastern Cape Province (Westaway 2017). The schools were purposefully selected as representative of the majority of schools in the province. These were no fee-paying schools in low-socio-economic environments. All the children were black isiXhosa home language speakers and the language of learning and teaching in the grade 3 was isiXhosa. The four participant-teachers, Nokhaya, Veliswa, Buhle and Nomsa (pseudonyms) were the only grade 3 teachers at the two schools. They were black, female isiXhosa speakers, between the ages of 39 and 55. This is representative of the primary school teaching force in terms of age and gender. In identifying the conditions giving rise to the expression of the participant-teachers' identities in teaching grade 3 mathematics, a series of interviews were conducted. These included life histories (LHI), mathematics histories (MHI) and practice-based (PI) interviews. Interviews were conducted in English (as teachers were aware that the first authors competence in isiXhosa was limited), audio-recorded and transcribed. All mathematics lessons were observed during the four weeks and recorded as fieldnotes. Three lessons were video-recorded over the four-week period. The videos were transcribed and translated by an isiXhosa home language (HL) speaker and verified by another isiXhosa HL speaker.

Three modes of inference informed the data analysis. Inductive reasoning was used to develop codes and categories emerging from the data. The purpose of this was to identify what was common to the four teachers and that which differed. Inductive reasoning however had limitations for this research. Specifically, it could not assist in identifying possible structural and cultural mechanisms that had given rise to teachers' identities in teaching mathematics. Structures and discourses are not immediately observable through events (i.e. the teaching of mathematics) nor experiences of events (i.e. what is observed and perceived during the teaching of mathematics). Thus, the critical realist thought processes of abduction and retroduction were used to identify possible mechanisms at the level of the real. Abduction enabled movement 'from a conception of something to a different, possibly more developed or deeper conception of it … [by] interpreting original ideas about a phenomenon in the frame of a new set of ideas' (Danermark et al. 2002). The new frame used to explain the conditions that enable and constrain the expression of teachers' identities in teaching mathematics was social realism and, in particular, Archer's morphogenetic approach. Put differently, Archer's morphogenetic approach was used to recontextualise (describe, interpret and explain) the phenomenon of study. Recontextualising the phenomenon (i.e. teachers' expression of their identities) using Archer's morphogenetic approach however did not assist in the analytic process of identifying the structural and cultural mechanisms in the social and cultural systems. Moving beyond the empirical to identify structural and cultural mechanisms required retroductive thinking (Danemark et al. 2002). 'Retroduction is about advancing one thing (empirical observations of events) and arriving at something different (a conceptualisation of transfactual conditions)' (Danermark et al. 2002, p. 96). To do this, the study drew on transfactual questioning and argumentation to identify the basic conditions without which the way teachers expressed their identities would not exist. Transfactual questions require looking back (e.g. What is it about teachers' identities and their expression in teaching mathematics that makes them such?). Retroduction, thus, enables the identification of the basic conditions (structural and cultural mechanisms) that give rise to teachers expressing their teaching roles in varied ways. In the context of this research, we focus on an empirical observation, that is, the expression of teachers' identities by teaching the standard procedure. The question we ask is what does the teaching of a standard procedure presuppose? Drawing on the interview data (the life history interviews, mathematics history interviews and practice-based interview data) and our reading of the South African context, we identify numerous possible mechanisms that enable teachers to express their teacher identity by teaching set procedures. Two mechanisms that we focus on in this article are the systemic roles of teachers and beliefs about mathematics, teaching and learning, and learners. In relation to these two mechanisms, the teachers express their agency by 'holding onto' particular beliefs and by 'acting back against' post-1994 systemic roles.

While the process of retroduction is useful in identifying the mechanisms enabling or constraining teachers' identities and their expression in teaching mathematics, it does not provide the truth, as new descriptions are always fallible. However, it is possible through the process of judgemental rationality to ascertain the validity of a particular recontextualisation (Danermark et al. 2002). Judgemental rationality, which involves evaluating findings in relation to existing findings, while simultaneously being aware that descriptions are always fallible, provides validity to the analysis.

