CHAPTER 4

An Exploration of what Grade 7 Natural Sciences Teachers Know, Believe and Say about Biodiversity and the Teaching of Biodiversity

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Introduction

This chapter shares the findings of a small-scale qualitative research project that investigated what three Grade 7 Natural Sciences teachers know, believe and say about biodiversity (Isaacs 2016). The study was sparked by the researcher's interest in environmental learning and the importance of school curricula in preparing children to take care of their local and global environments.

Biodiversity refers to Earth's rich variety of plants and animals. It has been described as 'the complex web of life' that includes diversity at genetic, species and ecosystem levels (Gurr et al. 2012: 4). The concept came to prominence in 1992 when the United Nations' Convention on Biological Diversity defined biological diversity as 'the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems' (United Nations 1992: Article 2).

South Africa is celebrated for its biodiversity. The South African National Biodiversity Institute (SANBI) reports that the country is home to an estimated 67 000 animal species and over 20 400 plant species. This diversity of species occurs

within nine biomes (such as the fynbos, Nama-Karoo and forest biomes) and a total of 458 types of terrestrial ecosystems. South Africa also boasts exceptional marine biodiversity, including 150 marine ecosystem types (such as kelp forests, sandy shores and shallow reefs) (SANBI 2019).

Alarming, numerous scientific reports confirm that Earth's biodiversity, including South Africa's, is deteriorating faster than ever before recorded in human history (United Nations 1992; MEA 2004; IPBES 2019; SANBI 2019). This is cause for concern because 'nature plays a critical role in providing food and feed, energy, medicines and genetic resources and a variety of materials fundamental for people's physical well-being and for maintaining culture' (IPBES 2019: 3). Aside from the obvious consequences for human well-being, biodiversity loss raises important questions about human values and our moral obligation to restore – or at least prevent the further loss of – biodiversity. Quality teaching and learning about biodiversity at school is therefore a very important building block for children's ability to understand and care for the natural world that sustains them.

In the Grade 7 Natural Sciences Curriculum Assessment Policy Statement (CAPS), biodiversity is presented as a concept to be explored during Term 1. Biodiversity is allocated three and a half weeks of teaching, covering the following: biodiversity (the classification of all living things); the diversity of animals; and the diversity of plants (South Africa DBE 2011: 13). Biodiversity as a topic is preceded in Term 1 by one week of teaching about the biosphere, which includes the lithosphere, hydrosphere and atmosphere where all life exists. However, despite its inclusion in the formal curriculum, biodiversity as a concept and topic for classroom teaching is not well understood or well taught by many teachers. Research by Songqwaru (2013) reported that many of the Life Sciences teachers in her study had content gaps and lacked confidence in teaching environment and sustainability content knowledge. This led them to rely heavily on textbooks even though, in some schools, teachers had access to only one textbook.

It is against this backdrop that Isaacs's study set out to answer the following research question: What do Grade 7 Natural Sciences teachers know, believe and say about biodiversity and the teaching of biodiversity?

Four sub-questions guided the inquiry:

1. What knowledge do teachers have of biodiversity?
2. How do the teachers represent biodiversity: for example, which biodiversity narratives and metaphors are evident in their discourses?
3. What beliefs and values of biodiversity do the teachers hold?
4. What accounts do the teachers give of why they teach biodiversity in the way that they do?

The following section outlines the main theories and concepts that were significant to the study and which guided the data analysis. Thereafter, we describe the research methodology, present extracts from the data and provide a discussion of the research findings and conclusions.

Guiding theories and concepts

The wide-ranging foci of the research questions required a range of theories that could guide interpretation of the data. Shulman's (1987) work on teacher cognition, especially teacher knowledge, was helpful in analysing the teachers' biodiversity knowledge, whereas literature on environmental discourses and metaphors was needed to analyse what was said about biodiversity. Many of the teachers' narratives revealed their values and ethics, and so the researcher turned to a framework developed by Kronlid and Öhman (2012) to analyse different environmental ethics positions. These guiding theories and the concepts associated with them are outlined below and summarised in Figure 1.

