CHAPTER 16

Enhancing Capabilities of Life Sciences Teachers: Professional Development, Conversion Factors and Functionings in Teachers' Professional Learning Communities

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Introduction and context

South Africa is rich in biodiversity and is home to about 95 000 known species (South Africa DEA 2014; SANBI 2019). Yet, compared to other southern African countries, the country has a high number of threatened species (Driver et al. 2012). Approximately 12 million South Africans depend on the natural environment to meet their needs. Among other factors, overharvesting of biological resources is one of the main causes of biodiversity loss in the country (South Africa DEA 2014; SANBI 2019). In line with assessment of biodiversity reports, Unesco (2018) notes that biodiversity loss is a global phenomenon. Emphasis in these reports is that over 7 billion people in the world rely on biodiversity to maintain and enhance their well-being. The realisation of biodiversity conservation as a global concern has resulted in various international conventions, policies, legislation and educational programmes that foreground biodiversity (Shava & Schudel 2013). Aligned with international trends, South Africa also has national policies and legislation aimed at protecting biodiversity. Among these is the National Environmental Management Biodiversity Act which introduces a legal framework for governing sustainable development in the country, and includes a

clause for all training and education programmes to integrate education for sustainable development (RSA 1998). Thus, like many other countries in the world, South Africa has incorporated biodiversity components in its ongoing curriculum reforms including in the Curriculum Assessment Policy Statement (CAPS).

An analysis of the CAPS curriculum clearly shows that Life Sciences as a subject covers a considerable amount of biodiversity-related elements (South Africa DBE 2011a). However, due to inadequate pedagogical content knowledge of new curriculum areas such as biodiversity among Life Sciences teachers, the implementation of this area of the curriculum lacks systemic coherence (Songqwaru 2012). Efforts have been made to support teachers to enhance their subject knowledge for effective implementation of environmental learning by including biodiversity content in the curriculum; however, very little has been achieved in ensuring that environmental issues such as loss of biodiversity and climate change are consistently and coherently implemented in the school curriculum (Lotz-Sisitka 2011; cf. Mmekwa and Schudel, Chapter 3 and Lotz-Sisitka and Mandikonza, Chapter 6). Many professional development initiatives have been described as one-off trainings, often with little relevance to the needs of teachers (South Africa DBE 2015). For professional development programmes to be successful, they have to be personally meaningful to the participating teachers, and should be aligned with their needs (Darling-Hammond 2008). In response to this and in line with international trends, South Africa calls for collaborative learning as a main strategy to support the ongoing professional learning and development of teachers. This is through providing support systems that promote the establishment of Professional Learning Communities (PLCs) (South Africa DHET & DBE 2011; cf. Thomas and Songqwaru, Chapter 17). PLCs aim to transform teachers from being subjects in their learning spaces to becoming educational change agents (South Africa DHET & DBE 2011). In South Africa, PLCs are a relatively new policy concept; thus, limited research exists on how PLC approaches contribute to teachers' professional development.

In line with the South African policy landscape, Fundisa for Change aims to pilot and develop the concept of PLCs within the context of environmental learning (Lotz-Sisitka 2011). Using the capability approach and the critical realist theory of causation, this chapter aims to answer the following question:

How can a continuing professional development programme act as a conversion factor that expands and/or constrains the conversion factors and functionings in teachers' PLCs related to the teaching of biodiversity?

The chapter explores how PLC approaches can enhance Life Sciences teachers' capability for teaching biodiversity content in the curriculum. This has the potential to contribute to the South African policy landscape on teacher professional development and related global policies such as the Education for Sustainable Development 2030 Agenda (Unesco 2020), as well as transforming and strengthening teachers' practices.

Professional Learning Communities

PLCs are defined as ‘on-going groups ... who meet regularly for the purpose of increasing their own learning and that of their students’ (Lieberman & Miller 2008: 2). PLCs comprise ‘teachers who work collaboratively to reflect on practice, examine evidence about the relationship between practice and student outcomes, and make changes that improve teaching and learning for the particular students in their classes’ (McLaughlin & Talbert 2006: 3–4). In the South African context, PLCs are defined as ‘communities that provide the setting and necessary support for groups of classroom teachers to participate collectively in determining their own developmental trajectories, and to set up activities that will drive their development’ (South Africa DHET & DBE 2011: 14). Examples of PLCs are: teacher learning communities, teacher networks, and critical friend groups. Reflected in these definitions of PLCs is that the focus of learning is not on individual teachers’ professional learning but rather on the professional learning within the community context. This communal conception of learning, according to Sfard (1998), assumes an inextricable bond with identity formation. The community aspect of a PLC enables collegial support for individuals (Stoll et al. 2006). Borko (2004) claims that professional development is situative and that outcomes are influenced by personal and group processes.