Results and discussion

Drawing on Archer's (2000) social realism, we claim that teacher identity refers to the manner in which teachers express their roles as teachers. Earlier in this paper, we describe the radical shift in curriculum policy between the pre- and post-1994 teacher roles, suggesting that this created a situational logic of contradiction for the teachers in this research. Key to the post-1994 systemic role of learning mediator in both CAPS (SA.DBE 2011a, b) and the Norms and Standards for Educators (SA.DoE 2000) are the principles of participation, active learning, sense making and inclusion. Teachers are required to develop learning programmes that enable learners to make sense of mathematics by actively participating in a variety of well-planned lessons. These learning programmes and activities ought to be respectful of difference and demonstrate sensitivity to the needs of all learners. Drawing on a limited selection of extracts from each of the four participating teachers' broader data corpus, we examine the relationship between the beliefs and the systemic roles of teachers. We illuminate the way in which the pre-1994 systemic roles of teachers and key beliefs that teachers 'hold onto' militate against their expression of the systemic role of learning mediator in teaching mathematics. Drawing on Archer's (1995) morphogenetic approach, we show how the systemic roles of teachers (structural mechanisms) and beliefs (cultural mechanisms) condition the manner in which teachers express their teacher identities. The beliefs that we refer to here are those that the four teachers have *chosen* to hold onto. In choosing to 'hold onto' beliefs, teachers express their agency, and in so doing, reproduce both beliefs and their teacher identities. The beliefs that we focus on in this paper include mathematics is 'difficult'/'not for everyone', 'mathematics is about taught procedures', procedures are learned by 'listening and following clear explanations', and that '*these* children are slow'. We have chosen to focus our analysis on these beliefs that teachers 'hold onto' and argue that these exist in a relation of complementarity with the manner in which they express their teacher identities.

Mathematics is difficult and thus not for everyone

That mathematics is difficult was expressed by all four teachers in relation their experiences as learners and those of their learners. Buhle explained:

> *These* kids it's so difficult for them … Have you noticed that I just did addition, I didn't do the carrying? I'm afraid, they don't know how to. It's few that can [carry]. I've done that with the two-digit numbers and we haven't done it with the three-digit (MHI, turns 94–96).

Her comment that 'few can carry' is underpinned by a belief that mathematics is a difficult subject that not all learners can grasp. Buhle's lesson on 2-D shapes requires children to name 2-D shapes (circles, triangles, squares and rectangles), identify them by the way they look, identify their properties by counting the number of sides and link these shapes to examples found in our everyday lives. Her lesson relates primarily to Van Hiele's level 1 (visualisation) in which children identify a shape by resemblance, rather than the properties of the shape. While Buhle attempts to move to level 2 thinking (description), this is limited to counting the sides of the shape. In this summary of Buhle's lesson on shape, she limits the knowledge that the children in her class have access to. This is a general criticism of South African mathematics teachers and is often attributed to the belief that not all children are able to do mathematics. Research points to teachers having low expectations of the children and thus offer learners a restricted curriculum (e.g. Hoadley 2012). By contrast, Nomsa's belief that mathematics is difficult leads to her presentation of mathematics as abstract and bereft of sense making.

> Nomsa and her class are discussing the mass of various household products brought to class. Nomsa holds up an empty 2.5kg packet of sugar. She asks what this is and the children reply that it is a 2.5kg packet of sugar. She suggests they add two packets of sugar and asks what the answer will be. One of the children says '5kg'. She repeats the question and the children respond in unison '5kg'. She explains that she wants to check if they are 'really going to get 5kg' (turn 98). She writes '2,5kg + 2,5kg' using the vertical format (shown in Fig. 3 below) and asks the class what they must do. There is no response. Eventually, a child from the 'first group' (Nomsa's term for learners deemed to be mathematically competent) comes up to the board and stares at the sum for a few seconds. Nomsa writes '10' next to the sum and asks what we should do with the '0'. The child does not respond, so Nomsa says 'we are going to scratch that zero and put it where?' (turn 100) to which another child, from her 'first group' replies, 'there by the five' (turn 101). The child comes to the board and places the '0' under the '5's' (see Fig. 3 below). Nomsa asks the children if the '1' (in her written 10 on the board) represents a 'ten' or a 'unit'. The children respond 'tens'. Pointing to the '2', she asks the children 'what are the tens here?' (turn 108) to which the children reply '2'. She puts the '1' next to the '2' and asks the children to add. They eventually say '5'. Nomsa writes in the '5', in front of the '0' (Westaway and Graven 2017).