Figure 1. Schematic of different theories used in the study to guide analysis of different aspects of the data – all centred around the Research Question

Knowledge as a key dimension of teacher cognition

As far back as 1986, Lee Shulman, an American educationist specialising in teacher education and cognitive psychology of instruction, argued that the knowledge base of education is growing, that knowledge is a vital part of teacher education, and that it should be available for teacher practice (Shulman 1987). Shulman proposed that,

the teacher must have not only depth of understanding ... but also a broad liberal education that serves as a framework for old learning and a [capacity for facilitating] new understanding. (1987: 9)

Shulman identifies four main sources for a teacher's knowledge base. These are:

- a) *Content knowledge in subject disciplines.* This refers to the knowledge, understanding and skills that a teacher has. This content knowledge is derived from accumulated literature on the content as well as historical and philosophical background to the content knowledge and alternative theories about it.
- b) *Learning and teaching support materials and the education system.* This includes textbooks and school resources, curricula, the structure of the school and its governance, the teaching profession and its rules, teacher unions, and finance. Significant organisations like the school governing body, the staff and the unions' perceptions of biodiversity may determine to what extent the teacher will receive support for biodiversity teaching, especially in terms of going on field trips, and purchasing resources like projectors and internet data to access biodiversity information. Teachers commonly acquire biodiversity content knowledge from the prescribed textbooks, although more extensive knowledge is available through multimedia resources and local experts.
- c) *Social and cultural phenomena.* This includes any developmental, social (including research), or cultural phenomena that may impact on teaching, teachers and education. Teachers who have access to developmental programmes such as Fundisa for Change will be exposed to biodiversity knowledge and effective teaching methods. Teachers may also participate in citizen science projects and access databases such as the IUCN Red List of Threatened Species.
- d) *Wisdom of the teaching practice.* This includes teachers' values and principles that guide their practice. Learners will be influenced by how teachers dispose of their waste at school, how they manage water, what living things they bring into the classroom, how they respond to fauna and flora that they encounter, and what they grow and maintain around the classroom and in the school grounds.

Environmental discourses

Discourses are established ways of talking and writing about the world; they use certain commonly understood concepts, words, styles of narration and imagery. Once aware of the range of discourses that occur in society, a careful listener can identify, for example, a *Christian* discourse, a *racist* discourse, a *feminist* discourse, and so on. Because discourses reflect the views, judgements and differences of groups of people,

they provide a good starting point for reflection and deliberation.

As environmental concerns such as climate change and biodiversity loss come to prominence in society, environmental discourses are developing and receiving more critical attention (Olvitt 2016). The research study elaborated in this chapter drew on John Dryzek's (2005) analysis of environmental discourses to get a better understanding of how the three teachers represented biodiversity concepts such as ecosystems, food chains, habitats and biodiversity loss. The study drew on four environmental discourses which are introduced below: Apocalyptic discourse; Sustainable Development discourse; Survivalism discourse; and Promethean discourse (Dryzek 2005).¹

Apocalyptic Discourse

Apocalyptic refers to environmental catastrophe due to the ignorance or greed of humans and their desire to dominate and control the natural world. The apocalyptic or doomsday discourse portrays nature as threatened by human expansion and greed and is characterised by use of metaphors such as 'population bomb' and 'war against nature' (Välvirronen 1998; Välvirronen & Hellsten 2002). Within this discourse, biodiversity could be represented as all forms of nature (oceans, forests, grasslands, and so on) that are battling to survive in the face of human destruction. Such a discourse can lead to a sense of hopelessness, but it can also lead to action. The main advantage of the apocalyptic discourse is that it seems to be a powerful trigger for people to protect the environment. One of its disadvantages is that people may be left feeling hopeless, fearful and paralysed to act.

Sustainable Development Discourse

The discourse of sustainable development emphasises connections between the environment and the economy and uses metaphors such as 'we are all in the same boat' and 'spaceship earth'. The well-being of people and natural ecosystems now and into the future is tied up with politico-economic systems. Within this discourse, biodiversity is commonly represented as a vital *resource* for human survival and development. An illustration of this can be seen, for example, in the way the Millennium Ecosystem Assessment (MEA 2005) emphasises the importance of ecosystems in providing regulatory, supporting, cultural and spiritual 'services' to humans.