PLCs are grounded in adult learning theories aligned with socio-cultural learning, grounded in the work of Vygotsky (1978). Through Vygotsky’s theories, the idea of scaffolding was identified by Bruner (1993), which implies that people learn at a much higher level when support for their learning gap is provided through peer interaction, or the contribution of a more knowledgeable other (Vygotsky 1978). In the case of PLCs, this suggests that Life Sciences teachers must understand their own acquisition of biodiversity knowledge, and its relationship within the social context, in order to enhance their knowledge. This requires a forum for teachers to construct biodiversity knowledge through a continuous cycle of learning rooted in reflection, social collegial interaction, professional dialogue, and processes that can provide scaffolding for improved knowledge for teaching (Stoll et al. 2006). In this chapter, the focus is on a course-initiated PLC and explores the potential of this approach for enhancing teachers’ biodiversity knowledge. Of particular interest are PLCs that operate outside the school and consist of Grade 10–12 Life Sciences teachers from various schools in one district. This is motivated by the model used by the Fundisa for Change programme. Fundisa for Change support to teachers is subject, grade and environmental-issue specific (Fundisa for Change Programme 2013). PLCs provide spaces for teachers to raise questions about their teaching, improving teachers’ content knowledge, teaching strategies and professional practice (Stoll et al. 2006). This implies that Life Sciences teachers can use PLCs to collaborate on their knowledge of biodiversity and experiment with new teaching methods that are encouraged for biodiversity teaching. This has the potential to improve learners’ knowledge of biodiversity and, ultimately, contribute to the conservation of South Africa’s biodiversity.

Theoretical framework

The study used the capability approach and critical realist theory of causation. The capability approach is developed by Amartya Sen. Among the core concepts of the capability approach are functionings, capabilities and conversion factors. Functionings are ‘the various things a person may value doing or being’ (Sen 1999: 75) which constitute the practical realisation of one’s chosen way of life. Capabilities are ‘the alternative combination of functionings that are feasible for [a person] to achieve; they are the substantive freedom a person has to lead the kind of life he or she has reason to value’ (Sen 1999: 87). Conversion factors are factors that can allow teachers in PLCs to convert resources to new functionings (Robeyns 2005). Robeyns distinguished between three sources of conversion factors that can constrain or enable people’s capabilities. These are:

- *Personal conversion factors*: those determined by one’s mental and physical aspects. They are internal to the individual, such as intelligence.
- *Social conversion factors*: those determined by the society in which one lives, such as curriculum policies.
- *Environmental conversion factors*: those determined by or emerging from the physical environment in which a person lives. These can be aspects of one’s geographic location, such as proximity to an ocean.

Robeyns further noted that personal, social and environmental conversion factors are interrelated. Therefore, the capability of individual Life Sciences teachers in the PLC is likely to be dependent on these interrelated conversion factors. The capability approach is not aimed at understanding causal structures and mechanisms that influence the conversion factors; for this reason, critical realism was used to understand and explain the causal structures and mechanisms that influence PLC functionings.

Critical realism is a philosophy of natural and social sciences developed by Roy Bhaskar (1978). It is based on the assumption that there are real generative mechanisms underlying the events of the world and our experiences of it (Benton & Craib 2001). Critical realism posits that natural and social phenomena are real but that our knowledge about them is theory-laden, imperfect and fallible (Sayer 2000). Critical realist researchers base their explanations of how people experience a phenomenon on mechanisms that operate at deeper levels of reality. The three levels of reality are: the empirical, the actual and the real. Benton and Craib (2001) asserted that scientific research employing a critical realist methodology goes beyond what is experienced, to uncover the underlying dynamics that give rise to generative mechanisms. A generative mechanism is ‘the way of acting of things’ (Bhaskar 1978: 14). The empirical is the layer of reality that is most accessible to us. It refers to our personal observations and experiences of the world (Danemark et al. 2002). This layer consists of knowledge that is fallible and unstable, meaning that knowledge is not static and can change. Empirical knowledge pertaining to Life Sciences teachers is their conceptions of their

valuable beings and doings as teachers and participants in PLCs. The actual is the layer of reality that consists of the events of the world, whether experienced by people or not (Danermark et al. 2002). An example would be the actual practices of Life Sciences teachers. The real refers to anything that exists that has power to cause events and experiences at the level of the actual and empirical (Sayer 2000). It is within the level of the real that causal mechanisms and causal powers are found. Martins (2006) differentiates between the concepts of structures, power and mechanisms as three fundamental concepts of critical realist ontology, noting that:

Structures are the underlying conditions of possibility that enable or facilitate the occurrence of a given phenomenon. Structures comprise powers that may or may not be exercised and, when exercised, may or may not be actualised in actual events and states of affairs. Mechanisms refer to the mode of operation of structures and exist as the power that a structure possesses of acting in a given way. (2006: 676)

Bhaskar (1978) argued that mechanisms are ways in which structured entities, by means of their powers and liabilities, act and cause particular events. Sayer (2000) posited that the same structures and mechanisms operating in different conditions cause different observed events. He notes that causal mechanisms do not act deterministically. Bhaskar (1998) asserted that causal mechanisms are better understood as tendency, which can be explained as activities that may or may not be actualised in concrete events and states of affairs. Tendencies can be linked to courses of action that one would take: for example, Life Sciences teachers participating in the PLC activities in order for their valued beings or doings to come to fruition (Tao 2013).

