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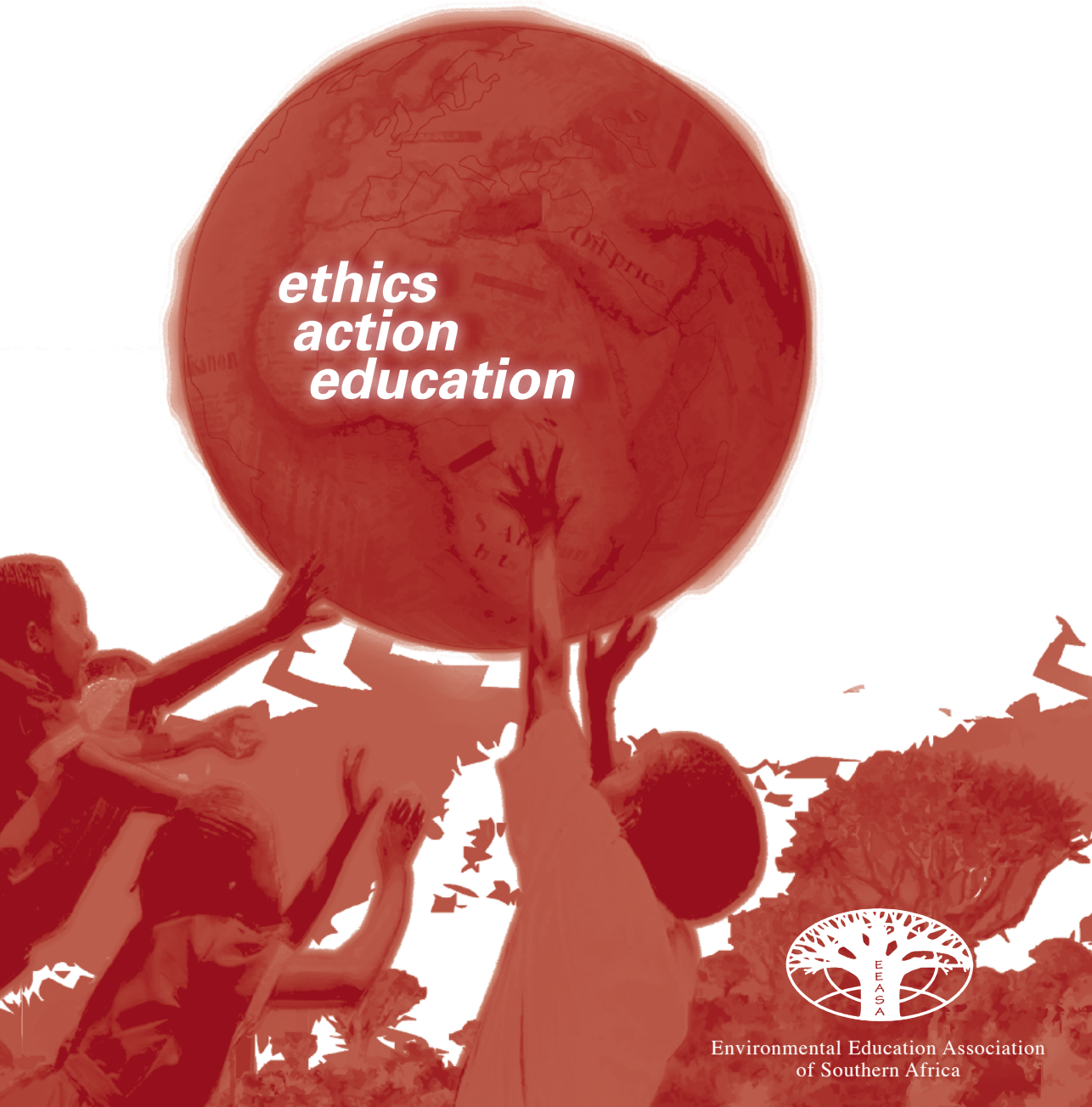

Environmental Education Association
of Southern Africa

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The *Southern African Journal of Environmental Education* (SAJEE) is an accredited and internationally refereed journal. It is published at least once a year, by the Environmental Education Association of Southern Africa (EEASA).

The SAJEE aims to publish and report on a wide range of aspects relating to Environmental Education, Ethics and Action in southern Africa and elsewhere, with a strong focus on research. The journal seeks to further the academic study and the practice of environmental education by providing a forum for researchers, scholars, practitioners and policy makers. The journal aims to carry papers reflecting the diversity of environmental education practice in southern Africa. It includes a variety of research genres; conference reviews and keynote papers; comparative studies; retrospective analyses of activities or trends in a particular field; commentaries on policy issues; and critical reviews of environmental education, ethics and action in a particular country or context. The journal actively seeks out international dialogue in order to provide perspective on and for environmental education in southern Africa.

The SAJEE aims to provide southern African and other authors with a forum for debate and professional development. The journal incorporates an author support programme to encourage new authors in the field to establish themselves as scholarly writers.

Papers published in the Research Paper section of the journal are reviewed by two or three reviewers. Keynote, Viewpoint and Think Piece papers are reviewed by one of the editors of the journal and/or another reviewer.

Institutional support for the journal is provided by the Rhodes University Environmental Learning Research Centre (South Africa), in the Faculty of Education at Rhodes University.

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Professor Eureta Rosenberg was appointed in 1991 to the Murray and Roberts Chair of Environmental Education at Rhodes University, where she obtained a PhD with a focus on research methodologies that straddle the natural and social sciences. Having played a role in establishing the field of environmental education in South Africa as an academic endeavour with an international profile, she was awarded an Associate Professorship in 2000, and a full Professorship in the Murray and Roberts Chair of Environment and Sustainability Education in 2016. In the years between 2000 and 2016 Professor Rosenberg ran a consulting practice offering support in strategic planning, materials development, and monitoring and evaluation in environmental education, training and capacity development. This is her second (non-consecutive) term as editor of the *SAJEE*.

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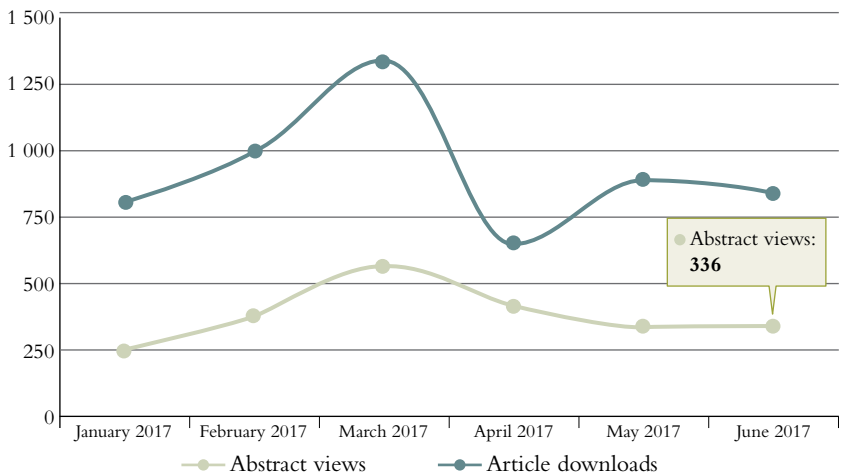
Journal Development, Scholar Development and Quality

Eureta Rosenberg, Rhodes University, South Africa; and
Mucha Togo, University of South Africa

Journal Development, Scholar Development and Quality

Recently, the 33-year journey of the *Southern African Journal of Environmental Education (SAJEE)* was the subject of reflection during an Open Access Publishing week convened by Rhodes University Library Services. Two former and current editors-in-chief shared the *SAJEE*'s story of publishing 'from the margins into the centre'. In the early 1990s, the Journal was mailed to the Environmental Education Association of Southern Africa (EEASA) membership from the foyer of the Rhodes Education Department (which had the floor space for stuffing and stacking A4 envelopes). In the first decade of this century, the Journal arrived at a symbolic 'centre' with digital distribution, first on the EEASA website and then from the Open Access platform provided by African Journals Online (AJOL). The digital move was vital for sustained and increased distribution in a time of shrinking budgets and growing costs. The results, shared with the EEASA Council earlier this year, were nothing short of spectacular: In March 2017, the *SAJEE* received more than 1 250 article downloads (www.ajol.info/index.php/sajee), and the number of downloads have stayed above 500 each month subsequently (Figure 1). Views and downloads are recorded around the world including,

Figure 1: Abstract views and article downloads by month for the *SAJEE*, January–June 2017



Source: www.ajol.info, visited July 2017

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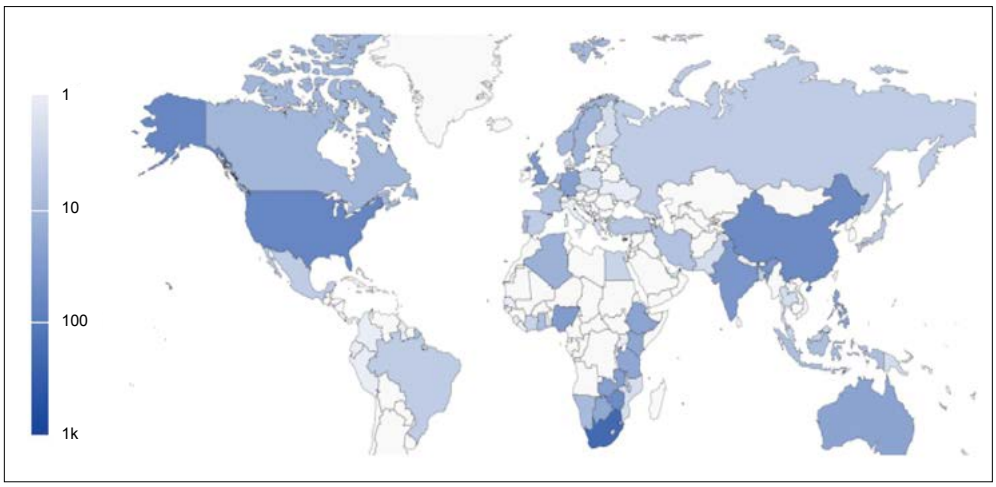
vitally, in English-speaking Africa, with a high percentage in the entire Southern African Development Community (SADC) region (Figure 2).

Figure 2: *SAJEE* article downloads from AJOL, June 2017



Source: www.ajol.info, visited July 2017

Online publishing is, however, a double-edged sword. It gives greater access to research findings and scholarly ideas and reduces the cost of reaching readers, educators, policymakers and fellow researchers. But, precisely because the limitations of physical publishing – printing, paper and postage – are removed, online publishing also has a dark side: the potential for poorer quality. It is easier to publish more papers and to cut corners in the processes that maintain the rigour of academic publishing, which are the very foundation of the reputation and value of scholarly work. Thus, at a conference on The Future of Scholarly Publishing in Stellenbosch, in October 2017, a contributor to a forthcoming report on scholarly publishing by the Academy of Sciences in South Africa (ASSAf), Prof. Johann Mouton, spoke of a 'crisis of quality'.

The *SAJEE*, as a government-accredited journal, adheres to strict policies to safeguard the quality and rigour of the works published. In this process, the contribution of the time and intellect of reviewers and editors is a critical component that needs greater recognition. Another contribution to quality is investing in the writing skills of the incoming scholars in the field. In 2016, EEASA invested in a development initiative for the research students among its members. The initiative resulted in this, the thirty-third volume of the *SAJEE*, which is dedicated to student publishing. With the exception of the Viewpoint by Prof. Chris Reddy, and the Editorial, all the other contributions, which are all research-based, have a student as first author. How did this wonderful situation come about?

For the EEASA's 2016 Conference in Johannesburg, the Gauteng Local Organising Committee raised funds to make an award for the Best Student Paper presented at the event. The award went to Inonge Milupi, a PhD candidate in Environmental Studies at the University of Pretoria, with

Sikhulile Msezane, a PhD candidate from the University of South Africa's College of Education the runner-up. The remaining funding was then used to provide professional writing support to help Milupi and Msezane to prepare papers for review and possible publication in this volume. The other authors published in Volume 33 who received writing support are Nondumiso Dumakude (University of the Free State), Mubanga Kapuka from the Copperbelt University, and Mapaleng Lekgeu (University of Pretoria). Congratulations to these students, their research supervisors and co-authors, and to EEASA for this worthwhile investment in the quality of future scholarship in our field. The level of interest was high: in total, 11 student papers from three countries in the region were reviewed. This bodes well for the future of the *SAJEE* and for African scholarship in environmental education, ethics and action.

Two other student authors are published in this volume. Both are from Rhodes University in South Africa, albeit from different faculties. Presha Ramsarup conducted her PhD studies in Education, while Siseko Hudson Kumalo was, at the time of producing his paper, a third-year student in Anthropology and Political & International Sciences.

Overview of the Contributions in Volume 33

Kumalo opens Volume 33 with a critical reflection on the content of university curricula, drawing on literature on sustainability and (de)coloniality. In South Africa, the years 2015 to 2016 were characterised by fierce calls for the transformation of higher education, starting in March 2015 with the #RhodesMustFall protests, directed initially at the statue of Cecil John Rhodes on the University of Cape Town campus, then more broadly at other colonial symbols and university curricula. These important debates continue and, in October 2017, the South African Education Research Association (SAERA) will dedicate its annual conference to 'education in an era of decolonization and transformation' (saeraconference.co.za).

Are discussions about 'decolonising' curricula relevant to environment and sustainability education?