Survivalism Discourse

According to Dryzek (2005), the discourse of Survivalism is based on the understanding that Earth's resources are limited and that, although economic growth is important, economic systems function *within* ecosystems – which are finite. Therefore, if people's

¹ Of course, in society we seldom encounter environmental discourses as neatly as they are described here. They are sometimes quite subtle, and more than one discourse can be evident in a single text (Olvitt 2016).

activities exceed the Earth's carrying capacity, ecosystems will be destroyed and people will not survive. The main proponents of the Survivalist discourse are experts in economics, politics and the sciences, for example, scientists who would prefer a hierarchical, authoritarian government and administration to ensure that Earth's resources are used responsibly.

Promethean Discourse

The Promethean discourse takes its name from Greek mythology where Prometheus stole fire from the god Zeus and this gave him the power to control the world. In contrast to the Survivalism discourse, people who subscribe to the Promethean discourse believe in humanity's ability – together with technology – to solve any problem. They assume that nature has an over-abundant supply of resources and that nature is always giving and creating, despite how badly people treat nature. Users of the Promethean discourse believe in economic growth above all, and see the natural environment as a material resource that is there to serve the economy.

Biodiversity metaphors

Since the 1960s, biodiversity has been an important concept within all environmental discourses. Of interest to environmental educators is how the concept of biodiversity gets used, by whom, and for what purpose. This section focuses on common metaphors that are used in environmental discourses when referring to biodiversity.

Metaphors function as conceptual tools for conveying abstract ideas in concrete, accessible ways. They contribute to discourses and are used to help people make sense of the world (Nerlich 2010). According to Välvirronen (1998), metaphors in environmental discourses (such as the 'ozone hole' and 'the greenhouse effect') are able to influence social conduct and perception, and they perform important communicative and connective functions. Communicatively, metaphors help to create common ground between scientists, politicians and teachers for making sense of difficult concepts such as biodiversity. In a connective role, metaphors connect different disciplines and institutions, making biodiversity knowledge common and shared.

Biodiversity is a complex concept and so scientists and educators often make use of metaphors to convey the concept of biodiversity and its importance. Välvirronen and Hellsten (2002) reviewed the most popular metaphors used in representations of biodiversity since the 1990s:

- One metaphor represents biodiversity as 'the library of life' or 'the book of life', which implies that the natural world is a collection of knowledge and information that can build links between scientific knowledge, political action and popular images.
- Biodiversity is also often spoken of in terms of 'bioprospecting' or 'biotic exploration' which evokes images of exploration, breaking new

ground or exploring new frontiers, and a sense of ‘there’s more out there that we don’t know’.

- Biodiversity is also frequently referred to as a ‘web’ or ‘network of relations’ between humans and non-humans. It is thus seen as a system of relations of which humans are an integral part (Välvirronen & Hellsten 2002).

A Framework for considering teachers’ values and ethical responses to biodiversity

Another important aspect of this study was to understand the teachers’ sense of personal connection to biodiversity: did it matter to them? Did they feel personally compelled to protect biodiversity? Did they seek to develop their learners’ ethical commitment to protect biodiversity? For this, the researcher drew on Kronlid and Öhman’s (2012) framework for analysing ethical responses to the natural world.

Many environmental ethics frameworks represent anthropocentrism (a human-centred position) and bio- or ecocentrism (a nature-centred position) as a simplified ‘either/or’ debate. In an effort to move away from over-simplified or unrealistic analysis, Kronlid and Öhman propose a combination of *value-orientated* and *relation-orientated* environmental ethics, based on three moral questions:

- a) **Who or what is the *moral object*?** I.e. what is the focus of people’s concerns that drives them to take moral action for nature? For example, if someone refuses to chop down a big old tree in their garden, is it because they care about the tree (for its own sake), or the shade that the tree provides, or the birds that nest in the tree, or because the tree has cultural significance (where culture is the moral object), or ecological significance (where integrity of ecological systems is the moral object)?
- b) **What are the human-nature relationships like?** For example, are people’s relationships with nature seen as intergenerational? Are they local, national or global? Are they based on a view of people as stewards of creation, or people as a humble part of a complex web of life, or people who have dominion over natural resources to exploit according to their needs?
- c) **How is nature valued?** For example, do people value nature because natural resources meet human needs or human desires? Or is nature valued because people are part of nature, or because nature is dynamic and has the potential to transform people and society?