Critical realism argues that reality is a differentiation between open systems and closed systems (Shipway 2011). Bhaskar (1978) noted that open systems result in a situation where particular mechanisms cause certain effects and those effects are observable. Education programmes such as Fundisa for Change always take place in open systems. Tendencies operate within the open systems (i.e. in the PLCs) of the social world among counter-tendencies. Archer (2007) noted:

If there is a congruent relationship between an individual's tendency with concurrently operating tendencies, there is enablement of action: but if there is incongruence, there is a constraint. At that point, an individual has the power to reflect upon one's circumstances and to decide what to do in them or to do about them; and this reflexive deliberation may result in compliance to counter-tendencies (in which original course of action is negated), or evasion of it (in an attempt to realise the action, albeit in a constrained way). (2007: 20)

Also important is to understand the causal factors and causal processes that explain how the generative mechanisms relate to the Life Sciences teachers' PLC activities, and the

conversion factors that enable or constrain their capabilities (their valued beings and doings as teachers). This is linked to the critical realism concept of causality. ‘To ask the cause of something is to ask what makes it happen, what produces, generates, creates or determines it, or more weakly, what enables or leads to it’ (Sayer 1992: 104). As outlined above, significant to critical realism is the notion of social structures (Sayer 2000). Like natural entities, social structures emerge from relations: the relations between people, and relations between people and nature (Easton 2010). Martins (2006) noted that structures can be physical, biological, psychological or social.

What inspired the use of the capability approach and critical realism in this chapter is Tao’s (2012, 2013) analytical framework (see Figure 1).

Figure 1. Locating capability approach concepts in a critical realist theory of causation (Tao 2013: 9)

To unpack this framework at the level of the real, structures and agency can interact to develop a functioning that an individual values (Tao 2012). These factors can be seen as causal mechanisms that trigger an individual's tendency of action. This happens in an open system (Collier 2005). Within the open system are conversion factors that can either enable or constrain the Life Sciences teachers' capabilities to achieve their valued functionings (Tao 2012). If the conversion factors are enabling, the teacher's functionings will be achieved and the individual then decides whether to actualise the functioning (Outcome 1) or not (Outcome 2). If the conversion factors are constraining, this may result in an individual teacher complying with the constraint (Outcome 3), or being content with the counter-tendencies that can result in a constrained version of the valued functioning (Outcome 4) (Tao 2012). This brief discussion clarifies how such a framework can be helpful in identifying causal mechanisms in the PLC as well as the conversion factors, and exploring how the agents (i.e. Life Sciences teachers) can deliberate on whether to realise their achieved outcomes in the PLCs or not.

Drawing on Archer's (1995) perspectives, the agential ability for teachers to reflexively deliberate on social structures explains why teachers do not respond in the same ways under the same circumstances. Agency refers to the reflexive, creative, innovative and purposeful actions of people (Archer 1995). It explains the choices that people make in their daily lives which either reinforce existing structures and cultures or transform them.

Drawing on the critical realist theory of causation explains why specific interventions such as Fundisa for Change will only generate particular outcomes. The outcome will depend on both the context and the generative mechanisms that exist (Smith & Seward 2009). Similarly, even though teachers participating in the PLC activities may be receiving the same resources, different contextual factors and mechanisms will determine how teachers can or will convert them into new functionings (Robeyns 2005; cf. Thomas and Songqwaru, Chapter 17).

Research design

The research was conducted as a qualitative case study, stressing the ontological foundations of the socially constructed nature of empirical experiences; the intimate relationship between researcher and what is studied; and the situational constraints that shape inquiry and practices (Denzin & Lincoln 2011; Bhaskar 1978). Case study methodologies are significant for learning about environmental learning (Lotz-Sisitka & Raven 2004) as they enable research into environmental issues such as biodiversity. All three PLC activities happened in two contact sessions (three days per session). Both sessions were attended by the same ten Life Sciences teachers and three facilitators. The teachers were qualified to teach Life Sciences and all had one or more qualifications in the field of education. Their qualifications varied from a Senior Secondary Teaching Diploma in Education to a Bachelor of Education Honours degree. Data was generated through ten semi-structured interviews with teachers, conducted by six facilitators, and with observations of the contact sessions. Document analysis was done on the

Life Sciences CAPS documents, which served as primary data sources (Harland 2014). The data generated was analysed using the capability approach and critical realist theory of causation described above. Careful attention was given to ethical issues that confronted the researcher, such as policies regarding informed consent, confidentiality and anonymity (Harland 2014).