Kumalo argues that, through socially responsive pedagogical and congruent conceptual frameworks, educators will validate the lived experience of learners and achieve epistemological or epistemic justice, which he sees as a critical dimension of sustainability education. Drawing on the work of Wolfgang Sachs and Amartya Sen, he troubles mainstream definitions of 'development' and explores an African ethical position for advancing sustainability objectives. As such, he joins a line of authors like Tsepo Mokuku and Soul Shava who have, over the years, published in this Journal and have maintained that bringing a new, African focus to school and higher-education curricula would also create openings to focus more strongly on sustainability and environmental justice.

Milupi, Somers and Ferguson remind us of the rich heritage of ecological knowledge still held by many on our continent, and of its role in helping Africans manage the natural resources that are so vital for the well-being of households and economies. Much has been written about the value of local, indigenous and situated knowledge in past editions of this Journal, and a 2018 edition (with Guest Editors Soul Shava from the University of South Africa and Rosa Guadalupe Mendoza-Zuany from Universidad Veracruzana) will again focus on this important

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topic. Currently, it would seem that indigenous and local environmental knowledge receives much more attention as a scientific curiosity than as substance for curriculum reform. The authors of this paper argue that there is a policy gap related to how local ecological knowledge can be mobilised.

Questions about what knowledge we teach shaped the research conducted by **Msezane** on the environmental content of the Grade 12 curriculum for South African schools as it appears in policy documents and in examinations. The study found that topics related to environmental impacts feature significantly only in three of the subjects examined in the final exit examination. Even in these subjects, the author is concerned that the content is too limited and inconsistently examined from year to year, compared with the policy.

In their study on the perceptions of climate change among Grade 11 Geography learners in two South African schools, **Lekgeu and Davis** explore the impacts of the environmental content in the curriculum, but also other influences such as social media. They note that the methods teachers use may also be responsible for differences observed between schools. They find that, while a percentage of learners in both schools are very knowledgeable about climate change and are positive about their ability to make a difference, another percentage have little hope that anything can be done.

The study from the Copperbelt University, by **Kapuka, Shumba and Munthali**, also illuminates the impacts of the curriculum. In this case, the focus is on the university, and not the explicit or policy content of the curriculum, but the 'hidden' curriculum of the educators' actual practices. They explore the impact of the introduction of electronic course materials on students' behaviour: Are the students reducing printing? Do they understand the connections with climate change? The authors conclude that educators need to model the kinds of behaviours they teach about in sustainability-related courses.

In his Viewpoint paper, **Reddy** from Stellenbosch University, puts the spotlight on teachers' ability to teach environmental education. As a curriculum specialist, Prof. Reddy gives attention to the body of research conducted on the nature of the knowledge and teaching practices that would most appropriately achieve the desired objectives of environmental education in schools. He notes that the particular nature of the 'subject' matter of environmental education, and its objectives, requires special approaches to teaching environmental education, for which, he argues, the national policy context in South Africa does provide adequate spaces that should be taken up by teacher educators.

One of the epistemological features of environmental and sustainability education that Reddy and other authors in this volume highlight is that the content is never 'complete'; more than most other subject areas, it is always under construction.

Dumakude and Graham propose that people learn not just by receiving information, but also by participating in knowledge creation. They investigated the testing of a scientific tool for assessing the state of wetlands, a tool that has been adapted so that people without specialist knowledge (citizen scientists) can determine and track the health of wetlands, thereby not only contributing to the pool of knowledge, but also increasing their own understanding and ability to act.

What happens to that percentage of learners who leave school where they have been exposed to environmental content and enabling teaching methods, and then decide that they

want to do environment work, like wetland management or environmental law? How does one become an environmental specialist? In the final paper of our student edition, we learn that, in South Africa, environmental career pathways can be diverse and fluid, causing the authors to employ the term 'boundaryless' occupations. **Ramsarup and Lotz-Sisitka's** contribution on environmental engineers' work and learning pathways identifies the challenges of progression within and between work and learning environments, which is of much interest to the South African Qualifications Authority and Quality Councils, and relevant across the SADC region. This is a pioneering paper which opens up a new field of scholarly study for the environment and sustainability community: the field of 'green skills' or work-related skills for sustainability.

In December 2017, South Africa will host researchers from around the globe at RWL10, the biannual conference of the Researching Work and Learning Community. Several EEASA members will present papers on research into green work and associated learning, and a future EEASA journal will also be dedicated to this theme.

Closing Reflection on Using the SAJEE

In reflecting on the contributions to Volume 33, it is evident that a variety of theories about learning and social change inform the scholars in environmental education, ranging from behaviourist, to social behavioural, constructivist and social constructivist learning theories, social and critical realism, and more. What unites these papers is a shared concern about learning in relation to the future well-being of the planet and its people. New scholars entering the field of environmental and sustainability education have the task of mastering not only the social–ecological subject matter of the field, but also their chosen learning theories. In this regard, drawing on the back copies of the *SAJEE* can be of great value. Much research and writing has already been done on curriculum, education and learning inside and outside of formal institutions, yet many more questions remain. The field is best advanced by noting and building on, challenging and advancing past studies and existing scholarship. The fact that all 33 Volumes of the *SAJEE* are available online, just a 'few clicks away' from any student or supervisor with Internet access, is therefore an enormous boon. We encourage readers and future authors to draw on the work in this and other environmental education journals as they conceptualise, design and reflect on their own studies.

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Problematising Development in Sustainability: Epistemic Justice through an African Ethic

Siseko Hudson Kumalo, Rhodes University, South Africa

Abstract

This paper critically engages with the concept of development through an analysis of epistemological justice in education for sustainable development (ESD) and presents alternative strategies for adaptation of the concept in the South. Many definitional challenges still surround development studies. The paper draws on the work of Wolfgang Sachs (1999) who asserts that the notion of sustainability has been consumed by development, presenting a view of sustainability which challenges the current and dominant economically driven hegemonic development discourse in which sustainability has become embedded. Further useful perspectives for this paper are offered by Amartya Sen (2001) who refers to development as a form of freedom. Sachs (1999) maintains that global definitions of development cement the dominant hegemonic discourse of the leading North, which has resulted in an obfuscation of the epistemological contribution from the South. The paper argues that, in the integration of congruent and enabling conceptual frameworks, allowing epistemic justice and validating the lived experience of learners through socially responsive pedagogical frameworks, South Africa is beginning to respond to the global environmental crisis. At the core of the paper is the question of whether an African ethical position advances the attainment of sustainability objectives. The paper concludes by positing a shift in scholastic and social understandings of development, and redefining the term from a changing terrain which may seem immutable with the current environmental crisis.

Keywords: Epistemology, development, pedagogy, justice, African ethics.

Introduction

At the core of problematising development lies the question of defining and critiquing the term. In extending the definition, this paper draws on Sachs (1999), a developmental theorist who critiques Western (Anglo-American and European) ideas of development and Sen (2001), who writes from an economic position. Both scholars are drawn on in this paper for questioning epistemic justice.

In incorporating an African ethic into sustainability discourse, the question of epistemic justice is most appropriate as a starting point in the debate of sustainability and epistemology. Locating this discussion in a decolonial theoretical framework (Grosfoguel, 2013), evoking an African ethic in sustainability, there is a need to first define an African ethical position. Prior

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to critiquing development, or extending the definition as considered by the arguments of both scholars who will be discussed in this paper, the link between epistemic justice and sustainability needs to be clarified. Arguing for epistemic justice that is substantiated by an African ethical framework will underscore the link between the two.

Clarifications on epistemic justice will serve the purpose of advancing the role of an African ethic in producing a critical citizenry which understands the moral obligation in meeting sustainability goals. Using a reflective understanding of the Eco-Schools programme (with my own experience of it), interactive models of teaching and learning are explored as the premise for the argument in this paper, which demands epistemic justice in defining development.

The need to fully exhaust the debate of epistemic justice from an African ethical position will become clear, through making the link between sustainability and epistemology as a point of discussion. To substantiate Sachs's position, who argues 'that development is the never ending race' (1999:29), understanding 'modernity as synonymous with colonialism' (Grosfoguel, 2007:218) is of fundamental importance. An African ethical position and its use in the sustainability discourse should thus be understood in two parts: 1) as a shift from the universal conceptions of development; and 2) as creating an ecology of knowledges which is a 'constitutive part of the pluriversity' (Grosfoguel, 2012:2).

This paper posits that epistemic justice arises as a response to the call from the decolonial theoretical position (Grosfoguel, 2013) for alternative conceptions of development and modernity, one which necessitates a conceptual shift in understanding education for sustainable development (ESD) through the use of an African ethic. In texturing the conceptual critique in this paper, Sen's (2001) capabilities approach (with specification to capabilities deprivation, conceptualised in this argument as epistemic injustice) will be considered for the purpose of extending the definition of development. Capabilities deprivation, understood as the privileging of Western conceptions of modernity, leads to epistemic injustice, highlighting the dialectical relationship between epistemic injustice and capabilities deprivation. The dialectic here being the privileging of Western definitions of development as the thesis, resultant capabilities deprivation as the antithesis, and epistemic injustice as the synthesis – thereby revealing the interactive relationship between epistemic injustice and capabilities deprivation. This paper raises key problematics in Western ideas of equating development with progress, and highlights the tensions between progress and sustainability. The paper seeks to resolve this tension by broadening the definition of development, using the capabilities approach as proffered by Amartya Sen. This is in line with the 'architectonic capability' argument advanced in the work of Le Grange (2012a:139). Le Grange argues that *ubuntu/ukama* (informed by an African ethic) 'can be seen as an architectonic capability, as it gives rise to the realisation of other capabilities' (2012a:143). *Ukama*, as explored by Le Grange, denotes an African moral principle derived from the Shona language and means 'interconnectedness with the universe' (2012b:62). From this definition, developed through an analysis of language (Shona, isiXhosa and isiZulu), the parameters of an African ethic become more apparent, making the task of setting up an African ethical position attainable.

At the core, this paper seeks to posit how epistemic justice, defined from an African ethical position, upholds and advances the attainment of sustainability objectives.

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Defining an African Ethical Position

Ramose defines ethical responsibility as acting to 'promote life and avoid killing' (2014:68) while further substantiating that this ethical position should meet the criteria of acknowledging the living and the living-dead, while leaving the land as good as we found it (2014:75). This, he argues, meets the African understanding of community, which necessitates 'an overall obligation towards the living – which can otherwise be articulated as human beings, plant and animal kingdoms – the living-dead, or ancestors, who continue to live with us and leaving the land as good as we found it' (2014:75). A moral obligation to the community implies that which allows one to truly 'realise personhood in caring not only for themselves but also for the others' (Le Grange, 2012c:333). The assertion of a moral obligation towards others, which should not be 'limited to human life, but extended to the natural environment' (Le Grange, 2012a:143), re-inscribes the African ethical definition of community as outlined by Ramose (2014). It is clear how the 'architectonic capability' (Le Grange, 2012a:139) can be understood as epistemic justice, through recognising an African ethical position and incorporating this ethic within the sustainability discourse as it has framed the historical responses of African communities of southern Africa to their natural environments. The 'architectonic capability', as coined in the work of Le Grange (2012a:139), begins the discussion which seeks to broaden the definition of development.

The conception of the ethical position presented in this paper shifts away from a communalism conception of personhood, which looks at the 'relationship between the individual and the community while linking this relationship to morality, moral thought and reasoning' (Ikuenobe, 2006:51). The caution against conceptualising this ethical position as a form of communalism or humanism is aptly articulated by Le Grange, who quotes from Ramose, 'humanness [...] is thus opposed to any "–ism", including humanism, for this tends to suggest a condition of finality, a closedness or a kind of absolute either incapable of, or resistant to, any further movement' (2012b:63). This limitation is once more raised by Ramose, in response to Metz, as Ramose rejects an attempt to mould African morality and ethics into a Western conception. He states:

> Wiredu, and Bujo, including many other African philosophers do not speak to Metz's conception of 'normative theory' as 'articulation and justification of a comprehensive, basic norm that is intended to account for what all morally right actions have in common as distinct from wrong actions'. On the contrary they speak to a multiplicity of ethical principles that found and permeate African morality without any implicit or explicit claim to immutability, essentiality or eternity. (Ramose, 2007:351)

A distinction should therefore be made between 'ethical' and 'moral' African positions which would seek to clarify the differences between Ramose (2014) and Ikuenobe (2006). Articulating an ethical responsibility or obligation, Ramose seeks to propose a sense of reasoning which defines our actions in what he terms 'right reason' (Ramose, 2014:75) underscored by justice; while Ikuenobe could be understood to be articulating moral obligation from an internal

truth perspective, which demands the ethical as the juridical adjudicator in the clash between conflicting internal truth positions. In this adjudication, the ethical becomes the forebear of justice, as both positions of conflicting internal truths will be judged against reason, premised on what is ethically just. Right reason, in the juridical system used in mediating between conflicting internal truth positions, is to be understood in this argument as that which is justly fair.

Ikuenobe's conception of personhood, which is linked to a 'communalism definition of the self' (2006:52), extends Ramose's argument (though differing in its presupposition of communalism) 'through a recognition of the collective community as a constitutive part of the self' (2006:75), stressing the first two elements of social responsibility and ethical obligation noted as regarding: 'the living' and 'the living-dead' (Ramose, 2014:75). The third prescriptive element of the ethical position, defined by Ramose as 'leaving the land as we found it' (2014:75), can be understood as social responsibility that is a 'constitutive part of personhood' (Ikuenobe, 2006:52). This element supports Le Grange's claim, which highlights the three ecologies otherwise known as 'self, social and nature' (2012b:57).

Moving away for a moment from the philosophical framework used in developing this argument, the constituent parts of personhood can otherwise be taken to mean homoeostasis. Homoeostasis in the ecological sciences is understood to be that which is whole, with individual parts serving the purpose of 'self-regulating feedback mechanisms which maintain the whole' (Sachs, 1992:31). Once more, the concept of homoeostasis substantiates the argument of Le Grange (2012b:59), who notes that the effect, be it negative or positive in one category, will inherently influence the other categories within the three ecologies. The argument of homeostasis therefore can be understood as underscoring the ethical obligations set out in Ramose's argument, which demands that we 'leave the land as we found it' (2014:75) as this serves the purpose of supporting life for future generations – an argument rooted in an African ethical position.