When applied to the case study data, Kronlid and Öhman’s framework was useful because it offered a perspective on the teachers’ values and ethical positions regarding biodiversity and the way they approach teaching biodiversity.

Research methodology

The study focused on three Natural Sciences teachers from three primary schools in Port Elizabeth in the Eastern Cape province of South Africa. All three teachers worked in government no-fee schools that fall under the Port Elizabeth Education District. All three schools had high learner enrollment of between 1 000 and 1 200 learners with a staff of between 30 and 33.

Permission to conduct the study was granted first by Rhodes University and subsequently by the Eastern Cape Department of Basic Education. The three anonymised teachers and the Natural Sciences Senior Education Specialist all gave their voluntary informed consent to participate in the research.

The case study data was generated using three qualitative research methods: (i) classroom observations (one session per teacher, when teaching the topic of biodiversity during Term 1); (ii) semi-structured interviews (with the three teachers and a Department of Education official); (iii) document analysis (a review of the CAPS Natural Sciences Grade 7 policy documents and relevant extracts from the Grade 7 Natural Sciences textbooks used by the teachers).

The raw data generated from these methods was coded according to the following analytical themes:

- Teachers' knowledge about biodiversity
 - Teachers' representations of biodiversity
 - Biodiversity narratives
 - Biodiversity metaphors
 - People-nature relationships
 - The moral object
 - Intrinsic or instrumental value
 - Anthropocentric or non-anthropocentric
- Teachers' beliefs about, and values of, biodiversity and the importance of teaching biodiversity
- Teachers' decisions/reflections on their approach to teaching biodiversity:
 - Own classroom practice
 - Contextual factors

Case Study 1: Lance at Seaview Primary School

Lance is a qualified Commerce teacher with seventeen years' experience teaching English, Economic Management Science and Social Sciences at high school level. However, for the past two years he has been teaching Grades 6 and 7 Natural Sciences at Seaview Primary in Port Elizabeth. The school is situated in a low-income, high-density suburb that is surrounded by a sprawling informal settlement with very low levels of biodiversity. Learners are exposed to high levels of poverty, violence, gangsterism

and abuse. The school is fenced, with two police reservists manning the gate daily from 8.00 a.m. to 3.00 p.m. to protect learners and teachers from crime and gangsters.

Lance's views on biodiversity were influenced by childhood experiences such as camping and visiting natural areas. In his opinion, he had good Biology teachers at school and was socialised to respect animals and all living things. Lance's environmental discourse suggests that, although humans threaten nature, there is cause to be optimistic about the future. He said, 'The Earth is still busy proving itself ... each day [scientists] discover new species and they are just becoming more and more as time goes by.' He did not seem aware of the rapid rate of global biodiversity loss and the consequences for a sustainable future. Lance's positive view of the natural environment was further illustrated by his description of biodiversity as 'bright, life and continuity' and 'biodiversity is like jelly tots [multi-coloured sweets], different colours, different flavours, it's just like species of animals' (Isaacs 2016).

Lance feels that the two days' training he received the previous year was not enough to prepare him to teach the CAPS curriculum. He also feels limited by the school's lack of resources (such as microscopes) which affects his teaching of biodiversity. Before his lesson on biodiversity, Lance consulted his CAPS document to see what he had to teach and then used one textbook to support his lesson. The textbook defined biodiversity as, 'all living things on the Earth, all the plants, animals and micro-organisms and their habitat together forms biodiversity on Earth'. This definition does not refer to ecological systems or interconnectedness. The pictures of animals in the unit on biodiversity resembled passport photos, that is, a snapshot of the animal only. They did not reveal the animals' relationship to other animals, humans, vegetation or the climate. Similarly, Lance only spoke of animals and plants in isolation and not in relation to each other. In his lesson, the learners identified different animals, birds and fish. After he gave a definition of biodiversity, Lance taught classification and the distinguishing characteristics of animals and the five Kingdoms. He asked the learners to identify the life processes of the five Kingdoms, as depicted in the textbook.