Research findings and discussions

The teachers' valued functionings were mainly to expand their content knowledge, pedagogical practices and assessment practices related to the teaching of biodiversity (Tshiningayamwe 2016). Teachers also valued improving their confidence for teaching biodiversity, exploring study opportunities on marine biodiversity, receiving teaching and learning support materials, and expanding other capabilities such as having a good-looking curriculum vitae and supporting learners and the community to be knowledgeable on biodiversity. As discussed previously, capabilities can be expanded or constrained by conversion factors (Robeyns 2005). In PLCs there are different factors that enable or constrain the teachers in achieving their valued beings and doings. These include policies, teachers' qualifications, and the context in which PLC activities take place. Tao (2013, 2015) has argued that when located within a critical realist theory of causation, teachers' valued functionings can be viewed as the causal mechanisms that generate much of their actions as they relate to the teaching of biodiversity. She has developed an analytic framework that helps explain how causal mechanisms can lead to realised achieved functionings, or not. Using Tao's analytic framework here will provide an explanation of how the causal mechanisms among teachers in the PLCs can lead to realised functionings, or not. Figure 2 offers a visualisation of the intersections of capability approaches and critical realism with the realist causality that shapes the emergence of teachers' functionings in the PLCs.

Figure 2 outlines a process that begins at the level of the real with the dialectical interaction between structure and agency that produces the valued functionings of teachers as they relate to the teaching of biodiversity. The interplay was between Life Sciences teachers (agency) and the policy documents (structures) on teaching practice and professional development, such as the Life Sciences CAPS documents and the opportunity to participate in the PLCs. Teachers engaging in a reflexive deliberation process determined to what extent, as individuals, they wanted to be knowledgeable Life Sciences teachers, with improved practices on biodiversity. As shown in Figure 2, it is evident that the teachers' valued beings and doings related to biodiversity is an interplay between structures and agency. It is evident that in South Africa, contributing to teachers' lack of biodiversity knowledge is the fact that after 1994, school and teacher education curricula were implemented in a country with high poverty and social inequalities. It is also evident that unsuccessful or poorly monitored education policies, such as the Integrated Quality Management System, contributed to teachers' lack of biodiversity teaching knowledge. Another causal mechanism for teachers' lack of biodiversity knowledge is the ongoing curriculum change in South

Africa (Tshiningayamwe 2016); at the time of writing, teachers had already had to adapt to three different versions of the national curriculum since 1994. The curriculum changes in South Africa introduce concepts and content that teachers are not trained to teach, including the concept of biodiversity. This implies that the education system and policies in South Africa are among the generative mechanisms that influence teachers' valued beings and doings as they relate to the teaching of biodiversity.

Figure 2. A visualisation of critical realism and capability approaches (SCF = social conversion factors; PCF = personal conversion factors; ECF = environmental conversion factors)

As discussed earlier, critical realism bases explanations of how people experience a phenomenon on mechanisms that operate at deeper levels of reality. At the level of the actual, the causal mechanism triggers a person's tendency for action (Tao 2013). People's courses of action are triggered in open systems. The individual teacher's course of action was triggered in an open system that entailed teachers participating in the PLC activities to achieve their valued beings and doings. Some practising teachers do not have formal qualifications for the subjects they teach (South Africa DHET & DBE 2011b).

The teachers' differential qualifications have been influenced by the apartheid legacy and social inequalities (Tshiningayamwe 2016). This has an impact on both the teachers' lack of biodiversity knowledge and the quality of education in South Africa. It was therefore evident that teachers' different experiences and qualifications – personal conversion factors – influenced their biodiversity teaching.

Good facilitation among the facilitating team in the PLC was an important personal conversion factor that enabled teachers to expand their capabilities for biodiversity teaching in the PLCs (Tshiningayamwe 2016; Songqwaru 2020) (see Brundrit and Schudel, Chapter 18 for insight into aspects of facilitation appreciated by teachers). The Fundisa for Change partners who facilitated the PLC activities had different experiences (i.e. as teachers, teacher educators or subject advisors) and qualifications (i.e. master's and PhDs in Sciences and Environmental Education) that enabled them to facilitate the PLC activities together, drawing on this diversity of pedagogical, subject specialist, and facilitation expertise (Tshiningayamwe 2016). The facilitators' experiences and qualifications, related to environmental learning and related active learning pedagogies, were found to be contributing factors to the facilitators' good facilitation skills. In addition to teachers' capabilities and good facilitation, it was evident that in PLCs, another personal conversion factor that enabled teachers to expand their capabilities for teaching biodiversity was subject specialisation (Tshiningayamwe 2016). The Minimum Requirements of Teacher Education Qualification in South Africa notes that different subjects have different disciplinary or subject matter knowledge (South Africa DHET 2011: 8). Therefore, subject specialists who are knowledgeable in the subject matter in the PLCs enabled teachers' capabilities for teaching biodiversity.