Defining this as an African ethic demonstrates how this moral and ethical position moves away from individualistic reasoning claimed by the autonomous agent affirmed by Descartes's *cogito* claim, 'I think therefore, I am' (Grosfoguel, 2007:214). Later, this paper will consider the power of this claim that has been used in dismissing African ontologies, leading to epistemic injustice, otherwise termed 'epistemicide' (Grosfoguel, 2013:73). Using an African ethic demonstrates the intrinsic relation between the individual and the ecological, highlighting the ethical and moral obligations for a collective existence which speaks to realising sustainability objectives. If the conceptual framing of interactive teaching models recognises the individual as constituted by collective community and ecological components, social responsibility becomes imbued in pedagogical practices. Pedagogies of social responsibility substantiate Ramose's requirement to leave the land as we found it (2014).

An African Ethic and Epistemic Justice

Understanding local knowledge and indigenous knowledge systems (IKS) within the framework of an African ethic is critical to the argument being advanced in this paper. Writing from a position advocating for the integration of IKS into university curricula, Magara notes

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the 'particularity and specificity of indigenous knowledge to a geographical locale' (2015:25). To fully realise the objectives of this paper as set out in the introduction, Magara's definition needs extension, with clear limitations which caution against an essentialist understanding of IKS and which are underpinned by an African ethic.

Local knowledge can be understood as that which is particular, site-specific and determined by the locale. IKS, conversely, specifically regarding the southern African sustainability discourse, should be evaluated against the ethical position that denotes a moral obligation to leave the land as we found it, in order to meet the criteria of being defined as an IKS. The move of locating IKS in an African ethic suggests a limitation on any knowledge system from being seen as indigenous to Africa. The inclination towards the African ethical proposition discussed above connotes a personhood rooted in social responsibility as a constitutive part of that personhood, therefore allowing for southern African knowledge systems to be viewed as indigenous on the premise of espousing a moral obligation. Indigeneity in knowledge systems must be understood to include variations in local knowledge, substantiating Ramose's claim of 'different internal truth positions' (2014:70). Further, the differing internal truth positions make room for the continuously growing, changing and becoming, which is embedded in *ubuntu* as a humanness.

Navigating the difference in 'internal and external truth, which constitutes reality for a given individual' (Ramose, 2014:68), the question of epistemic justice arises in the oppressive ontological denial masquerading as universal truth, as articulated in Western positions. Grosfoguel problematises the hegemonic power of 'Western countries being the leading voices in constructing the realities of the rest of world' (2013:87).

The Truman doctrine of underdevelopment, initiated in 1949, subsequently led to the 'never ending race of development' (Sachs, 1999:30) and underscores the notion of epistemicide as argued by Grosfoguel (2013). Understanding epistemicide in African ethics requires a consideration of inherent power relations in the knowledge-production process. Almeida looks at the epistemology discussion from a race-based perspective and critiques the exclusion of Oriental/indigenous knowledge on the premise of its 'experiential as opposed to empirical underpinnings' (2015:82). This exclusion can otherwise be seen as an existence which serves to validate Western civilization (2015:82). Through privileging Western epistemes by defining progress as 'developmental goals, judged on economic growth rates, Gross National/Domestic Product (GNP/GDP) rates' (Sachs, 1999:32), ecological concerns are obfuscated if not entirely erased from the sustainability discourse, along with any contributions from indigenous knowledges which may respond to the ecological crisis using alternative epistemic frameworks.

In playing what Sachs terms 'the catch up game' (Sachs, 1999:30), the developing world assumes the role Almeida talks about (2015), which is that of validating Western civilizations. Grosfoguel (2007) aptly demonstrates how the language of deficits continues to trap the indigenous subject in a constant colonial paradigm which began in the 16th century 'with the colonial subject as having no language', continued in the 18th and 19th century as having 'no history', and in the 21st century, 'no democracy' (2007:214).

Epistemic justice clearly illustrates the need for an African ethic in suggesting ecological solutions, taking into consideration the ontological position of the African subject. To

illustrate this effectively, Martin, who speaks from a decolonial theoretical position, makes the claim that 'African social organisation models, ethics and politics were never in English, Portuguese, Spanish or French' (1992:49). Martin's argument is nuanced by Mkandawire's assertion illustrating gatekeeping, 'which privileges Western researchers, even on matters of local policy development on the continent' (1997:28). Appealing once more to epistemic justice, while working towards formulations which seek to advance the sustainability agenda, the incorporation of African ethics in response to the current ecological crisis could be termed appropriate and necessary.

Using interactive teaching models demonstrated in the work of the Eco-Schools project, – which looks at acknowledging the specificity of location while responding meaningfully to the ecological challenges of that specific locale – epistemic justice becomes imbued in teaching and learning practices. Through inculcating social responsibility fostered by interactive teaching models, rooted in an understanding of personhood as a constitutive part of the broader community as advanced in an African ethic as the starting point, there is a clear link between epistemic justice and sustainability. Sustainability is therefore derived from social responsibility inherent in an African ethic and which, when recognised, begins to deliver on epistemic justice. Justifying the sustainability discourse in this way creates room for recognising different social organisation models that are not premised on development as defined from an economic understanding that continues the language of deficits, if a society does not meet the development standards as defined by the Western world. However, one would need to qualify why a response to the ecological crisis would use this approach to sustainability as opposed to the propositions which have been proffered by Western modernity.

Having explained the limitations of Western modernity (as a trapping which continues to highlight deficits in the Oriental/indigenous subject, and manifesting as a neo-colonial ordering of the contemporary world, what Le Grange terms 'Integrated World Capitalism' [2012b:57]), further articulations prove the need to redefine our conceptions of sustainability and development. Esteva, a developmental theorist, points out how 'contemporary understandings of development elucidate the deficit discourse and continue to subjugate the indigenous body' (1992:8). Further to this, Western conceptions of the sustainability discourse alienate and remove the socio-cultural specificities in sustainability, reinforcing the need to make economic development sustainable, which should be understood as a fundamental contradiction in the pursuit of a more sustainable future. This approach to sustainability has its origins in the first attempt at an internationally cohesive effort towards mitigating environmental degradation – notably, the Brundtland Report, otherwise known as our *Common Future* (1987). In the process of mitigation, sustainable development has come to mean a form of 'managerialism of the environment' (Sachs, 1999:33), with cybernetics used in the homoeostasis conceptions of the world as a means of exercising dominion over the environment through cybernetic manipulation or regulation.

In approaching the development debate from a position which divorces human interaction from ecology, but which rather assumes a management strategy for dealing with key challenges facing the imminent threat of global climate change, Grosfoguel's 'sub-zero position of the God-Knower' (2007:213) begins to reveal the implications of colonialism. This position

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explicates two fundamental tenets of this argument. Firstly, the sub-zero Eurocentric perspective is the focal point for creating universalisms which silence indigenous ways of knowing by proffering solutions couched in universality when, in fact, they themselves are provincial ways of knowing. Secondly, this position assumes the God-Knower perspective, which alienates humanity from the environment, and removes the African ethic in understanding personhood as a constitutive part of the third element of Ramose's definition, which is that of 'leaving the land as we found it' (2014:75). In removing the third element of the ethical definition, cybernetic manipulation, masquerading as homoeostasis management, undermines a genuine commitment to sustainability and thus allows the developmental agenda to continue unchecked and dressed-up in a new coat.

The first tension presented by the sub-zero position presents another challenge, which is that of the power relations inherent in the knowledge-production process. In acknowledging the provinciality of an African ethic, the sub-zero position dismisses any contributions which could be proffered as peripheral. The act of peripherising continental/provincial positions highlights the endemic epistemological injustice of the contemporary world order, while taking us back to the claim that 'African social organisation models, political organisation and economic principles were never articulated in English, French, Portuguese or Spanish' (Martin, 1992:49). In the act of defiance through challenging the Western definitions of development, there is the continual gating of the indigenous subject, what Esteva (1992:8) calls the 'pathologising, anomaly and unnatural behaviour' (as termed by the West) in not following unilinear conceptions of development.

Through the pathological ascriptions given to states which do not follow the Western modes of development, wa Thiong'o (1993:51) calls our attention to the use of 'economic and political control invariably leading to cultural domination'. Cultural domination understood as epistemic injustice cannot, thus, be escaped with the constant totalitarian hegemonic ideas of development which still permeate globally. Calling for a shift in such a conceptual understanding of sustainable development is premised on the need for epistemic justice as a means to effectively deal with the ecological crisis facing us today. However, the economic and political control articulated by wa Thiong'o (1993) cannot be divorced from the concerns raised by Mkandawire (1997:28) earlier in the paper, which speak to the gatekeeping stance taken by policy developers and the African state in privileging the voice of Western researchers and academics, even in matters of local policy development.

Sustainability obfuscated by development presents the discourse on ecology with a multitude of challenges which need attention. Fundamentally, development can be understood as a tension between sustainability and the course towards economic growth and expansion. Forever attempting to escape the connotations of being termed underdeveloped, lacking and deficient (Esteva, 1992:7), third world economies constantly strive for the economic growth rates of Western countries while neglecting the reality of the unsustainable nature of rapid growth and economisation. Other than the unsustainability of economisation, there is a further neglect, one which links this process of 'development with colonisation' (Esteva, 1992:17).

To resolve the tension between development and sustainability, the work of Amartya Sen can be of use to this argument. Looking at development through the lens of capabilities,

which can be defined as 'political freedom, social opportunities and protective security' (Sen, 2001:10), allows for the flourishing of individuals in any given society, and thus substantiates the term 'development'. Political freedom may be defined as the opportunity to participate in constructing social policy and defending individual rights, which can only be fully actualised in a social context that recognises the individual as a constituent part of society. Enabling factors such as social opportunities (access to education, health-care) and political freedom, allow the individual to live their desired life. Protective security speaks to a social environment which does not bring harm to the individual in their pursuit of these enabling factors. Fundamental in the realisation of these capabilities, however, is the notion of the architectonic capability, understood as *ubuntu* (Le Grange, 2012a:139), framed and informed by an African ethic.

It is imperative to understand the interactive relation amongst the capabilities stated earlier. Deprivation of these capabilities is a denial of access to the three elements, and priority should be given to the social opportunities (attainment of an education, access to medical facilities and freedom of trade) which allow for the full actualisation of political freedom and protective security. Social opportunities, with the advancement of society through education, introduce the concept of development without tensions in relation to sustainability.

Sen's (2001) conception of development is not underpinned by rigid economic assessments of GNP/GDP and economic growth rates, and can thus can be viewed as an enabling model in understanding development. It is enabling in that it allows for the provincial definitions of societal advancement to be actualised using contextual interpretations of what development may look like. From this position, sustainability linked to social advancement in the attainment of these capabilities speaks to epistemic justice, in the contextual definitions proffered in consideration of solutions, which may be used to advance the sustainability agenda within a given locale.

The tension between development and sustainability can be resolved by proffering solutions which are based on an understanding of what is most pressing within each context in relation to the current ecological crisis. Using different epistemic positions not only allows for epistemic justice, but, through a site-specific ecological education that also responds to international demands, also allows for a more sustainable use of the human commons.

Interactive Models

Interactive teaching and learning models, briefly introduced in this argument, are fundamental to a model of ecological education that is site-specific while teaching from a position seeking to respond to the international challenge for more sustainable uses of the global commons. The Eco-Schools project, through its environmental education programme, not only integrates environmental education across the school curriculum, but further calls for practical learning. Taking the discussion on the ecological crisis outside of the classrooms and investigating local challenges (such as river acidification, sustainable water consumption, and the recycling of greywater within the school – Maritzburg College), all point to the use of contextual knowledge in responding to the ecological crisis.

Interactive teaching models which look at the everyday impact of our consumption patterns and their effects on the environment, bring the discussion of the African ethical

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position back into the debate. Personhood, constituted by the third element (Ramose, 2014:75), is exemplified in the interactive teaching models advanced above.

Social opportunities can also be recognised as the underpinning component of this form of teaching and learning. Without these social opportunities in education (advocated in this paper as interactive teaching methodologies, otherwise known as capabilities deprivation), development cannot be actualised. This use of the term 'development' can be clarified as: development defined outside the scope of rigid economic measurement instruments such as GDP/GNP and economic growth rates, but rather looking to the Human Development Index (HDI). A concession should be made in this argument to recognise that the use of the HDI itself may have shortcomings, in that it is defined from a Western perspective; however, as used in the work of Sen (2001), there is more room to navigate the definitions of development.

Invoking the African ethic obliges the debate on development to start with the recognition of how African social organisation, political theory and legal frameworks are written from the African position. Criticality is therefore necessary in formulating African articulations of development which are neither romanticised nor distorted in an arrested conception of what the African position may be. Mbembe, writing from a post-colonial theoretical perspective, notes the need for a differentiation between the 'traditional and fictive conceptions of the African subject' (2002:257). It is at this juncture that criticality must be deployed when formulating African ideas, so as to move away from essentialist arguments and understanding of what an African ethic in sustainability may be. While noting this caution as given by Mbembe (2002), it is also fundamentally important to note how Western modernity has appropriated elements of African thought, qualifying the argument made by Ramose which necessitates 'a critical explication of Western modernity acknowledging the contributions of African thought in advancing certain areas of Western civilisation' (2014:72).