^{1}2,5kg <u>2,5kg</u> 5,0	10

Fig. 3 From Nomsa, FN, pp.10–11

Nomsa expects and insists her grade 3 children add the 2.5 kg to 2.5 kg using the standard vertical algorithm even while many of the children are able to solve this mentally. While assisting the children with the procedure, Nomsa seemingly confuses 'tenths' with 'units' and 'units' with 'tens'. This example suggests that that the role Nomsa performs is to teach formal procedures with little opportunity for sense making. While Nomsa teaches this lesson, she faces the 'first group' in her class. When asked about this, she responded 'it's because I know *the answer is going to obviously come from them*' (Nomsa, PI2, turn 88).

Evident in the manner in which both Buhle and Nomsa express their teacher identities is the belief that 'not everyone can do mathematics'. Buhle, when referring to children seated at the back of her class, commented that '*these* children are not struggling like that (they) won't know it tomorrow, they won't know it forever' (PI 2, turn 196). Nomsa similarly stated 'I will know that if he does not know it [now], he will never know it' (Nomsa, PI2, turn 114). In both classes, children deemed to be incapable of learning mathematics, tended to be excluded from the lessons despite the expectation that the role of learning mediator requires teachers to cater for the needs of diverse learners.

Like Nomsa, Veliswa also emphasises a view that mathematics is abstract and about formal procedures.

> Despite her children demonstrating that they could work out the difference between '35 and 45' in a variety of ways, she wanted them to use the standard vertical algorithm. While the children solved the sum quickly and easily using their own methods, they were confused by the formal procedure and were not able to tell her what was 'five take away five'. Veliswa drew tallies on the board to show them (Westaway and Graven 2017).

Nokhaya, however, introduces her own rules into procedures to avoid common learner errors. She requires the children to insert '00' into the calculation 108−66=(100)+(00−60)+(8−6) in order to signify the 'tens'. The double zero is an important feature in her class when children 'break down and build up' numbers. Nokhaya alters the way the children break down a number when there are '0 tens' (e.g. 309). Nokhaya insists that the children write '300 + 00 + 9' and when asked why the children should write '00' for the 'tens' she stated that they need to know that tens consist of two digits. She was concerned that they would get confused if they did not write the '00' (Nokhaya, FN, p. 12). Yet this intention to bring attention to the place value of the tens through writing '00' created problems further down the line. For example, in a later lesson observation, children write three digit numbers in a 'house' Nokhaya has drawn on the board. Nokhaya asks one of the children to write '401' in the house as shown below (Fig. 4) (Westaway and Graven 2017).

Evident in the examples above is the belief that mathematics is difficult and that not all children can do mathematics. These beliefs are enacted in the manner in which the four teachers express their teacher identities. These examples demonstrate how the teachers present maths procedurally, offer a

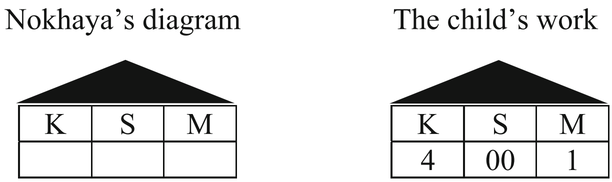

Fig. 4 Nokhaya, FN, p. 11

curriculum of low cognitive demand and attempt to 'make calculating 'error proof' through stating 'rules' for children to follow' (Westaway and Graven 2017). As such, the teachers express their identities by demonstrating abstract mathematical knowledge to all the children in their respective classes. While the teachers' identities are conditioned by the pre- and post-1994 systemic roles of teachers, and the beliefs related to those roles, the teachers chose to hold onto the pre-1994 roles. In this sense, the post-1994 roles of the teacher as learning meditator stand in contradiction to the beliefs that the teachers continue to 'hold onto' and express in teaching grade 3 mathematics.