In the Fundisa for Change PLCs, an important social conversion factor that enabled teachers to achieve their valued functionings was teaching and learning support materials and policy documents used in the PLCs and professional training programme. These were provided by the Fundisa for Change programme and were specially designed for enhancing Life Sciences Biodiversity knowledge, pedagogy and assessment practice in a context where good teaching and learning resource materials for teacher education programmes are rare (Tshiningayamwe 2016). This lack has been caused by inadequate support for teachers and teacher educators to develop quality teaching and learning support materials (Fundisa for Change Programme 2013). In some institutions of higher education, teachers have not been adequately prepared to design their own resources for teaching and learning (South Africa DHET & DBE

2011b). In some cases, there is a lack of curriculum understanding among those who support teachers with their professional development needs (Tshiningayamwe 2016). For this reason, the Fundisa for Change teacher education materials were designed specifically to be important social conversion factors in the PLC context for supporting biodiversity content knowledge, pedagogy and assessment practice.

The environmental conversion factors that enabled teachers to achieve their valued functionings in the PLCs were: collaborative spaces; sites for PLC activities (the presence of the botanical garden, wetland and ocean); and the actual beings and doings (the activities) in the PLCs (Tshiningayamwe 2016). The collaborative space is associated with the teachers' professional modalities that encourage teachers to share best practices together (Schmoker 2006). This is in response to a situation in South Africa where once-off models were among the popular models used for teachers' professional development, despite these having been found inadequate for substantive teacher professional development. These models have not fully transformed teachers' practices; in fact, they have contributed to teachers having inadequate biodiversity knowledge and expertise for their teaching. It is this historical situation that led to the introduction of the policy on PLCs in South Africa (South Africa DBE 2015) and motivated the more substantive response in the Fundisa for Change teacher education programme.

Another causal mechanism influencing environmental conversion factors of teachers' functionings is linked to the loss of biodiversity. As with most countries, biodiversity in South Africa is under threat as outlined above. This is due to the development model used in the country (Abdu-Raheem 2010). Land has been cleared for development purposes and loss of habitats has led to loss of biodiversity and/or species being threatened with extinction (Abdu-Raheem 2010). Long histories of occupation have produced human activities that have had impacts on natural habitats, leading to habitat destruction. Even though there is legislation at both international and national levels that aims at protecting biodiversity, some of the policies have not been fully implemented. In response, the South African government, as in other countries, has sought to integrate the concepts and content of biodiversity in the formal school curriculum, including the Life Sciences CAPS curriculum.

The personal, environmental and social conversion factors discussed above enabled the individual teachers' tendencies in the PLCs. Archer (2007) noted that if there is a congruent relationship between a teacher's tendency and the social, personal and environmental conversion factors, then the teacher's capabilities are expanded: for example, when teachers were able to convert the social conversion factor of good learning materials into their aspirations for improved teaching of biodiversity lessons; or where the social conversion factor of good facilitation provided teachers with better pedagogical knowledge and experience on how to go about teaching biodiversity in the outdoors. Here, the conversion factors were the enabling of teachers valued beings and doings, especially as these related to their intentions to improve their biodiversity teaching in the Life Sciences. As shown above, however, some of the conversion factors in the PLCs were constraining of teachers' capabilities, for example, the personal

conversion factors that were constrained by inadequate qualifications or opportunities for obtaining qualifications that included biodiversity knowledge.

With the enabled conversion factors, the teachers had expanded capabilities for the teaching of biodiversity. Thus, teachers, through reflexive deliberations, had to decide what to do with their enabled or expanded capability of teaching biodiversity. Most teachers who participated in the Fundisa for Change PLCs realised their achieved functionings that resulted from expanded capabilities (Outcome 1). Tao (2013) noted that if teachers' valued functionings are expanded they are likely to be actualised. The expanded capabilities were in line with teachers' valued functionings, thus some teachers had actualised their expanded capabilities. This was mainly through teaching some of the biodiversity concepts they had learnt in the PLCs, and the use of pedagogical approaches and assessment practices learned in the PLCs. In this way they transformed their actual classroom practices related to biodiversity teaching. This outcome was reported by other Fundisa for Change researchers including Chitsiga (2015), Isaacs (2015), Songqwaru (2020) and Nkahle (2021), as well as in other environmental learning professional development research (Schudel 2012). The researchers observed that the Fundisa for Change programme has the potential to expand the valued beings and doings of teachers (i.e. their capabilities) and their professional learning interest, both in expanding their own environmental knowledge and teaching practices and in successfully teaching the curriculum (cf. with Songqwaru 2020).