Conclusion

Understanding the African ethical position which speaks to social responsibility and an ethical obligation as defined by 'a) the recognition of the living, b) the living-dead and c) leaving the land as we found it' (Ramose, 2014:75), has been the premise of this argument. From this position, epistemic justice has been argued for in the advancement of the sustainability agenda, taking into consideration the different epistemic positions which are dismissed by the Western hegemonic conceptions of development while arresting the attainment of sustainability objectives.

The tension between sustainability and development has been examined through showcasing how development envelopes sustainability, and is used to manage the continued objectives of development, economisation and subsequently colonisation in a new form. Economisation and colonisation have been argued against from a position of epistemic injustice that negates the ontological existence of the African/Oriental subject and uses the development discourse to validate Western civilisations (Almeida, 2015).

Explicating the problematics of development in the sustainability discourse has been used to showcase how continued epistemic injustice masquerading as Western

universalisms perpetuates a degradation of the natural environment. Western countries have responded to the ecological crisis with a managerial strategy that assumes 'the sub-zero, God-Knower position' (Grosfoguel, 2007:214) and cloaks the manipulation of cybernetics for the purpose of managing homoeostasis. Clear distinctions have been made between this approach to the current ecological crisis and the African ethical response.

Attempting to resolve the tensions between sustainability and development, this paper has put forward a more inclusive definition of development, one which looks at the capabilities approach as argued by Sen (2001). Capabilities rooted in interactive teaching methodologies, illustrated by a short exploration of the Eco-Schools programme, locates the argument in the African ethical position of 'leaving the land as we found it' (Ramose, 2014:75).

Notes on the Contributor

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References

Almeida, S. (2015). Race based epistemologies: The role of race and dominance in knowledge production. *Wagadu*, 13(1), 79–105.

Esteva, G. (1992). Development. In W. Sachs (Ed.). *Development dictionary: A guide to knowledge as power*. London: Zed Books. (pp. 6–25)

Grosfoguel, R. (2007). The epistemic decolonial turn: Beyond political-economy paradigms. *Cultural Studies*, 21(2), 211–223.

Grosfoguel, R. (2012). Introduction: From university to pluriversity: A decolonial approach to the present crisis of Western universities. *Human Architecture: Journal of the Sociology of Self-Knowledge*, 10(1), 1–6.

Grosfoguel, R. (2013). The structure of knowledge in westernised universities: Epistemic racism/sexism and the four genocides of the long 16th century. *Human Architecture: Journal of the Sociology of Self-Knowledge,* 11(1), 73–90.

Ikuenobe, P. (2006). *Philosophical perspectives on communalism and morality in African traditions.* London, Boulder, New York, Toronto & Oxford: Lexington Books.

Le Grange, L. (2012a). Ubuntu as an architectonic capability. *Indilinga: African Journal of Indigenous Knowledge Systems*, 11(2), 139–145.

Le Grange, L. (2012b). Ubuntu, Ukama and the Healing of Nature, Self and Society. *Educational Philosophy and Theory*, 44(2), 56–67.

Le Grange, L. (2012c). Ubuntu, ukama, environment and moral education. *Journal of Moral Education*, 41(3), 329–340.

ISSN 2411-5959 | DOI 10.4314/sajee.v.33i1.2

Magara, E.C. (2015). Integration of indigenous knowledge management into the university curriculum: A case for Makerere University. *Indilinga: African Journal of Indigenous Knowledge Systems*, 14(1), 25–41.

Martin, D.C. (1992). Out of Africa! Should we be done with Africanism? In V.Y. Mudimbe (Ed.), *Presence Africaine and the Politics of Otherness (1947–1987)*. Chicago and London: University of Chicago Press.

Mbembe, A. (2002). African modes of self-writing. *Public Culture*, 14(1), 237–273.

Mkandawire, T. (1997). The social sciences in Africa: Breaking local barriers and negotiating international presence. The Bashorun M.K.O. Abiola Distinguished Lecture presented to the 1996 African Studies Association Annual Meeting. *African Studies Review*, 40(2), 15–36.

Ramose, M.B. (2014). Dying a hundred deaths: Socrates on truth and justice. *Phronimon*, 15(1), 67–80.

Ramose, M.B. (2007). But Hans Kelsen was not born in Africa: A reply to Thaddeus Metz. *South African Journal of Philosophy*, 26(4), 347–355.

Sachs, W. (1992). Environment. In Sachs W. (Ed.), *Development dictionary: A guide to knowledge as power*. London: Zed Books. (pp. 26–37)

Sachs, W. (1999). *Planet Dialectics: Explorations in environment and development*. London: Zed Books

Sen, A. (2001). *Development as freedom*. Oxford and New York: Oxford University Press.

wa Thiong'o, N. (1993). *Moving the centre: The struggle for cultural freedom*. London: James Curry.

WCED (World Commission on Environment and Development). (1987). *Our common future*. http://www.un-documents.net/our-common-future.pdf, visited 3 January 2017.

Local Ecological Knowledge and Community-based Management of Wildlife Resources: A Study of the Mumbwa and Lupande Game Management Areas of Zambia

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Abstract

The aim of this study was to investigate the scope of local ecological knowledge (LEK) in the Lupande and Mumbwa Game Management Areas (GMAs) of Zambia and to assess the extent to which such knowledge has been used in the management of wildlife resources in the two areas. Quantitative and qualitative data were gathered through interviews and surveys in the two case-study areas. It was found that LEK in the study areas included taboos associated with the sustainable use of natural resources, traditional teachings that guided the local people as to the correct time to harvest their natural resources and provided knowledge of the natural distribution of plants in the two areas. Finally, it is recommended that, in order to complement modern scientific knowledge in the realisation of sustainable wildlife resource management, greater attention be paid to the LEK possessed by communities.

Keywords: Local ecological knowledge, sustainable utilisation, wildlife resources, Zambia.

Introduction

Local ecological knowledge (LEK) may be defined as the knowledge possessed by indigenous people that is distinctive to a particular culture in society. It is the informal knowledge that a particular group of people has about their indigenous ecosystems and their relationship with the environment (Olsson & Folke, 2001). Some scholars see LEK as the integration of a system of knowledge, innovations, skills and practices, as well as beliefs (Berkes, 1999). This unique knowledge is viewed as an attribute of societies and is characterised by historical continuity in order to maintain practices relevant to the management of natural resources. Consequently, LEK may be seen as the means by which indigenous people interact sustainably with their surrounding environment.

In improving the sustainable use of natural resources by local communities, the transmission of LEK has become an important consideration in natural-resource management, the reason

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being that such transmission ensures the continuation of this unique body of knowledge from one generation to the next. The transmission mechanisms have evolved down the generations by way of adaptive processes as humans exchange information on issues relating to their environment (Berkes, 1999).

LEK is not to be viewed as common knowledge. Rather, it is knowledge that is confined to a specific group of people who disseminate it among the rest of the community. LEK may also be confined to one of the genders. Hunting knowledge, for example, is restricted to men. One aspect of knowledge transmission is knowledge acquisition, which may involve individuals or social groups (Takako, 2003). Knowledge dissemination, as the communication of the acquired knowledge and skills within the community, is another aspect of transmission. In many communities, such as among the Lozi-speaking people of Zambia, LEK was disseminated orally by the older adults in the community to the younger people as they were growing up. It was also acquired through observation (Moonga & Milupi, 2015).

LEK has been seen to play a key role in managing various ecosystems (Berkes, Folke & Gadgil, 1995; Phuthego & Chanda, 2004; Mmassy & RØskaft, 2013). The relevance of LEK for the sustainable management of natural resources such as tropical forests, dry land, and mountain and Arctic ecosystems has been recognised by various academics (Sasaoka & Laumonier, 2012; Mmassy & Roskaft, 2013; Rim-Rukeh, Irerhievwie & Agbozu, 2013), as well as by international agencies, including the World Commission on Environment and Development, the International Union for Conservation of Nature (IUCN), the United Nations Environment Programme (UNEP), and the World Wide Fund for Nature (WWF) (Mmassy & RØskaft, 2013). In India, for example, Rim-Rukeh et al. (2013) observed that forests designated as sacred groves and landscapes were respected and protected from product extraction by the community, and that they were consequently still rich in biological diversity. They also noted that traditional practices such as restrictions against residential settlements close to shrines in India further promoted the conservation of biodiversity, as such restrictions protected the surrounding vegetation. In central Himalaya, too, studies conducted by Negi (2010) and Rim-Rukeh and Irerhievwie (2014) on local resource management and sacred natural sites showed that traditional practices such as taboos contribute to the conservation of habitats and biodiversity. International documents such as the World conservation strategy and Our common future also endorse the relevance of LEK in natural-resource management (Berkes et al., 1995). Both documents stress the integration of local indigenous knowledge in plans for the management of sustainable resources (Dudley, 1999).

LEK is relevant to biodiversity conservation in Game Management Areas (GMAs) because it provides novel insights into sustainable wildlife resource use and offers strategies for preserving cultural and ecological diversity, which are the main purposes and challenges of protected areas (Carvalho & Frazão-Moreira, 2011). LEK can furthermore inform and improve wildlife management decisions in GMAs (Saylora, Kamal, Alsharif & Torres, 2017).

LEK is a product of the accumulation of knowledge through a long series of observations and practice. Such a long-term series of observations could, if free of superstitions, complement the modern scientific management of natural resources, in which strategies are usually based on much shorter series of observations (Gadgil, Berkes & Folke, 1993). Local people are often more

familiar with a given area and the species in it than outsiders, yet may not have the knowledge or means to use valuable scientific methods of enquiry or conservation; hence, combining the two types of knowledge may help in the sustainable management of natural resources. In Arctic Canada and Greenland, for example, LEK has been used together with modern scientific knowledge (MSK) by biologists studying migratory bird species (Gilchrist, Mallory & Merkel, 2005). Scholars such as Barsh (1997) and Ferguson, Williamson and Messier (1988) observe that LEK may be particularly useful when managing wildlife populations in remote locations where extensive scientific studies are unrealistic. Rasalato, Maginnity and Brunnschweiler (2010) further note that LEK could contribute to the knowledge of critical habitats and their fauna in areas where data are inadequate. Besides providing important indicators that help direct scientific investigation, LEK can also be used to develop policies on wildlife research that incorporate cultural values (Gunn, Arlooktoo & Kaomayok, 1988).

However, some scholars, such as Raymond, Fazey, Reed, Stringer, Robinson and Evely (2010), have argued that LEK and scientific approaches to natural-resource management may be difficult to integrate, as they are quite different. MSK encompasses systematic, recorded knowledge or practice which focuses on agreed principles or processes of study, including reliability and validity (Barnhardt & Kawagley, 2005). This is not the case with LEK, which is mostly acquired orally and is therefore not systematically recorded. The critical issues in applying LEK are therefore reliability and validity (Kimmerer, 2002; Maurstad, Dale & Bjørn, 2007). Despite these differences between LEK and MSK, there is growing international recognition that LEK can be a useful source of information to complement MSK in resource management (Chemilinsky, 1991; Berkes, Colding & Folke, 2000; Gilchrist *et al.*, 2005).

In this paper, the aim is to investigate the nature of LEK and the extent to which such knowledge is utilised in wildlife management in the Lupande and Mumbwa GMAs of Zambia. We regard this as important, not only for the reasons outlined above, but because it can also ensure the involvement of local communities in managing wildlife.

Description of Case Studies

In Zambia, GMAs are buffer zones around a national park where subsistence hunting and licensed safari or trophy hunting are permitted (ZAWA, 2007). GMAs are thus communal areas where people coexist with wildlife and practise semi-subsistence agriculture (Bandyopadhyay & Tembo, 2010). The GMAs were selected for this study because they have abundant biological diversity and valued trophy animals, such as roan (*Hippotragus equinus*) and sable (*Hippotragus niger*), lion (*Panthera leo*) and leopard (*Panthera pardus*), among others (Simasiku, Simwanza, Tembo, Bandyopadhyay & Pavy, 2008). Safari hunting is the main commercial activity in the two GMAs (Musumali, Larsen & Kaltenborn, 2007). Through a Community Based Natural Resource Management (CBNRM) Programme, the Zambia Wildlife Authority (ZAWA) shares revenue from hunting licences and wildlife management responsibilities with the communities living in the GMAs (Bandyopadhyay & Tembo, 2010). The ZAWA collects the revenue in respect of licences sold, retains 50% and distributes the rest to the community. Of the 50% allocated to the community, 5% is apportioned to the area chief (ZWA, 1998; 2015) and 45% to Community Resource Boards (CRBs), where

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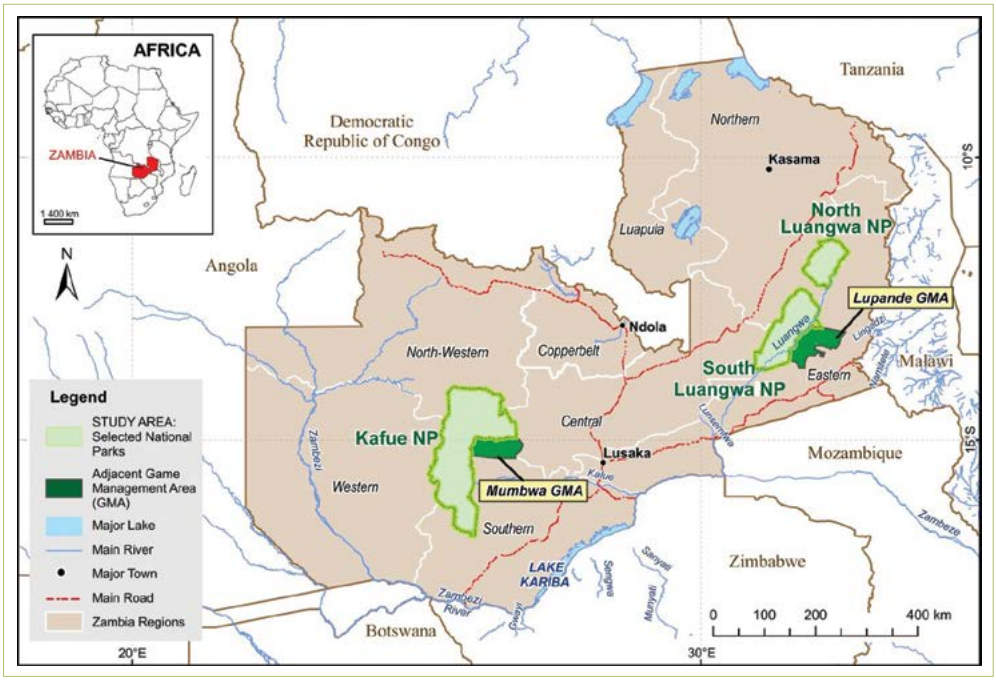
the money is used to pay scouts. Some money is also spent on community-development projects in the chiefdom.