Mathematics is about taught procedures

All four teachers taught the learners methods for solving calculations involving number operations and focused on correct answers during their mathematics lessons. Nokhaya, Buhle and Nomsa taught addition and subtraction of two three-digit numbers, and Veliswa taught addition of two three-digit numbers. The teachers all asserted in the interviews that the children were allowed to use their own methods, but this seldom occurred in practice. Buhle and Nomsa explicitly taught the children methods for solving addition and subtraction sums, taking the learners through the procedures step-by-step. Nokhaya and Veliswa, by contrast, would give the children calculations and invite them to show the class how they calculated on the board.

Buhle taught her learners the 'breaking down and building up' method (expanded notion) as it is referred to in CAPS (SA.DBE 2011b). Figure 5 is a representation of a handwritten chart Buhle made which she placed on the board for her lesson on addition of two three-digit number.

During the lesson, Buhle takes the children line-by-line through the 'breaking down and building up' method. Using a pointer to point to each part of the calculation as she reads it to the children, she asks the children to read the calculation line-by-line. Pointing to the '200' in the second line of the first sum, she explains that this comes from the '2' in '239'. She explains how she has decomposed the number '239' into 'ikhulu' ('hundreds'), 'amashumi' ('tens') and 'imivo' ('ones'). Then she shows the children how she adds the hundreds, tens and ones to get the answer. Once she has explained to the children that they must add the hundreds, then the tens and finally the ones she uses the standard vertical procedure to add the '300 + 80 + 15'. Buhle follows the same procedure with the second sum. Having explained how to calculate each sum using the 'breaking down and building up' method, she writes another sum on the board and asks one of the children in the class to solve it. Throughout the time that the child is calculating, Buhle observes

Dibanisa (Add)	
239 + 156 = 395	
(200 + 30 + 9) + (100 + 50 + 6)	
200 + 100 =	300
30 + 50 =	80
6 + 9 =	15
Isiphumo (Equals)	395
125 + 234 = 359	
(100 + 20 + 5) + (200 + 30 + 4)	
100 + 200 =	300
20 + 30 =	50
5 + 4 =	9
Isiphumo (Equals)	359

Fig. 5 Chart with 'breaking down and building up' method for solving addition with two three-digit numbers (Westaway 2017, p. 323)

her intently to ensure that she is using the method on the poster, which is still up on the board. In this way, the poster further emphasises a 'correct way' of performing mathematics. The focus is on the product rather than an unfolding process led by the children's thinking.

Nomsa taught her class two methods, 'breaking down and building up' and the traditional vertical algorithm. She encouraged the children to solve various addition and subtraction sums using both methods. However, during both Nomsa's lesson on measurement, as noted above, it was clear that her default method was the traditional vertical algorithm and she became impatient with the children when they could not do it. After a lesson on subtraction of two three-digit numbers in which she taught the standard vertical procedure and the 'breaking down and building up' method, she explained that her learners could choose any method but that she likes them to be able to use one of these two she has taught.

Lise Do you encourage children to use their own methods?

Nomsa Yes I do that, as long as the answer is the same. As long as the learner can be able to explain why he chose to do this.

Lise Okay so can I be provocative now. (We laugh). Are these children's methods (pointing to the two methods on the board – traditional vertical method and 'breaking down and building up')?

Nomsa No, these are my methods, but I'm doing these methods with them. As you can see I got the answers from them. These we did together.

Lise So, what you're saying is because you got the answers from them, they then become their methods.

Nomsa Yes

Lise Or am I misunderstanding?

Nomsa No. They can do this method but I'm allowing them to do their own method as long as the answer is the same. As long as they're going to explain why do this method instead of that one.

(Nomsa, MHI, turns 59–66)

It appears from this interaction that it is difficult for Nomsa to conceive of other methods even though she says the children have the option to choose their own methods. Should they use an alternative method, they would need to justify their choice, and get the correct answer. In taking the children through the calculation procedures step-by-step and getting the answers from the children, Nomsa is trying to get the learners to take ownership of the methods so that they ultimately become their methods.

Unlike, Buhle and Nomsa, Nokhaya does not teach the set procedures step-by-step. Instead, she writes each sum horizontally on the board (e.g. 298 − 147=) and asks who would like to calculate the answer – a girl volunteers and writes on the board: $(200-100)+(90-40)+(8-7)$. She works each bracketed component out, writes '$100+50+1$', adds them together and gets '151'. Another sum is written on the board and another child uses the same method. While Nokhaya is not using the standard vertical algorithm, it is clear that she has taught the children this procedure for calculations. This procedure is based on the 'breaking down and building up' method.