As shown in Figure 2, some of the teachers who had expanded capabilities did not realise their achieved functionings (Outcome 2). This was mainly because of external constraints such as inadequate teaching and learning support materials; finances to take learners on field-work trips; large class sizes; too much CAPS content which allowed little time for teaching biodiversity concepts adequately; and learners' struggles with reading and writing.

It is arguable that teachers not realising their achieved functionings is also due to aspects that affect their agency (or passive agency). For example, in terms of teaching and learning support materials as required in the CAPS curriculum, they could have improvised to realise their achieved functionings. However, as noted by facilitators in the PLCs, some teachers were still not feeling confident to realise their achieved functionings. Even though teachers did not mention lack of confidence as one of the reasons for not realising their expanded capabilities, it is implied in the valued new functionings.

In the PLCs some individual tendencies were met by counter-tendencies or conversion factors that constrained capabilities. Social environmental factors such as lack of time spent on the activities were the main conversion factor that constrained teachers' capabilities (see Figure 2). As a result, some of the teachers did not expand their capabilities to teach all of the biodiversity concepts. Through reflexive deliberation they decided to contend with the conversion factors by expressing a need for further support in the PLCs to expand their capabilities with those biodiversity concepts not dealt with (Outcome 3). Some teachers' valued functionings were to explore study opportunities around marine biodiversity. That valued functioning was not achieved

in the PLCs, therefore, as shown in Figure 2, teachers contended with this valued functioning by expressing a need for funding from the Fundisa for Change programme to study marine biodiversity further. Alternatively, as shown in Figure 2, through reflexive deliberations, teachers could have complied with the conversion factors, in which case a constrained form of the valued functioning would be achieved (Outcome 4). An example of this outcome would be teachers giving up on the PLC activities or not expressing a need for more professional development activities to expand their constrained capabilities related to the teaching of biodiversity. However, as shown in Figure 2, there was no evidence in the teachers' data that pointed to compliance of a constrained capability.

It is evident from Figure 2 that the critical realism theory of causation offers an explanation as to why teachers in the PLCs value ongoing support for their professional development. In these PLCs the same causal power can produce different outcomes, depending on the individual teachers' capabilities and contexts in which they work (Sayer 2000). Critical realists argue that because 'events are not pre-determined before they happen but depend on contingent conditions, the future is open – things could go in many different ways' (Sayer 2000: 15). This implies that the same causal mechanisms will not necessarily produce the same outcomes in the future. Thus, even though teachers in this study have expressed the need for continued participating in the PLC activities to expand their capabilities for biodiversity teaching, their ongoing participation might lead to different outcomes. However, by identifying that one of the key causal mechanisms in the PLCs is the teachers' valued functionings, and that conversion factors enable teachers' achievement of what they value in PLCs, we can improve teachers' practices on biodiversity components in the Life Sciences CAPS curriculum through understanding and addressing these mechanisms and/or their conversion factors in PLCs and in professional learning programmes more generally.

Conclusions and recommendations

This study shows that simply to criticise teachers' poor teaching practices in relation to biodiversity content in the Life Sciences CAPS curriculum is an inadequate response that fails to recognise the need for a better foundation for programmes and professional learning. The study shows that teachers have valued functionings and capabilities that need to be appreciated when it comes to their teaching practices. It also demonstrates a need to give adequate time to understanding the root causes of teachers' observed practices, their expressed valued beings and doings, and the support they desire to achieve their capabilities. What emerged is that the causal power that has led to teachers' poor content knowledge, pedagogical approach and assessment includes the following factors: inadequate training; lack of professional development support; ongoing changing curricula; apartheid legacy and social inequalities; lack of and/or poor policy implementations; and education quality. It is clear that relying on empirical observations of teacher actions is only helpful in offering an understanding as to what extent a particular action occurs; but drafting policy on teachers' poor teaching

practices, for example, will require a deeper understanding of the mechanisms that create the observed practices.