The Mumbwa GMA (Figure 1) is in the Mumbwa district and covers an area of approximately 3 370 square kilometres. It was proclaimed a GMA in 1972. The GMA shares a boundary with the Kafue National Park in the north (Figure 1). The Mumbwa GMA is a prime hunting area where highly valued trophy species such as buffalo (*Syncerus caffer*), lion and leopard are abundant (ZAWA, 2004; Rim-Rukeh & Irerhievwie, 2014). The human population of the Mumbwa GMA was estimated to be 33 500 in 2012 (UNDP, 2012). The Mumbwa GMA community comprises subjects in the three chiefdoms of Chibuluma, Kabulwebulwe and Mulendema, which together form the wildlife management authority for the Mumbwa GMA. Major threats and pressures that have affected the Mumbwa GMA include poaching and human population growth (MTENR, 2007a). Other threats have included charcoal production, illegal fishing when there was a ban on fishing, and agricultural activities. Charcoal production is common in the Mumbwa GMA because of the proximity of the GMA to big cities such as Lusaka where there is a ready market for charcoal.

The Lupande GMA (Figure 1) is located in the Luangwa Valley in the Eastern Province of Zambia (Balakrishnan & Ndhlovu, 1992). The GMA is 120km west of Chipata town, the provincial headquarters. It covers an area of 4 840 square kilometres and is bordered by South Luangwa National Park in the west, the Chipata–Petauke district boundary in the south, and the Chipata–Lundazi district boundary in the north and east. In 2012, the population of the Lupande GMA stood at 68 918 (CSO, 2012).

Figure 1. The location of the Mumbwa and Lupande GMAs within Zambia



The Lupande GMA has six chiefdoms, namely Kakumbi, Mkhanya, Nsefu, Jumbe, Malama and Msoro. The GMA experiences two seasons: a dry season (from May to October) and a wet season (from November to April). The dominant vegetation in the Lupande GMA includes woodlands such as Miombo (*Brachystegia*, *Isoberlinia* and *Julbernardia* species), Mupane (*Borassus aethiopus*) and Munga (*Acacia albida*). The majority of the people of Lupande are subsistence farmers who grow crops such as maize, cotton, millet, sorghum, beans, pumpkins, and sweet potatoes (Nyirenda, Myburgh, Reilly & Chabwela, 2013). Other crops grown in the area include cassava, groundnuts and rice.

Methodology

The study was based on secondary and primary data collected from June to August 2014. Secondary data were derived from published materials and policy documents, whereas primary data were collected through two ethnographic methods, namely household surveys and key-informant interviews, as outlined below. Ethical clearance for this work was received from the University of Pretoria (EC 140514–046).

Secondary data analysis provided a better understanding of: the relationship between LEK and wildlife resource management and how LEK is used in wildlife resource management; the transmission mechanisms of LEK and how LEK promotes the management and sustainability of natural resources; and the possible compatibility of LEK and MSK in the management of wildlife resources. In the present study, journal papers, the ZAWA Act, the Forest Act, the Fisheries Act and government records such as the national environmental policy were examined. These documents provided background information for the research and allowed for assessment of the suitability of the project before conducting interviews (Dvora, 2007 – as cited in Owen, 2014).

Household surveys

Household surveys generated quantitative data through the structured, researcher-administered questionnaires, which comprised both closed and open-ended questions. The sampling unit for the two GMAs was the household, with the target respondent being the household head. Households were randomly selected. In total, 349 household heads from the Mumbwa and Lupande GMAs were interviewed – 76 in Mumbwa and 173 in Lupande. Both men and women were interviewed during the survey. Of the respondents interviewed in the Mumbwa GMA, 63.1% were males, while 36.9% were females; and, in the Lupande GMA, 58.4% were males, while females constituted 41.6% of respondents.

Three chiefdoms, namely Kabulwebulwe, Mulendema and Chibuluma, were covered in the Mumbwa GMA, while, in the Lupande GMA, four chiefdoms were considered, namely Kakumbi, Mkhanya, Nsefu and Jumbe. To ensure that the questionnaire was suited to the context, a pretest was conducted in one of the chiefdoms in the Mumbwa GMA.

The households were interviewed as regards the following aspects of LEK:

- The sources of LEK, that is, where they acquired knowledge on how to manage natural resources such as the plants and animals in their areas;

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- The nature of LEK prevalence, for example taboos related to the sustainable use of natural resources such as plants and animals;
- Traditional teachings that directed the local people as to the best time to harvest natural resources such as plants and animals;
- Knowledge of plant distribution and the favourable conditions for plants to grow or flourish; and
- The extent to which LEK is used in wildlife management, particularly if the ZAWA is using local knowledge in the management of wildlife resources in the two GMAs.

Key-informant interviews

Key informants, including ZAWA officials and traditional chiefs from the Mumbwa and Lupande GMAs, were interviewed. The ZAWA officials were interviewed in English, while the traditional chiefs were interviewed in their respective local languages, which included Kaonde, Lamba, Kunda and Chewa. The responses of the traditional chiefs were transcribed and then later translated into English with the help of research assistants used in the study areas. The chiefs were specifically asked questions about their role in wildlife resource management, and the ZAWA officials were asked about the performance of the CBNRM Programme in the two GMAs in relation to community involvement and the use of LEK in wildlife resource management.

Quantitative data were coded and processed using Statistical Package for Social Sciences (SPSS) software to generate the frequencies of responses. Cross-tabulation of some variables was done to establish relationships between them.

Below, we report the results of the study, highlighting the nature of LEK found, as well as assessing how such knowledge is used in wildlife management and its role in the sustainable management of wildlife resources.

Results

As reflected in Figure 2, most of the respondents (58%) revealed that their source of LEK was older adults, who included parents and grandparents. Other interviewees (24%) said they acquired LEK from the ZAWA, while fewer than 10% of respondents stated that traditional leaders were also a source of LEK in their area. Less than 1% of respondents said that LEK was gained in schools or from books.

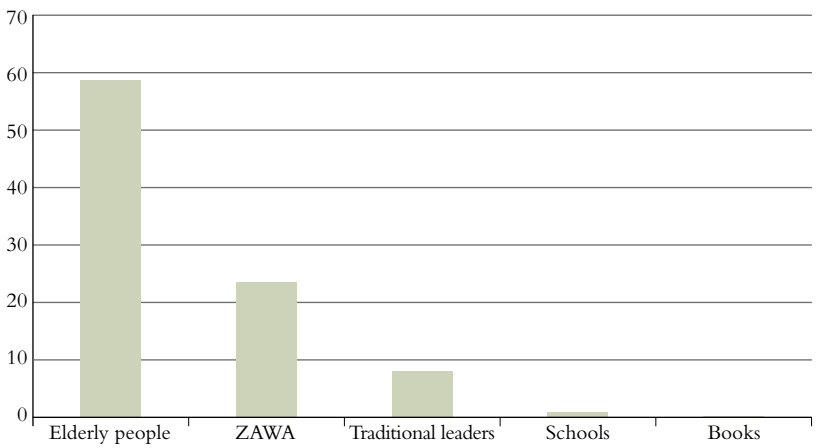
The nature of LEK prevalent in the Mumbwa and Lupande GMAs

The local people in the two study areas, especially the elderly, have developed certain taboos regarding the sustainability of natural resources, as described below:

- The Tonga tradition in the Mumbwa GMA considers animal species such as lion and elephant (*Loxodonta africanas*) as totems, and, therefore, the Tonga may not hunt and kill them because the lion and the elephant symbolise the clan. One of the clans among the Tonga-speaking people for whom a lion is a totem and may consequently not be killed, is the Bachindu. In this way, the animals are protected.

- The Lozi tradition considers the eland (*Taurotragus oryx*), locally known as Pofu, as the animal of the king and chiefs. Thus, eland may not be hunted without authorisation from them. This is common in the Western Province of Zambia where Paramount Chief Litunga controls all matters related to hunting in his area.
- Elephants have been hunted for ivory and used by chiefs as a symbol of power. This means that any elephant hunting had to be authorised by the king or the chief and the ivory was then taken to his house.
- The myths associated with hunting lions have served to safeguard the species. For example, only strong men were said to be eligible for hunting lions and only the chief or king of the area could own the skin as a symbol of power or greatness.
- Animals with perceived attractive skins, such as leopards, cheetah (*Acinonyx jubatus*) and other rare species, belong to the king or chief when killed. This provides these species with a form of protection.

Figure 2. Responses regarding the sources of knowledge used to manage natural resources in Mumbwa and Lupande (percentage)



Traditional teachings on the time to harvest natural resources

In both the Mumbwa and Lupande GMAs, the traditional teachings guiding the local residents as to the right time to harvest plants or animals appear to be similar. It is believed that these teachings help to conserve natural resources and save them from depletion.

Traditional teachings concerning plants

Respondents observed that there are restrictions on when to harvest plants. For example, appearance (e.g. colour) and the season are used to guide them as to the right time to harvest. Medicinal plants are not allowed to be cut down, as they are used to treat different types of ailments, for example *mululwe* is used for malaria and *musamba* for stomach problems, whereas *mukuyu* and *musombosombo* are used as blood boosters in the Mumbwa GMA. Trees that bear fruit are also not allowed to be cut down, nor are young and flowering plants. To respondents,

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young plants are the future forest. Plants near the village and those found in places such as cemeteries are not allowed to be cut down because these are considered sacred places. In general, it is believed that cutting down trees will disturb the pattern of rainfall. These restrictions and beliefs of the local community help them to conserve and use the natural resources in a sustainable manner.

Traditional teachings concerning animals

There are restrictions on animal harvesting that prevent animal stocks from being depleted. For example, there are restrictions on hunting gear. Only spears are allowed when hunting. This is intended to reduce the numbers of animals that are harvested or killed. Killing animals using snares is prohibited. The time to hunt is also restricted to times of important traditional ceremonies. Further, there are restrictions on the type of animal to be killed. For instance, female animals are not allowed to be killed, especially those that are pregnant or are suckling young ones. These teachings have positive conservation implications, in that the local communities in effect practise selective hunting.

Knowledge of plant distribution

The local people in both the Mumbwa and Lupande GMA also have extensive knowledge of the distribution of plants in their area, as reflected in the information provided by them (see Tables 1 and 2).

The tables indicate the LEK that the community possesses regarding the distribution of plants in the Mumbwa and Lupande GMAs. Since vegetation provides a habitat and food for animals, this knowledge is critical in wildlife management and assists in determining animal distribution in the two GMAs.

Table 1. Plant species distribution in the Mumbwa GMA

Plant species	**Distribution**
Mumososmoso (*Vangueriopsis lanciflora*)	Found mostly in sandy areas
Mululu (*Entandrophragma caudatum*)	Found in woodlands and in thickets
Mubanga (*Pericopsis angolensis*)	Woodland habitat
Mubuyu (*Adansonia digitata*)	Commonly found near anthills and thickets
Mulala (*Borassus aethiopum*)	Usually found in woodlands
Mukwa (*Pterocarpus angolensis*)	Woodland habitat
Musamba (*Lannea stuhlmannii*)	Found in thickets and sometimes on anthills

Source: Field data (2014)

Table 2. Plant species distribution in the Lupande GMA

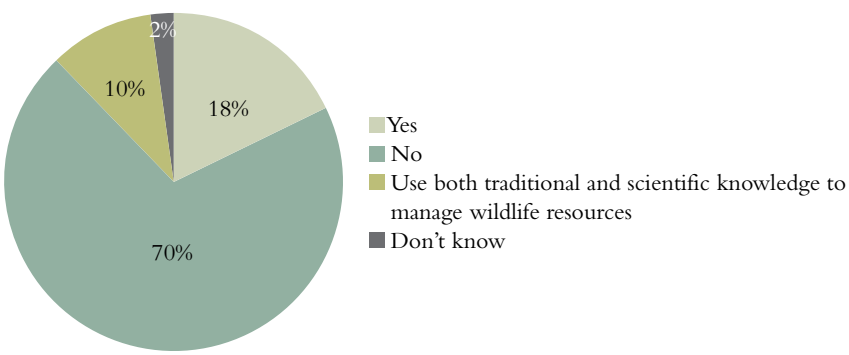
Plant species	Distribution
Mopane (*Colophospernum mopane*)	Found in the Luangwa Valley
Mutondo (*Julbernardia globiflora*)	Commonly found in sandy areas and escarpment soils
Mubombo (*Brachystegia floribunda*)	Commonly found in the plateau area
Mpapa (*Afzelia quanzensis*)	Commonly found in Kalahari sand and also occasionally in the highlands and hills
Msuku (*Uapaca kirkiana*)	Commonly found in woodlands
Msolo (*Pseudolachynostylis maprouneifolia*)	Commonly found in the plateau area
Mpundu (*Parinari curatellifolia*)	Found in the plateau area

Source: Field data (2014)

Extent to which LEK is used in wildlife management in the GMAs

Figure 3 indicates that the majority of respondents were of the opinion that the ZAWA is not using LEK to manage wildlife resources. Of the remaining respondents, 18% said that the ZAWA uses LEK to manage wildlife resources, 10% said that the ZAWA uses both LEK and scientific methods, and 2% did not know. Respondents' answers depended on the area where they lived. In the Lupande GMA, local people are sometimes employed by the ZAWA to help guide officials to where animal species may be found, as well as to provide information on the plant species present and on the general condition of the environment. This helps the ZAWA to determine and monitor animal distribution in the Luangwa GMA and the nearby national park without using expensive scientific methods such as aerial surveys.