In Veliswa's class, the children are still learning the 'breaking down and building up' method and it is clear that most do not have ownership of the method yet. Veliswa writes an addition sum on the board. She writes '$242+16$'. A boy comes up to the board and writes:

$$200+40+2+10+6,$$

$$200+40+10+$$

Veliswa asks him to use brackets and he gets confused. He writes:

$$200\Big)+40\Big)$$

He rubs this out when the teacher comments and continues $200+40+10+2+6$.

In this example, the child is unsure where to place the brackets. While the child can solve the sum, he is confused when Veliswa tells him to insert the brackets. As explained above, Veliswa, like Nomsa and Buhle, has a default method (with an accompanying format for writing the method) which is the standard vertical algorithm.

In all four classes children were taught set methods for solving addition and subtraction calculations. This suggests that the teachers believe that key to learning the four operations is reproducing taught procedures. The teacher's role, as evident above, is to impart 'objective mathematical knowledge' to children using set procedures – this despite the move away from this post-1994. In this sense, they express their identity by 'acting back' against the post-1994 roles. In this way, teachers' expression of their teacher identities together with their beliefs leads to the continued reproduction of the roles (structural mechanisms), beliefs (cultural mechanisms) and teachers' identities (agents).

Teachers must explain mathematics clearly and children must listen attentively

All four teachers maintain that it is the teacher's role to explain mathematical concepts *clearly.* The word 'clear' was used as an indicator of 'good' teaching. Nokhaya, in contrasting her primary and high school experiences, noted:

> [In primary school] [o]ur teacher was good at explaining because maths is about explaining what to do. So he was good … [whereas in high school] I didn't like it much. There was a lot to be done and our teacher was not quite clear about maths because he was not a maths teacher, but he was told to teach maths so I didn't get it the way I wanted (Nokhaya, MHI, turn 20).

Similarly, Veliswa complained that 'the person who taught us that maths, didn't explain thoroughly how it was done' (Veliswa, MHI, turn 112).

Buhle contrasted her high school mathematics experiences, with that of her experience at teachers' training college. She was critical of her high school teachers and suggested that they were not able to explain the mathematics sufficiently clearly, whereas she held her college lecturers in high regard. Buhle explained 'The teacher that was teaching us in Grade 12 … was not clear when he was teaching us' (MHI, turn 22), however, at the college 'we were doing didactics and content. It was taught. It was very good. It was clear. I never failed that' (MHI, turn 50). Nomsa agreed that her mathematics lecturer at college 'was teaching us very clearly' (Nomsa, MHI, turn 44).

The importance given to the provision of clear explanations suggests that the teachers regard the transmission of mathematical knowledge to learners as one of their key roles. However, in the classrooms, providing clear explanations was not a simple process. Teachers relied on a number of supporting devices to assist with providing clear explanations to enhance the children's understanding.

In Nokhaya's lesson on analogue time, she explains the difference between 'before' and 'after' as represented on a clock. This involves her trying to have children understand that 'when the hand of the clock moves up', it is 'before the hour' and 'when it moves down', it is 'after the hour'. To support her explanation of 'before and 'after', Nokhaya uses a clock and questioning. Specifically, she uses these techniques to get the children to focus on her explanation and to determine when time is 'before the hour' or 'after the hour'. Her explanation is coupled with getting the children to repeat the words 'phambi' ('before'), 'phambili' ('going forward') and 'emva' ('after'), and the phrases 'uya phambili' ('you are moving forward'), 'luyenyuka' ('it is moving up') and 'luyehla' ('it is moving down'). The learners in this lesson are positioned as passive recipients of knowledge, required to listen and recite and chorus answers taught by the teacher.

Nokhaya and Veliswa attributed their success at primary school, to their being good listeners. While contrasting her primary and high school experiences, Nokhaya commented:

> Yho, it was very different, because in primary school, I used to listen from the teacher, now in high school I had to study. I didn't like studying; I preferred

> listening and then go to the book. But most of the teachers there, they referred us to the book. You must read chapter what, chapter what and chapter what, then the following day, you must come and discuss. I didn't like that (Nokhaya, LHI1, turn 130)

Likewise Veliswa explained:

> It's just that I was a good listener. I listened and if, apart from the fractions that I had to learn by rote, I listened and kept what I was learning. I tried to keep it and remember it when I was to write an exam or something (Veliswa, MHI, turn 14).