Case Study 2: Pam at Palm Plains Primary School

Pam has been a primary school teacher for 22 years. She currently teaches at Palm Plains Primary School in a middle-class suburb in Port Elizabeth. Although it is a mainstream school, about 45% of the learners have special educational needs which places a strain on the tuition.

Pam reflected that her childhood in the rural Eastern Cape laid the foundation for her understanding of biodiversity. She was surrounded by livestock and it was easy for her to go to the river to catch crabs and insects, which she stored in bottles to show her teacher. Pam notes that it is difficult for her learners to do the same because there are no rivers or open spaces near their homes in the high-density suburbs.

Pam obtained her biodiversity knowledge mostly from the Grade 7 Natural Sciences textbooks she uses to teach the topic. She recognises that biodiversity has intrinsic value but, more importantly, biodiversity should be protected because it provides for human

needs. Pam believes that human beings are individually responsible for biodiversity because God ordered people to be responsible for all that He created. However, like Lance in Case Study 1, Pam believes that there is an abundance of natural resources and that animals will always be there. She explained in an interview that, ‘the animals won’t decrease in number, the animals will always be there ... because reproduction is still there’.

Pam believes that teaching biodiversity is like teaching ‘the old Biology’. For the observed lesson, she drew on three textbooks which she believes are well aligned with CAPS. A general feature of all three textbooks was their provision of very clear definitions and detailed examples of vertebrate and invertebrate species, but always in isolation. Biodiversity is thus constructed as a list of living organisms to be classified, not as a complex ecological phenomenon that includes human beings.

So, guided by CAPS and the textbooks, Pam’s lesson focused on classification, in particular classification of vertebrates in the Animal Kingdom. She did not define biodiversity at all. Before she asked the learners to classify the pictures of animals into the five classes, she taught the characteristics of the five classes of vertebrates.

Case Study 3: Mandy at Omega Primary School

Mandy, a Natural Sciences teacher with 25 years’ teaching experience, teaches at Omega Primary School situated within a low-cost housing development on the outskirts of Port Elizabeth. She completed her schooling and teacher training in the rural Eastern Cape during the early 1990s when primary school science teaching was approached very differently.

Similarly, to Lance and Pam, biodiversity was a new knowledge area for Mandy and most of what she knows about the topic comes from the CAPS-aligned textbooks that she uses. She felt that she had not been sufficiently prepared by the Department of Basic Education to teach biodiversity.

Mandy defined biodiversity as, ‘the variety of living organisms in a particular area’, and later as a ‘good picture ... all about plants and animals’. She appeared to value biodiversity primarily because it meets humans’ needs and stimulates economic activity. For example, she explained that ‘we need [animal skins] to make leather jackets, to make us warm’, and ‘we get food from plants ... sell some of these, export some of the food’.

Mandy feels that although the biodiversity topic was not difficult for Grade 7, it was too long, with many new concepts for the learners to grasp. In her lesson, Mandy used sentence strips to help learners understand the definition of biodiversity. After that, she had the learners classify the plants and animals. She then taught the difference between plants and animals; she introduced the Plant and Animal kingdoms and then, within the Animal kingdom, defined vertebrates and invertebrates. She taught the five classes of vertebrates before giving the learners an activity where they had to identify vertebrates in the five classes. Mandy used two textbooks extensively for biodiversity knowledge and activities.

Research findings

This section summarises the main research findings in relation to the initial research question: ‘What do Grade 7 Natural Sciences teachers know, believe and say about biodiversity and the teaching of biodiversity?’

Finding 1: The three teachers’ biodiversity knowledge was rudimentary and mostly limited to what they accessed in the textbooks.

The teachers in this study had all learned about the concept of biodiversity for the first time at the CAPS training and through reading the CAPS document. One teacher believed that biodiversity is the ‘old Biology’. This was echoed by the Senior Education Specialist for Natural Sciences who suggested that the biodiversity content is the same as the previous curriculum and that only the process skills of grouping, sorting and classifying were ‘new’. The teachers’ biodiversity knowledge seems limited to facts about plants and animals. In the classroom, the teachers did not notice or correct some of their learners’ misconceptions about biodiversity. For example, during the lesson on classification, Lance accepted learners’ claims that octopus and dolphins are fish. Although they are marine organisms, they are not fish and exploring the reasons for this could have provided a good learning opportunity about animal classification – had the teacher had the necessary content knowledge. In another instance, one of the teachers implied that humans are responsible for the growth of plants.