Figure 3. According to respondents, does the ZAWA use LEK to manage wildlife resources?



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The seven chiefs who were interviewed (three from the Mumbwa GMA and four from the Lupande GMA) all said that the ZAWA is not using LEK to implement and manage sustainable wildlife resources in the two case study GMAs. We believe this is because the ZAWA officials do not consult the traditional leaders in either of the GMAs about using LEK for wildlife management. The chiefs further commented that the ZAWA is more involved in enforcement than in using LEK for environmental conservation and the sustainable management of wildlife resources in the GMAs. They did mention the application of LEK by the ZAWA in determining the distribution of animals in the GMA, especially in the Lupande GMA, but regarded this use as minimal.

Key respondents from the ZAWA confirmed that very little LEK is used by their institution in the sustainable management of wildlife resources in the Mumbwa and Lupande GMAs and in Zambia in general. They explained that the ZAWA is not using LEK because the organisation is seeking to become more business-oriented by making use of what officials believed to be 'less expensive' methods of monitoring animal and plant species, such as aerial and ground survey methods that do not necessarily involve local inhabitants.

Policy provision/position on the use of LEK

Information from policy documents that were examined, such as the ZAWA Act and the National Policy on Environment (MTENR, 2007b), stipulates explicitly that the local community should be involved in the planning and establishment of CRBs, but does not offer insights into the role of LEK in the GMAs. The policy therefore does not make provision for the use of LEK in these areas.

Discussion

The aim of this study was to describe LEK and assess its use in wildlife management in the Lupande and Mumbwa GMAs in Zambia. The study revealed the scope of LEK, ranging from taboos and restrictions on natural-resource use to in-depth knowledge of where plants and animals occur.

The taboos and restrictions that emerged can be drawn on for the sustainable management of wildlife resources. For instance, local knowledge about flora and fauna could help to flag situations that affect the environment and guide the development of responses so as to prevent further degradation of natural resources. This knowledge could then be incorporated in wildlife management programmes, along with the MSK that is currently being used by the ZAWA, and possibly strengthen the sustainable utilisation of wildlife resources.

The study shows that the nature of LEK in the two GMAs could contribute to the sustainable harvesting of wildlife populations and the protection of rarer species. For example, the taboos among the Tonga- and the Lozi-speaking people ensure that wildlife resources are only harvested at the appropriate time. Furthermore, the practice of traditional teachings concerning plants and animals (by parents and grandparents) in the Mumbwa and Lupande GMAs indicates that LEK would contribute to the use of wildlife resources in a sustainable manner (see Chemilinsky, 1991; Berkes *et al.*, 2000).

Based on these findings, we would argue that LEK could serve as a useful source of information to complement scientific approaches to resource management. For example, LEK on plant distribution in the two areas could enhance biodiversity conservation and consequently lead to sustainable utilisation of wildlife resources (Johannes, 1998), particularly in remote areas where adopting standard scientific approaches may be impossible. By drawing on both LEK and MSK for wildlife management, local communities could be more actively involved in the sustainable management of wildlife resources.

Finally, LEK on plant distribution in the two study areas, if utilised in wildlife management, could help in guiding tourists and hunters. The local guides rely on their ecological knowledge and knowledge of plant distribution to locate animal species in their natural habitats. Further, although perhaps not as reliable, using LEK could be much cheaper than using MSK to locate and count animals. The consequence of using LEK would be active involvement of the local community in wildlife resource management, and this may improve wildlife resource management in general. The main implication of LEK exhibited in both GMAs is that the local communities practise sustainable utilisation of natural resources, which has positive conservation implications.

Conclusion

There are various forms of LEK in the Mumbwa and Lupande GMAs. These range from taboos that are associated with the sustainable use of natural resources, to traditional teachings that guide the local people in determing the time to harvest their natural resources, to traditional signs of environmental degradation, and to knowledge of the natural distribution of plants in the two areas. This range of LEK, if used in wildlife management along with MSK, could foreseeably encourage greater involvement of local communities in wildlife management and, therefore, promote sustainable management of wildlife resources.

Based on policy documents such as the ZAWA Act, the Forest Act, the Fisheries Act and the National Policy on Environment, the Zambian government regards community participation in natural-resource management as important. For example, the National Policy on Environment (MTENR, 2007b) stipulates that the local community should be involved in the planning and establishment of CRBs. The policy does not, however, explain how the local community should be involved and does not make provision for the use of LEK in the GMAs.

This study identified a considerable body of LEK possessed by communities in the Mumbwa and Lupande GMAs, and it is strongly recommended that greater attention be paid to this knowledge as a useful source of information to complement scientific approaches to wildlife resource management. The diverse LEK systems identified in the study carry strong conservation messages and could all be used as entry points into sustainable wildlife resource utilisation and management. Doing so would ensure the involvement of the local communities in wildlife management and promote sustainable management of wildlife resources, which would have positive conservation implications. It is further recommended that policymakers consider including the use of LEK in the design and management of GMAs, something that is not presently provided for.

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References

Balakrishnan, M. & Ndhlovu, D.E. (1992). Wildlife utilization and local people: A case study of upper Lupande Game Management Area, Zambia. *Environmental Conservation*, 19(2), 135–144.

Bandyopadhyay, S. & Tembo, G. (2010). Household consumption and natural resource management in Zambia. *Journal of Natural Resources Policy Research,* 2(1), 39–55.

Barnhardt, R. & Kawagley, A.O. (2005). Indigenous knowledge systems and Alaska native ways of knowing. *Anthropology and Education Quarterly*, 36(1), 8–23.

Barsh, R.L. (1997). Forests, indigenous people, and biodiversity. *Global Biodiversity*, 7, 20–23.

Berkes, F. (1999). *Sacred ecology: Traditional ecological knowledge and resource management*. Philadelphia: Taylor & Francis.

Berkes, F., Colding, J. & Folke, C. (2000). Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications*, 10, 1251–1262.

Berkes, F., Folke, C. & Gadgil, M. (1995). Traditional ecological knowledge, biodiversity, resilience and sustainability. In C. Perrings, K.-G. Mäler, C. Folke, C.S. Holling, & B.-O. Jansson (Eds), *Biodiversity conservation*. Dordrecht, The Netherlands: Kluwer. (pp. 269–287).

Carvalho, A.M. & Frazão-Moreira, A. (2011). Importance of local knowledge in plant resources management and conservation in two protected areas from Trás-os-Montes, Portugal. *Journal of Ethnobiology and Ethnomedicine*, 7, 36.

Chemilinsky, E. (1991). On social science's contribution to government decision making. *Science*, 254, 226–231.

CSO (Central Statistical Office). (2012). *The national population and housing census for 2010 in Zambia.* Lusaka: Central Statistics Office.

Dudley, A.M. (1999). Indigenous forest use practices and sustainability: A case study of the Adivasis of the Nilgiri biosphere region, South India. Unpublished masters dissertation, St Mary's University, Twickenham, United Kingdom.

Ferguson, M.A.D., Williamson, R.G. & Messier, F. (1998). Inuit knowledge of long-term changes in a population of arctic tundra caribou. *Arctic*, 51, 201–219.

Gadgil, M., Berkes, F. & Folke. C. (1993). Indigenous knowledge for biodiversity conservation. *Ambio*, 22, 151–156.

Gilchrist, G., Mallory, M. & Merkel. F. (2005). Can local ecological knowledge contribute to wildlife management? Case studies of migratory birds. *Ecology and Society*, 10(1), 20.

Gunn, A., Arlooktoo, G. & Kaomayok, D. (1988). The contribution of ecological knowledge of Inuit to wildlife management in the Northwest Territories. In M.M.R. Freeman & L.N. Carbyn (Eds), *Traditional knowledge and renewable resource management in northern regions.* IUCN Commission on Ecology and the Boreal Institute for Northern Studies, Occasional Publication Number 23, Edmonton, Alberta, Canada. (pp. 22–30)

Johannes, R.E. (1998). The case for data-less marine resource management: Examples from tropical nearshore fisheries. *Trends in Ecology and Evolution*, 13, 243–246.

Kimmerer, R.W. (2002). Weaving traditional ecological knowledge into biological education: A call to action. *BioScience*, 52, 432–438.

Maurstad, A., Dale, T. & Bjørn, P.A. (2007). You wouldn't spawn in a septic tank, would you? *Human Ecology*, 35, 601–610.

Mmassy, E.C. & Røskaft, R. (2013). Knowledge of birds of conservation interest among the people living close to protected areas in Serengeti, Northern Tanzania. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 9(2), 114–122.

Moonga, M. & Milupi, I. (2015). *Transmission mechanisms of local ecological knowledge in Zambia: The case of the Lozi speaking people of Western Province.* Research paper presented at the 5th African RCE Conference, Kampala, Uganda.

MTENR (Ministry of Tourism, Environment and Natural Resources). (2007a). *Synthesis of completed management effectiveness tracking tool for protected areas managed by the Zambia Wildlife Authority*. Lusaka, Zambia: Ministry of Tourism, Environment and Natural Resources.

MTENR (Ministry of Tourism, Environment and Natural Resources). (2007b). *National Policy on Environment*. Lusaka, Zambia: Ministry of Tourism, Environment and Natural Resources.

Musumali, M.M., Larsen T.S. & Kaltenborn. B.J. (2007). An impasse in community based natural resource management implementation: The case of Zambia and Botswana. *Oryx*, 41, 3.

Negi, C.S. (2010). The institution of taboo and the local resource management and conservation surrounding sacred natural sites in Uttarakhand, Central Himalaya. *International Journal of Biodiversity and Conservation*, 2(8), 186–195.

Nyirenda, V.R., Myburgh, W.J., Reilly, B.K. & Chabwela, H.N. (2013). Wildlife crop damage valuation and conservation: Conflicting perception by local farmers in the Luangwa Valley, eastern Zambia. *International Journal of Biodiversity and Conservation*, 5(11), 741–750.

Olsson, P. & Folke, C. (2001). Local ecological knowledge and institutional dynamics for ecosystem management: A study of Lake Racken watershed, Sweden. *Ecosystems*, 4(2), 85–104.

ISSN 2411-5959 | DOI 10.4314/sajee.v33i1.3

Owen, G.T. (2014). Qualitative methods in higher education policy analysis: Using interviews and document analysis. *The Qualitative Report*, 19(26), 1–19.

Phuthego, T.C. & Chanda, R. (2004). Traditional ecological knowledge and community-based natural resource management: Lessons from a Botswana wildlife management area. *Applied Geography*, 24, 57–76.

Rasalato, E., Maginnity, V. & Brunnschweiler, J.M. (2010). Using local ecological knowledge to identify shark river habitats in Fiji (South Pacific). *Environmental Conservation*, 37(1), 90–97.

Raymond, C.M., Fazey, I., Reed, M.S., Stringer, L.C., Robinson, G.M. & Evely, A.C. (2010). Integrating local and scientific knowledge for environmental management. *Journal of Environmental Management*, 91, 1766–1777.

Rim-Rukeh A. & Irerhievwie, G. (2014). Assessment of water quality of traditionally protected and unprotected rivers, streams and ponds in the Niger Delta, Nigeria. *Journal of Ecology and the Natural Environment*, 6(1), 25–31.

Rim-Rukeh, A., Irerhievwie, G. & Agbozu. I.E. (2013). Traditional beliefs and conservation of natural resources: Evidences from selected communities in Delta State, Nigeria. *International Journal of Biodiversity and Conservation*, 5(7), 426–432.

Sasaoka, M. & Laumonier, Y. (2012). Suitability of local resource management practices based on supernatural enforcement mechanisms in the local social-cultural context. *Ecology and Society*, 17(4), 6.

Saylora, C.R., Kamal, A., Alsharif, K.A. & Torres, H. (2017). The importance of traditional ecological knowledge in agroecological systems in Peru. *International Journal of Biodiversity Science, Ecosystem Services and Management*, 13(1), 150–161.

Simasiku, P., Simwanza, H.I., Tembo, G., Bandyopadhyay, S. & Pavy, J.M. (2008). The impact of wildlife management policies on communities and conservation in game management areas in Zambia: Message to policy makers. Natural Resources Conservation Forum.

Takako, H. (2003). Transmission mechanism of traditional ecological knowledge. *Anthropological Quarterly*, 50(2), 77–89.

UNDP. (2012). Strengthening management effectiveness and generating multiple environmental benefits within and around the greater Kafue national park and west Lunga national park in Zambia, Project document. Available at https://info.undp.org/docs/pdc/Documents/ZMB/PIMS%204625%20Zambia%20PRODOC%20Final.pdf, visited 10 November 2017.

ZAWA (Zambia Wildlife Authority). (1998). Zambia Wildlife Act. Chilanga, Lusaka, Zambia. http://theredddesk.org/sites/default/files/wildlife_act_12_1998_1.pdf, visited 18 September 2014.