Nokhaya and Veliswa describe how in their primary school their teachers were positioned as the knowers of all while they were passive recipients of knowledge. Nokhaya contrasted this with her high school teachers who required more independent self-study. In these classes 'authority' seemingly shifted from the teacher to the textbook.

Nomsa suggested that her children struggled with mathematics because they are not good listeners.

> I think another problem, when you are doing examples on the board; they are playing, they are not listening. They are not listening at all, especially those ones who are not clever in class. They are the ones who are not listening while you are teaching. …When it comes the time to answer questions they know nothing (Nomsa, MHI, turn 116).

The above data suggests that three of the four teachers seemingly equate learning with listening. Learning by listening requires teachers to make explicit what the children must do. Here clarity of explanations concerns giving instructions and/or teaching procedures. As noted above, the belief that teachers should explain mathematics clearly is consistent with the pre-1994 systemic roles. In this way the pre-1994 systemic roles of teachers exist in a logical relationship with the belief that teachers must explain mathematics clearly while children listen attentively. In choosing to hold onto this belief, teachers reproduce their teacher identities, the pre-1994 systemic roles and the associated beliefs.

These children are slow

All four teachers were concerned about the slow pace of the children in their class and noted that the children struggle to complete the annual national assessment papers.

Nomsa attributes the slow pace of the children to their not reading fluently, and not understanding what the question is asking. She explains in the interview that her children's literacy levels impact on their slow pace.

Nomsa	They (referring to the children) are very slow
Lise	And why, why do you think they are slow?

Nomsa	I don't know, maybe they don't understand the question and if they don't understand question 1, they will be stuck on question 1, they will not proceed to the next question.
Lise	And if one then takes, like you take your learners through the worksheets. If you explain carefully the question in the worksheet. Do you still find them slow when they complete the worksheet?
Nomsa	Yes, they are, they are very slow. It's because they will say they understand, although they do not understand. They will get stuck.
Lise	So, it's really a lack of understanding of what they're reading? Could there be anything else …
Nomsa	No

(Nomsa, PI2, turns 135–142)

Reflecting on when she was at school, Nomsa said 'Yes there was a lot of competition [when I was at school] … with our days, those learners that were slow learners or those who were at the last group, they were shy … but now the slow ones are the ones that are making a lot of noise. I don't know' (Nomsa, PI2, t. 220). For Nomsa, not only do these children work at a slow pace, but they also disrupt the other children in the class. She believes that having the children's position in class written on their reports would motivate them to work harder.

While Nomsa attributes the slow pace of the children to lack of understanding and the loss of competition in schools, Veliswa and Nokhaya are concerned that it reflects poorly on their teaching. Veliswa's response to why she thought the children worked so slowly was 'I don't know. Maybe we are, we let them when they do not finish, and we let them go on and on. Maybe that's one of the reasons' (Veliswa, PI1, turn 90).

Nokhaya expressed a similar sense of helplessness with the fact that some of her learners are seemingly not able to understand the mathematics. 'They are too slow. It's the pace and my last group, I sometimes don't know how to help them because others don't seem to understand, even if I explain timeously they don't understand, so I have got a problem with the last group' (Nokhaya, MHI, turn 96). Despite the teachers' attempts to explain the different mathematics concepts and procedures to their children, they complained that many children are not able to grasp them, leaving them to conclude that 'some children are not able to do mathematics'.

All four teachers referred particularly to groups of children that were struggling in class as slow. The belief that these children are slow provides the teachers with an explanation which doubles as an explanation for why the children are not performing and why they are not managing to get through the curriculum. In many respects, it takes the pressure off them as teachers and places it directly onto the children and the backgrounds 'these' children come from.