Unpacking teachers' practices related to biodiversity teaching, and understanding the underlying structures, mechanisms, tendencies and counter-tendencies that produce these observed practices is important. This provides information for programmes such as Fundisa for Change on the kind of support teachers need to expand their capabilities to transform classroom practices. This will enable programme initiators to put in place the requisite interventions to ensure that teachers' biodiversity practices are improved. It is important that such interventions take heed of teachers' capabilities, because these are the valued beings and doings that, as Sen (1999) described, are central to the types of lives that teachers would like to lead. If interventions such as the Fundisa for Change programme are aligned to teachers' valued beings and doings, then this could lead to improved teacher practices around biodiversity. It is also important that interventions aim to address the constraining conversion factors (counter-tendencies) such as time constraints. It can be argued that if professional development activities do not consider teachers' valued functionings and the constraining conversion factors, they are less likely to positively impact on the teachers' teaching practices as they relate to biodiversity.

References

- Abdu-Raheem KA (2010, September) Expanding biodiversity conservation beyond the official mandate of the Dwesa-Cwebe nature reserve of South Africa: Qualitative assessment based on Nqabara administrative area. Paper presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa
- Archer MS (1995) *Realist Social Theory: The Morphogenetic Approach*. Cambridge: Cambridge University Press
- Archer MS (2007) The ontological status of subjectivity: The missing link between structure and agency. In: C Lawson, J Latsis & N Martins (eds) *Contributions to Social Ontology*. London: Routledge. pp. 17–31
- Benton T & Craib I (2001) *Philosophy of Social Science: The Philosophical Foundations of Social Thought*. New York: Palgrave
- Bhaskar R (1978) *A Realist Theory of Science*. Sussex: Harvester
- Bhaskar R (1998) *The Possibility of Naturalism: A Philosophical Critique of the Contemporary Human Sciences*. London: Routledge
- Borko H (2004) Professional development and teacher learning: Mapping the terrain. *Education Researcher* 33(8): 3–15
- Bruner JS (1993) *Actual Minds, Possible Worlds*. Cambridge, Mass: Harvard University Press
- Chitsiga C (2015) An examination of teaching strategies for mediating the construction of environmental content knowledge: A case of Grade 11 Life Sciences teaching in two Eastern Cape schools. Unpublished Master's thesis, Rhodes University, Makhanda
- Collier A (1994) *Critical Realism: An Introduction to Roy Bhaskar's Philosophy*. London: Verso
- Collier A (2005) Philosophy and critical realism: Critical realism. In: G Steinmetz (ed.) *The Politics of Method in the Human Sciences: Positivism and its Epistemological Others*. Durham: Duke University Press. pp. 327–345
- Danermark B, Ekstrom M, Jakobsen L & Karlsson J (2002) *Explaining Society: Critical Realism in the Social Sciences*. London: Routledge

- Darling-Hammond L (2008) Teacher learning that supports student learning. *Teaching for intelligence* 2: 91–100
- Denzin NK & Lincoln YS (2011) *The Sage Handbook of Qualitative Research*. Thousand Oaks: Sage
- Driver A, Sink KJ, Nel JN, Holness S, Van Niekerk L, Daniels F, Jonas Z, Majiedt PA, Harris L & Maze K (2012) National Biodiversity Assessment 2011: An Assessment of South Africa's Biodiversity and Ecosystems. Synthesis Report. Pretoria: South African National Biodiversity Institute and Department of Environmental Affairs
- Easton G (2010) Critical realism in case study research. *Industrial Marketing Management* 39: 118–128
- Fundisa for Change Programme (2013) *Fundisa for Change: Introductory Core Text*. Makhanda: Environmental Learning Research Centre, Rhodes University
- Fundisa for Change Programme (2014) The Fundisa for Change Teacher Education Conference and Launch: 27–28 February 2014. Johannesburg, South Africa
- Harland T (2014) Learning about case study methodology to research higher education. *Higher Education Research and Development* 33(6): 1113–1122
- Isaacs D (2015) An exploration of what Grade 7 Natural Science teachers know, believe and say about biodiversity and the teaching of biodiversity. Unpublished Master's thesis, Rhodes University, Makhanda
- Lieberman A & Miller L (2008) *Teachers in Professional Communities: Improving Teaching and Learning*. New York: Teachers College Press
- Lotz-Sisitka H (2011) National case study: Teacher professional development with an Education for Sustainable Development focus in South Africa – development of a network curriculum framework and resources for teacher education. *Southern African Journal of Environmental Education* 28: 30–71
- Lotz-Sisitka H & Raven G (2004) Learning through cases: Adopting a nested approach to case-study work in the Gold Fields participatory course initiative. *Environmental Education Research* 10(1): 67–87
- Martins N (2006) Capabilities as causal powers. *Cambridge Journal of Education* 30: 671–685
- Martins N (2007) Ethics, ontology and capabilities. *Review of Political Economy* 19(1): 37–53
- McLaughlin MW & Talbert JE (2006) *Building school-based learning communities: Professional strategies to improve student achievement*. New York: Teachers College Press
- Nkahle LJ (2021) Continuing teacher professional development in the Environment Sector: A case study of Fundisa for Change continuing teacher professional development programme. Unpublished Doctoral thesis, Rhodes University, Makhanda
- Republic of South Africa (RSA) (1998) National Environmental Management Act 107 of 1998. Pretoria: Government Printers
- Robeyns I (2005) The capability approach: A theoretical survey. *Journal of Human Development* 6(1): 93–114
- Sayer A (1992) *Methods in Social Science: A Realist Approach*. London: Routledge
- Sayer A (2000) *Realism and Social Science*. London: Sage
- Schmoker M (2006) *Results NOW: How we can Achieve Unprecedented Improvements in Teaching and Learning*. Alexandria: Association for Supervision and Curriculum Development
- Schudel I (2012) Examining emergent active learning processes as transformative praxis: The case of the schools and sustainability professional development programme. Unpublished doctoral thesis. Rhodes University, Grahamstown
- Sen A (1999) *Development as Freedom*. Oxford: Oxford University Press
- Sfard A (1998) On two metaphors for learning and the dangers of choosing just one. *Educational Researcher* 27: 4–13
- Shava S & Schudel I (2013) Teaching Biodiversity. Fundisa for Change Programme. Makhanda: Environmental Learning and Research Centre, Rhodes University
- Shipway B (2011) *A Critical Realist Perspective in Education*. New York: Routledge
- Smith M & Seward C (2009) The relational ontology of Amartya Sen's capability approach:

- Incorporating social and individual causes. *Journal of Human Development and Capabilities* 10: 213–236
- Songqwaru NZ (2012) Supporting Environment and Sustainability Knowledge in the Grade 10 Life Sciences Curriculum and Assessment Policy Context: A Case Study of the Fundisa for Change Teacher Education and Development Programme Pilot Project. Makhanda: Rhodes University
- Songqwaru NZ (2020) A theory-based approach to evaluating a Continuing Teacher Professional Development Programme aimed at strengthening environment and sustainability education. Unpublished Doctoral thesis, Rhodes University, Makhanda
- South Africa Department of Basic Education (DBE) (2011a) *Curriculum Assessment Policy Statement: Further Education and Training Phase Grades 10–12: Life Sciences*. Pretoria: Department of Basic Education
- South Africa Department of Basic Education (DBE) (2011b) *Action Plan 2014: Towards realisation of schooling 2025. Full Version*. Pretoria: Department of Basic Education
- South Africa Department of Basic Education (DBE) (2015) Professional Learning Communities – A Guideline for South African Schools. Pretoria: Department of Basic Education
- South Africa Department of Environmental Affairs (DEA) (2014) South Africa's Fifth National Report to the Convention on Biological Diversity. Pretoria: Department of Environmental Affairs
- South Africa Department of Higher Education and Training (2011) *The minimum requirements for teacher education qualifications*. Pretoria: Department of Higher Education and Training
- South Africa Department of Higher Education and Training (DHET) & Department of Basic Education (DBE) (2011) Integrated Strategic Planning Framework for Teacher Education and Development in South Africa. 2011–2025. Full version. Pretoria: DHET/DBE
- South African National Biodiversity Institute (SANBI) (2013) Life: The State of South Africa's Biodiversity 2012. Pretoria: South African National Biodiversity Institute
- South African National Biodiversity Institute (SANBI) (2019) National Biodiversity Assessment 2018: The status of South Africa's Ecosystems and Biodiversity. Synthesis Report. Pretoria: South African National Biodiversity Institute
- Stoll L, Bolam R, McMahon A, Wallace M & Thomas S (2006) Professional learning communities: A review of the literature. *Journal of Educational Change* 7: 221–258
- Tao S (2012) Why are Teachers Absent? Examining the Effects of Inequalities on Teachers in Tanzania: Addressing Inequalities, the Heart of Post-2015 Developing Agenda and the Future We Want for All. Global Thematic Consultation. London: Institute of Education, University of London
- Tao S (2013) Why are teachers absent? Utilising the Capability Approach and Critical Realism to explain teacher performance in Tanzania. *International Journal of Educational Development* 33: 2–14
- Tao S (2015) *Using the capability approach to improve the efficacy of teacher training*. Cambridge: Cambridge Education
- Tshiningayamwe SAN (2016) Exploring functionings and conversion factors in biodiversity teacher professional learning communities. Unpublished Doctoral thesis, Rhodes University, Makhanda
- United Nations Educational, Scientific and Cultural Organization (Unesco) (2018) UNESCO's Commitment to Biodiversity – Connecting People and Nature for an Inspiring Future. Paris: Unesco
- United Nations Educational, Scientific and Cultural Organization (Unesco) (2020) *Global Education Monitoring Report 2020: Inclusion and Education: All Means All*. Paris: Unesco
- Vygotsky LS (1978) *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University