An important aspect of teachers’ subject content knowledge is their ability to represent the subject content matter to their learners (Wilson et al. 1987). In other words, teachers should be able to explain the subject matter in different ways using metaphors, analogies, examples and illustrations to enable their learners’ understanding of the subject content concepts. This study found that biodiversity content knowledge was poorly represented by the teachers’ own illustrations or examples, possibly due to their own limited knowledge of biodiversity. The teachers relied heavily on generalised pictures in the textbooks to illustrate biodiversity knowledge to their learners.

Finding 2: Teachers’ reliance on the textbooks seemed to limit the depth, scope and criticality of their biodiversity teaching.

A review of the textbooks used by the three teachers indicated that the textbooks generally foregrounded the development of concepts related to biodiversity but did little to situate learners’ understandings of biodiversity in the global or local context. They were also found to present biodiversity as an information-rich topic that concentrates on facts about plants and animals. One textbook, used by two of the teachers, presents scientists as the holders of biodiversity knowledge. As such, people’s connections to biodiversity, either as beneficiaries or as the source of threats to biodiversity, were not addressed.

In teaching about biodiversity, all three teachers were guided by the textbooks to focus almost exclusively on vocabulary, definitions of the basic biodiversity concepts, and

classification of plants and animals. This is in line with what the curriculum demanded of them, even though it falls short of acknowledging the complexity, dynamism, inter-dependencies and significance of biological diversity. The CAPS for Natural Sciences emphasises process skills of sorting, grouping and drawing; the textbooks align very closely with this policy and thus also focus only on the development of learners' process skills. This is contrary to international perspectives on teaching biodiversity which emphasise the importance of an integrated approach to the relationships of plants, animals and people, and to pedagogies that stimulate learners to ask questions, deliberate, find solutions to problems, and examine cause and effect.

Finding 3: The teachers held a positive view of biodiversity and valued it partially for its intrinsic value but primarily for its instrumental value in inexhaustibly meeting human needs.

The study found that all three teachers were inclined towards a Promethean environmental discourse, that is, they viewed biodiversity as abundant and assumed that the 'supply' of plants, animals and their by-products will always be available to people. The metaphors that the teachers used reflected their perception of biodiversity as continuous, good, beautiful and economically stable. All three teachers valued biodiversity but in different ways, for different reasons: for its systemic, transformative and demand value, and because it meets basic human needs (Kronlid & Öhman 2012).

All three teachers expressed the belief that humans dominate over other forms of life on Earth, although one expressed concern that such domination is not good for the environment, while another was of the opinion that, although people's self-interest, business, economic and religious interests do result in animals being killed, there is no need for concern since animals reproduce. All three teachers seemed to identify effective governance as the key to what was needed to manage biodiversity, protect species and ensure an economically stable environment. Interestingly, there was little evidence that these values influenced how the teachers taught the Grade 7 curriculum because they generally adhered quite rigidly to the process skills and narrow content knowledge as required by CAPS.

Conclusion and recommendations

The main conclusions that can be drawn from this study are that the teachers did not have a sound or extensive knowledge base in terms of biodiversity, and that their approach to teaching biodiversity was heavily influenced by the CAPS and the selected textbooks. Against this backdrop, the study recommends that:

- The Natural Sciences CAPS as well as textbooks should reflect a more systemic or integrated approach to biodiversity knowledge, recognising the dynamic nature of biodiversity and the interrelations and interdependence of the ecological systems that make up biodiversity –

including relationships with humans.

- Natural Sciences teachers should be supported in broadening their own understandings of biodiversity and biodiversity loss based on up-to-date local and global examples. This would enrich not only their teaching of biodiversity but their ethical connection to it.
- Teachers should also be encouraged and supported to enhance the basic textbook material and develop learner activities that encourage more active, critical and solutions-orientated engagement from a sustainability perspective.
- Getting involved with practical, citizen-science biodiversity projects could contribute to generating local, relevant biodiversity knowledge that would also benefit learners and teachers.

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Chapter 4

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- Statement Natural Sciences Grade 7–9. Pretoria: South Africa Department of Basic Education
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