To summarise, above we have focused on four beliefs that these teachers' hold about mathematics, pedagogy and children. We showed, through excerpts from the life history, mathematics history and practice-based interviews, and observations of their teaching practice, that these teachers hold onto beliefs promoted in the past (Westaway 2017; Westaway and Graven 2017). Rather than deal with the situational logic of contradiction brought about by the radical pendulum swing (Graven 2002) from the pre- to post-1994 systemic roles for teachers, these teachers hold onto their pre-1994 beliefs. Given the complementarity between the pre-1994 roles and the teachers' beliefs, teachers generate a *situational logic of protection* (Archer, 1995, p.220), enabling them to reproduce the systemic roles of the past. The result of this situational logic of protection is morphostasis of pre-1994 roles, beliefs and teachers' identities (Westaway 2017; Westaway and Graven 2017), and the choice not to 'take up' progressive pedagogies.

Concluding remarks

This article highlights the disparity between the post-1994 systemic roles of teachers, as expressed in policy, and the pre-1994 systemic roles that the four teachers experienced as learners. We have illuminated how this variance has created a situational logic of contradiction for teachers. The teachers' responses to this are to 'hold onto' beliefs of the past that informed their schooling and initial teacher education. These beliefs stand in a relation of complementarity with the past systemic roles of teachers and in contradiction with the current systemic roles. It is this relation of complementarity that creates a situational logic of protection, that is, the reproduction of the old systemic roles and thus, teachers' identities.

In our work as teacher educators, both in-service and pre-service, we are working to shift teachers' identities through increased opportunities for experiencing, rather than being instructed about, more progressive forms of teaching. The second author is the South African Numeracy Chair (SANC), a position that requires her to integrate research and development for the betterment of learning and teaching in the country. Research into the nature of teacher learning through participation in a community of practice-based in-service professional development programme (run by the SANC project) indicate key enablers for the 'take-up' of more progressive roles in practice that cohere with international literature. That is, establishing mutually respectful partnerships with teachers, as professionals, that enable active engagement with and interrogation of 'new' resources (including new methods and theories) that are based on teachers' practical classroom experiences are key (Graven and Pausigere 2017; Darling-Hammond and Richardson 2009). We have argued for the need to move from teacher training formats that provide information about what teachers must do - often resulting in teachers adopting the form of the message rather than the function (e.g. Brodie et al. 2001). A teacher who has not fully engaged with, and from a teaching practice perspective, 'a message' passed on in 'teacher training' or professional development sessions, is likely to express her agency in terms of morphostasis (so for example, even while strategies such as using the number line; bridging through ten and jump strategy are proposed for two-digit addition rather than the vertical algorithm, Veliswa, Buhle and Nomsa continue to teach the vertical algorithm). Thus, while in many respects Nokhaya expressed acceptance of new curriculum policy in interviews, her classroom practice departed from this. As such, we argue that if we want teachers to express their agency in terms of morphogenesis (for example, choosing a new role or changed practice in their classrooms) then they must have the opportunity to fully experience the 'new' in a space where they are able to perform new roles themselves - actively engaging with and interrogating the possible value of a method and its usefulness for their learners. Moreover, they should be given opportunity to perform new roles as active partners in professional development rather than receivers of 'training' that they are mandated to implement.

In our work we continuously search for innovative ways to do pre- and in-service teacher development. We engage actively with research, particularly into the development of communities of practice, and participate in and lead a number of national initiatives. These include initiatives funded through the Department of Higher Education and Training and European Union, a ministerial task team, the Higher Resource Development Council, and the annual National Research Foundation Community of Practice forum.

Key to our work is understanding the way the past systemic roles (i.e. the structural mechanisms) and beliefs (i.e. cultural mechanisms) have conditioned teachers' identities, into the present. Illuminating these structural and cultural mechanisms, that is, to make them visible, provides an opportunity for a more explicit understanding of how the old systemic roles of teachers are sustained. Understanding how the roles of the past exist in complementary relations with the beliefs of that period, generating a situational logic of protection of past roles, provides an opportunity to explicitly focus on 'disrupting' these structural and cultural mechanisms at the level of the real to enable teachers to 'take up' more progressive roles. While teachers in South Africa, and internationally, have adopted the rhetoric of reform curricula, many continue to reproduce the old systemic roles through the manner in which they express their teacher identities while teaching mathematics. Social realism provides a framework for identifying the base conditions that enable or constrain teachers' practices, and the extent to which they 'take on' new roles as defined in policy.

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