ZAWA (Zambia Wildlife Authority). (2004). *Quota setting and monitoring of hunting manual*. Lusaka: Zambia Wildlife Authority.

ZAWA (Zambia Wildlife Authority). (2007). *Technical report on the rapid assessment of the Kafue and Kafue Flats ecosystems*. Chilanga, Zambia: Zambia Wildlife Authority.

ZAWA (Zambia Wildlife Authority). (2015). Act No. 14. http://www.parliament.gov.zm/sites/default/files/documents/acts/The%20%20Zambia%20Wildlife%20Act%2C%202015.pdf, visited 19 August 2017.

An Analysis of the Policy Coverage and Examination of Environmental-impact Topics

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Abstract

Environmental education and education for sustainability are educational responses to negative environmental impacts both locally and globally. In South Africa, the schooling sector has experienced several shifts in the curriculum since 1994, with implications for the coverage, teaching and examination of environmental-impact topics in subjects such as Life Sciences, Physical Sciences, Life Orientation, Agricultural Sciences, and Geography. The aim of the research reported here was to investigate the coverage and examination of environmental-impact topics in the Further Education and Training (FET) Phase of the South African school curriculum. Data sources were the Curriculum and Assessment Policy Statement (CAPS) documents and examination papers. In analysing the coverage and examination of environmental-impact topics, thematic content analysis was used. The findings indicate that there is unequal coverage of environmental-impact topics in the curriculum, despite the CAPS indicating that environmental content should feature in all subjects. The present paper shows that Life Sciences has the widest coverage and that Geography examination papers sometimes exceed the policy allocation. Agricultural Sciences has the least coverage. The study also found that there is general, but not complete, alignment between policy and examination papers. The study concluded that there is too little focus in the FET curriculum on environmental education and warns that this will constrain the development of a pro-environmental culture among learners. This has relevance for curriculum and policy developers in responding to societal and environmental issues.

Keywords: Environmental education, education for sustainable development, environmental-impact topics, curriculum.

Introduction

Among the biggest challenges facing humans today are environmental pollution, land degradation and global warming. Sitarz (1994) noted that the increase in the world's population and in consumption, particularly in the industrialised countries, had stimulated economic growth but also worsened negative environmental impacts. Erdogan, Bahar, Ozel, Erdas and Usak (2012:3259) blame 'science and technology, industrialisation, changes in life habits and routines' for environmental pollution and the destruction of nature. The nations of the world now recognise that the exploitation of the Earth's resources has degraded the environment and generated unmanageable amounts of waste and pollution. They agree that there is an urgent need to address environmental threats and their consequences for the future of humankind.

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The United Nations declared the period from 2005 to 2014 to be the Decade of Education for Sustainable Development. This was followed in September 2015 by the adoption of the 2030 Agenda for Sustainable Development, which includes a set of 17 Sustainable Development Goals (SDGs) (UN, 2016). South Africa is a signatory to these goals and needs to play its part in achieving them.

One way to do this is by means of educating young people on environmental-impact topics. Kyburz-Graber (2013) argues that education is essential in solving environmental problems. She states that environmental education was launched in many countries towards the latter part of the 1960s as a new demand in education systems in response to the growing fears about the degradation of the environment.

This paper examines the South African school curriculum, and, specifically, the inclusion of 'environmental-impact topics', that is, topics that cover negative effects on people or the environment. These may encompass rising levels of carbon dioxide in the atmosphere, global warming, the depletion of ozone in the atmosphere, deforestation, and improper waste disposal (see, for example, Rockström *et al.*, 2009).

One of the studies conducted in South Africa on the incorporation of environmental education in the curriculum (Togo, Zhou & Khan, 2015) noted that issues such as climate change are well covered in policy documents such as the 1995 *White Paper on Education and Training* (Ministry of Education, 1995), yet not much has been achieved in translating this into curriculum and teaching. According to the Department of Basic Education (DBE, 2016), the national curriculum aims to ensure that learners acquire and use knowledge and skills in ways that change their lives for the better. We would argue that this implies that the curriculum should promote knowledge in local contexts by integrating environmental education in all subjects taught in the school system. To fulfil this obligation, the curriculum must encourage respect for human rights, inclusivity, and environmental and social justice.

It is important that environmental-impact topics be sufficiently covered not only in curriculum documents, but also in examinations in order to instil the values of sustainable development in the minds, attitudes and behaviour of the youth (Hill, Alan & Woodland, 2006). Fundisa for Change (2013) highlights that many national curricula, such as South Africa's CAPS, are rich in environment and sustainability content where the subjects address aspects of sustainability. However, it is also necessary to analyse coverage in examinations. Birdsall (2013) argues that the infusion of environmental concepts into learning areas will be negatively impacted and the goal of education for sustainability will be compromised if there is low coverage of environmental themes in examinations.

In the interest of sustainable development and the alleviation of environmental problems, this research therefore aims at analysing environmental-impact topics in South Africa's FET curriculum and how they are examined. The FET curriculum forms the focus of this study because it is the final stage of schooling, at the end of which learners write the Grade 12 exit-level examinations that determine whether they can progress to tertiary education. The study investigates CAPS documents as well as examination papers set between 2012 and 2015 for the Grade 12 exit examinations. The policy documents and past examination question papers were sourced from the DBE's website (2016).

The analysis is based on three subjects: Life Sciences, Geography and Agricultural Sciences. These subjects were selected after initial data analysis of all 11 core subjects taught in Grade 12, which indicated that only three subjects showed environmental-impact topics coverage in both the policy and in the exit-level examinations. These subjects were then purposefully sampled for further analysis in this study. The paper adopts Margaret Archer's ideas as proposed in her work, *Realist Social Theory (RST): The morphogenetic approach* (1995), in order to evaluate the depth of the concept of environmental education in the selected subjects.

Environmental education and the school curriculum

While it may be widely accepted that environmental education has to be accommodated in the goals and structural organisation of schools, Stevenson (2007) notes that the critical enquiry and action orientation inherent in environmental education create a challenging task for schools. This challenge is at the root of the purpose of this paper.

Has educational change kept pace with developments in the global environment? There is a need for education to make people aware of their influence on nature and the consequent effects on their quality of life. Erdogan *et al.* (2012) argue that the increase in environmental problems and issues has resulted in global conferences and events focusing on a sustainable environment as well as in environmental-impact topics starting to be incorporated in school curricula. For example, environmental-impact topics are mandated in the current school policy in Serbia, which envisages that environmental education should be implemented through curricular, extra-curricular and after-school activities. According to Stanišić and Maksić (2014), environmental-education topics in the Serbian curriculum include the living and non-living aspects of nature and the impact of human activities on the environment.

Hill *et al.* (2006) pointed out that environmental education should not just blindly reproduce the current realities of living with nature, but should allow people to explore alternate realities, enable them to critically evaluate these realities, and help them to make informed decisions as to what the appropriate interaction with nature should be in their local context. On this aspect, Lotz-Sisitka (2013) remarks that environmental education curriculum research has been shaped and influenced by post-structuralism and critical realism.

The present study is an attempt to develop a better understanding of the way in which environmental education is incorporated, or not incorporated, in the South African FET curriculum, and is being approached from a related theoretical framework, which is outlined next.

Theoretical Framework

This paper adopts Archer's (1995) Realist Social Theory (RST) as a meta-theoretical framework. This explanatory theory seeks to understand the operations of social programmes by evaluating their operational successes and failures for various interest groups functioning in a particular context (De Souza, 2013). De Souza (2013) describes RST as a social theory focusing on how individuals and society are related and how the interactions between them might bring about or hinder change in the social context of interest. Young (2008) and Creswell (2011) explain that knowledge is socially produced and that it is dependent on social

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interests and the related dynamics of power as individuals seek understanding of the world in which they live and work. For example, students would interact with society by applying knowledge they have learnt in school through environmental education, and teachers would interpret the content of the curriculum they ought to teach in relation to their understanding of their work context, as reflected in examination papers.

Archer (1995) explains that the work on RST has generally been directed at explaining society and its transformation or reproduction. In order to describe and explain the mechanisms of the workings of a society, social realists have adopted certain terminology. Such terminology includes 'structure', 'culture', 'agency' and 'relations' (De Souza, 2013). In this paper, 'structure' refers to prevailing institutional structural conditions that can produce a particular outcome, such as the curriculum as it is actually taught. 'Culture' refers to dominant ideas or prevailing cultural conditions that can affect an individual's perception of what can or cannot be done in a social context, such as including certain forms of knowledge in a curriculum or excluding them from the curriculum. 'Agency' is related to beliefs and reasons that people use to justify actions they take, or do not take, such as policymakers and curriculum writers choosing what knowledge to include in the curriculum, and how to do so. The possible interaction of individuals with policy documents and examinations may result in a change of behaviour towards the environment. Extensive coverage of environmental-impact topics in the curriculum may shape a new culture of responding proactively to environmental issues.

The social reality that this paper deals with is the global environmental crisis as evident in such phenomena as depletion of the ozone layer, rising levels of carbon dioxide in the atmosphere, global warming, deforestation, and improper waste disposal. The development of a curriculum to respond to this reality should involve teachers and the development of resources such as books, journals, worksheets, and water or soil test kits (Schulze, 2014). From a realist perspective, the learner is actively learning through experiences in relation to the environment created by the curriculum and by teachers (Schulze, 2014).

The curriculum, as a structure, is influenced and created in a particular cultural setting by curriculum writers exercising agency in certain ways, either enabled or constrained by the curriculum and the policy environment surrounding it. Curriculum writers need to consider not just what environmental issues and topics are included or excluded. They also need to consider how to encourage and enable the teaching of critical thinking, as well as connections between learners' own views and those of environmentalists, thus encouraging learning and changes in knowledge about, and changes in behaviour towards, the environment.

Research Design and Methodology

Data was selected from the Grade 12 CAPS documents, teacher and learner support materials, and examination question papers in order to analyse the proportion of environmental-impact topics in the curriculum based on the structure of policy documents and examinations between 2012 and 2015. This period was chosen because it followed the introduction of CAPS to the FET band of schooling.

Sampling strategies and population

The sampling method was purposive. An initial analysis of all 11 core Grade 12 subjects revealed that environmental-impact topics occurred in both the policy documents and examination question papers for only three subjects: Life Sciences, Geography and Agricultural Sciences. These subjects were therefore selected. The questions papers were analysed for alignment with what the policy projected in terms of the proportion of coverage of environmental-impact topics. Three subject policy documents and 12 past examination questions papers (2012–2015) were analysed across the three subjects. In each subject, both Paper 1 and Paper 2 were analysed.

The following environmental issues, derived from Dreyer and Loubser (2014), were used to select data from the documents analysed: ozone depletion, global warming, energy consumption, acid rain, air pollution, marine pollution, mineral-resource depletion, soil destruction, soil erosion, desertification, biodiversity reduction, extinction of plants and animals, nuclear reactors and waste disposal, human health and diseases, world hunger, land use, solid-waste disposal, hazardous chemicals, habitat destruction, invasive species, water quality, and wildlife management. An environmental-impact topic was defined as any section, word or phrase having the characteristics of one of these environmental issues.

Data-analysis technique

The Grade 12 CAPS documents and examination papers were analysed to determine the extent of inclusion of environmental-impact topics. The data analysis used focused and indexical transcription in the compilation of the data. Hartas (2010) indicates that focused transcription is helpful when a researcher is interested in recording the ways in which a given discourse was produced. Indexical transcription involves creating an index of the points at which key occurrences are found within the data. Descriptive and analytical coding (Richards, 2005) were also used. This can be seen in Tables 1 and 2 and also Figures 1 and 2.

Results

We begin the results of the document analysis by showing the breadth of content coverage, and then comparing breadth coverage in the different subjects.

Life Sciences requires learners to focus on biodiversity, to understand life-support systems and processes, to master basic ecological principles, and to learn about environmental impacts (Fundisa for Change, 2013). The analysis of the examination papers for Life Sciences (see Table 1) showed that questions were asked on threats to biodiversity. Themes included: the culling of elephants that are damaging vegetation and threatening the human population in the Kruger National Park; spillage of toxic minerals such as copper, thereby causing land degradation; carbon monoxide emissions in the atmosphere; alien-plant invasion; the negative effects of crops; excessive fertilisation of soil; and food wastage (DBE, 2016).

Geography requires learners to understand climate change and changing weather patterns, sustainable-development principles and practices, urbanisation and land-use management and sustainability, the management of natural resources, including water, and solutions that will result in the production of less carbon energy (DBE, 2016). As shown in Table 2, Geography

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Table 1. Life Sciences Grade 12 results (2012 to 2015)

Policy document (1)	Environmental-impact topics found	Time allocation	Examination papers	Environmental-impact topics found
CAPS Life Sciences (http://www.education.gov.za/: visited August 2016)	(Revision of Grade 11 topics) Human impact on the environment (p. 51) Current crisis for human survival (p. 51) Problems to be solved within the next generation (p. 51)	2.5 weeks	2012 (DBE Life Sciences Grade 12 final paper: http://www.education.gov.za/: visited August 2016)	2012: Threats to biodiversity, culling of elephants that are damaging the Kruger National Park, and current crisis for human survival
			2013 (DBE Life Sciences Grade 12 final paper: http://www.education.gov.za/: visited August 2016)	2013: Carbon monoxide emissions, spillage of toxic minerals such as copper, and invasion by alien plants in the environment
			2014 (DBE Life Sciences Grade 12 final paper: http://www.education.gov.za/: visited August 2016)	2014: Global warming and negative effects on crops
			2015 (DBE Life Sciences Grade 12 final paper: http://www.education.gov.za/: visited August 2016)	2015: Illegal killing of wildlife, excessive fertilisation of soil, and food wastage

Table 2. Geography Grade 12 results (2012 to 2015)

Policy document (2)	Environmental-impact topics found	Time allocation	Examination papers	Environmental-impact topics found
CAPS Geography (http://www.education.gov.za/: visited August 2016)	Climate change and changing weather patterns, and sustainable-development principles and practices (p. 41) Urbanisation and land-use management and sustainability, management of natural resources, including water, and solutions for low carbon energy production (pp. 8, 9 and 45)	Not stated	2012 (DBE Geography Grade 12 final paper: http://www.education.gov.za/: visited August 2016)	2012: Impact of climate change, loss of biodiversity, land degradation, drought, river pollution and air pollution
			2013 (DBE Geography Grade 12 final paper: http://www.education.gov.za/: visited August 2016)	2013: Health hazards caused by mines, poverty, the negative impact of human activities on wildlife, and food security
			2014 (DBE Geography Grade 12 final paper: http://www.education.gov.za/: visited August 2016)	2014: Effects of berg winds on veld fires, and negative effects of overpopulation in urban areas
			2015 (DBE Geography Grade 12 final paper: http://www.education.gov.za/: viewed August 2016)	2015: Water pollution in the Vaal River, the environmental impact of cyclones, the high levels of pollution of the outskirts of towns, soil erosion, and overstocking

examinations included questions on such aspects as: the negative impact of climate change; loss of biodiversity; drought; river pollution; the effects of berg winds on veld fires; land degradation and health hazards caused by mines; the negative effects of overpopulation in urban areas; and effective farm management of riverbanks (DBE, 2016). Geography also examines poverty, the negative impact of human activities on wildlife, food security, the effects of soil erosion, the impact of cyclones, pollution, and the effects of overstocking of rivers and dams (DBE, 2016).

In Agricultural Sciences, learners are required to develop an awareness of the management and care of the environment and natural resources, as well as the humane treatment of animals, through the application of science and related technology (DBE, 2016). Agricultural Sciences also encourages learners to be informed and responsible citizens in the production of agricultural commodities, in caring for the environment, and in addressing social-justice issues (DBE, 2016). Table 3 shows that Agricultural Sciences examinations were limited to the effects of alien plants on the environment, the threats from climate change, and the effects on natural resources of overstocking with livestock.

Table 3. Agricultural Sciences Grade 12 results (2012 to 2015)

Policy document (3)	Environmental-impact topics found	Time allocation	Examination papers	Environmental-impact topics found
CAPS Agricultural Sciences (http://www.education.gov.za/: viewed August 2016)	The management and care of the environment and natural resources, as well as the humane treatment of animals, through the application of science and related technology (p. 13) Being informed and responsible citizens in the production of agricultural commodities, in caring for the environment, and in addressing social-justice issues (p. 13)	Not stated	2012 (DBE Agricultural Sciences Grade 12 final paper: http://www.education.gov.za/: visited August 2016)	2012: Threats from climate change (heat stress in pigs) and adverse environmental conditions
			2013 (DBE Agricultural Sciences Grade 12 final paper: http://www.education.gov.za/: visited August 2016)	2013: Effects of high temperature on animals
			2014 (DBE Agricultural Sciences Grade 12 final paper: http://www.education.gov.za/: visited August 2016)	2014: Farm management
			2015 (DBE Agricultural Sciences Grade 12 final paper: http://www.education.gov.za/: visited August 2016)	2015: The greenhouse effect and the risk to the environment of genetically modified plants

Breadth of content coverage

'Breadth of content coverage' in this paper refers to the number of environmental-impact topics found in the CAPS documents as well as in Grade 12 examination question papers for the subjects, Life Sciences, Geography and Agricultural Sciences, from 2012 to 2015 (see Table 4).

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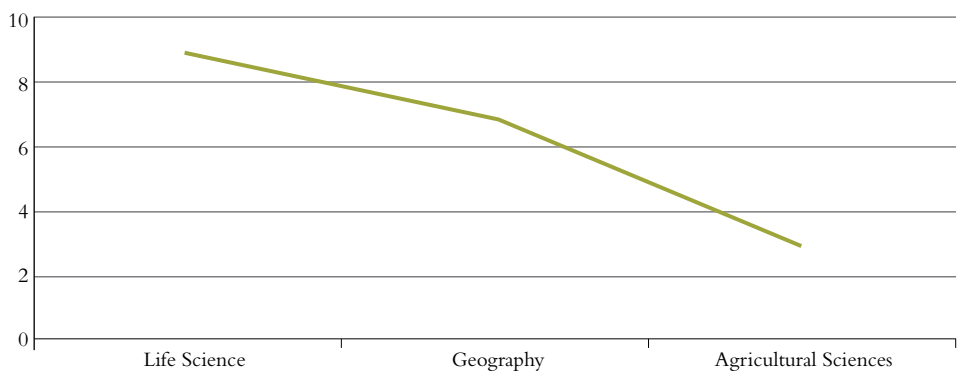
Table 4. CAPS document content coverage within three subjects in Grade 12

	CAPS documents		
	Life Sciences	**Geography**	**Agricultural Sciences**
Total number of curriculum topics	12	31	41
Total number of environmental-impact topics	1	3	1
Tuition time allocation for all the topics in the curriculum	28 weeks	27 weeks	29 weeks
Time allocation for environmental-impact topics	2.5 weeks	2 weeks	1 week
Percentage time allocation for environmental-impact topics	9%	7%	3%
Mark allocation for environmental-impact topics	25 marks out of 300	Not disclosed	Not disclosed
Percentage coverage in the examination of environmental-impact topics	8%	Not disclosed	Not disclosed

Table 4 shows that the subject policy documents contain only one environmental-impact topic in the Life Sciences, namely human impact on the environment and the sections thereof. Three topics appear in the Geography policy documents: the effects of soil erosion on people and the environment, the impact of coal mining, and the effects on the environment of using conventional energy. Only one relevant topic appeared in the Agricultural Sciences policy document, namely the effects of extensive farming on the environment.

Table 4 and Figure 1 show the extent (proportion) of coverage of environmental-impact topics in the CAPS documents for the three subjects selected for analysis. From Figure 1, it can be seen that Agricultural Sciences has the lowest coverage of environmental-impact topics, followed by Geography, and then Life Sciences, which has the largest proportion of environmental-impact topics. The proportion of environmental-impact topics in the CAPS documents varies. Of the three subjects analysed, Agricultural Sciences had the least coverage of environmental topics in terms of both time and content.

Figure 1. Percentage coverage of environmental-impact topics in three subjects



Proportion of content coverage in examinations

'Content coverage', here, refers to the proportion according to which environmental-impact topics in the CAPS curriculum are included in Grade 12 exit examinations in South Africa. In order to ascertain the depth of environmental themes in examinations papers from 2012 to 2015, percentages are compared against all other aspects covered in the examination paper using marks allocated for environmental-impact topics (as defined earlier).

Tables 5 and 6 and Figure 2 provide information on the comparison and depth of environmental-impact topics in the three subjects investigated. Figure 2 shows that Agricultural Sciences had the lowest percentage coverage in the examinations, in line with the CAPS document analysis above. Figure 2 also shows that Geography had the largest coverage of environmental-impact topics in 2012, 2014 and 2015. In 2013, Life Sciences recorded the largest coverage when compared with the other two subjects. It should be noted that, although Agricultural Sciences had few environmental-impact topics included, the number increased over the four years investigated. In contrast, the proportional coverage of environmental-impact topics in Life Sciences and Geography decreased from 2012.

Figure 2. Percentage coverage of environmental-impact topics in examination papers

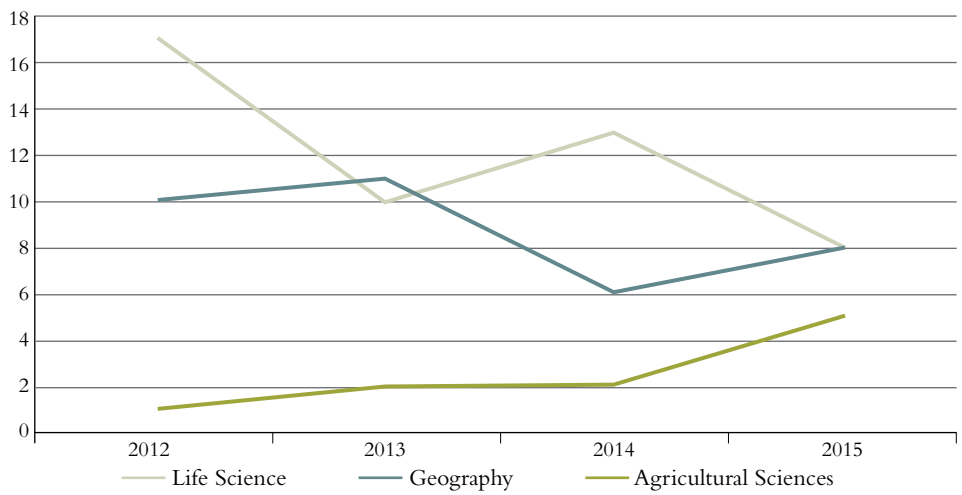


Table 5. Proportion of environmental-impact topics in examination papers (Life Sciences)

	Life Sciences			
Year	**2012**	**2013**	**2014**	**2015**
Marks allocated out of 300	31	33	19	23
Percentage coverage	10%	11%	6%	8%
Average percentage coverage	9%			

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Table 6. Proportion of environmental-impact topics in examination papers (Geography and Agricultural Sciences)

	Geography				Agricultural Sciences			
Year	**2012**	**2013**	**2014**	**2015**	**2012**	**2013**	**2014**	**2015**
Marks allocated out of 300	52	30	40	23	4	6	5	16
Percentage coverage	17%	10%	13%	8%	1%	2%	2%	5%
Average percentage coverage	12%				3%			

Discussion

The data shows the coverage and proportional coverage of environmental-impact topics for the three subjects in the CAPS document. The number of environmental-impact topics is compared with the total number of topics covered in the subject. In Life Sciences, only one environmental-impact topic is included in the Grade 12 subject policy document out of a total of 12 topics. Within this one environmental-impact topic, there are sub-topics covering human impact on the environment, the current crisis regarding human survival, and problems to be solved within the next generation. However, only 2.5 weeks out of 28 weeks are allocated for environmental-impact topics, which accounts for 9% of the time allocated to tuition.

In Geography and Agricultural Sciences, a total of 31 and 41 topics, respectively, are to be found, with three of these being environmental-impact topics in Geography, but only one being an environmental-impact topic in Agricultural Sciences. Environmental-impact topics constitute 7% and 3% in terms of time allocated for tuition purposes in Geography and Agricultural Sciences, respectively. The CAPS requirement for coverage of environmental-impact topics in Life Sciences, Geography and Agricultural Sciences is 9%, 7% and 3% of tuition time, respectively. These represent a low level of coverage of environmental education in the respective subject curricula, which is likely to constrain the development of a more pro-environmental culture among school learners.

The question that can now be asked is: To what extent are environmental-impact topics given attention in examinations?

The CAPS documents do not mention the Geography and Agricultural Sciences mark allocations for the actual final examination paper in Grade 12. However, the Life Sciences document indicates an average of 25 marks in a paper marked out of 300 (8%). Thus the Life Sciences policy document assists the examiners in knowing the specific proportion of environmental-impact topics that needs to be covered in the examinations. From this analysis, it is clear that Life Sciences is the subject where the most emphasis is placed on environmental-impact topics. If teachers and learners know there will be a summative assessment at the end of the year with questions on environmental-impact topics, they are likely to place emphasis on teaching and learning with regard to these topics. This may also lead to teachers and learners developing cultural values pertaining to the sustainable use of natural resources, as well as to the cascading of good environmental behaviour to communities. RST as a social theory

focuses on how individuals and society are related and how the interactions between them might bring about or hinder change in the social context of interest. Upon learning about environmental-impact topics, learners may be better able to become agents of change in relation to environmental sustainability.

The CAPS curriculum documents require 9% of the content of Life Sciences to be covered through the teaching of environmental-impact topics, and the results show that Life Sciences Grade 12 examinations indeed complied with the policy documents. Table 6 shows that Geography exceeded the 7% stipulated in the CAPS curriculum as shown in Table 4, with an average of 12% coverage in the Grade 12 examinations. The increased coverage of environmental-impact topics in the curriculum may well encourage teachers to continue teaching these topics, as they make up a significant percentage of the examinations at the end of the year. In Agricultural Sciences, there was an average of 3% allocated on the timetable, which is the same percentage as prescribed in the CAPS curriculum document.

The study found that the coverage of environmental-impact topics sometimes drops below the requirements of the policy documents. In Geography, for instance, there was a 9% drop in the marks allocated to environmental topics in the examinations between 2012 and 2015. This reduction of coverage in the examinations can have a negative effect on the way learners and teachers approach environmental content in the subject and could feasibly affect how they regard an environmental culture in the school as well as in society. Culture, according to RST, symbolises dominant ideas or prevailing cultural conditions that can affect an individual's perception of what can or cannot and should or should not be done in a social context. Where there is no alignment between policy coverage of environmental-impact topics with actual proportional coverage in the examinations, this may result in teachers being reluctant to emphasise such topics.

This paper argues that if teachers are going to be agents of change within school structures who act to change conversations and perceptions about environmental problems, they need to be supported by curricula that actively address environmental-impact topics consistently through the years. Consistency in the proportional coverage of environmental-impact topics in the curriculum, and alignment of the policy with actual practice in the examinations, would encourage pro-environment teaching practices, thereby enabling change in the culture of teaching environmental-impact topics. In the social realist analysis, the extent of the coverage of these topics in the examination papers may change the ways in which both teachers and learners focus on environmental-impact topics in their teaching and learning, both within and outside the classroom. A consistent presence of environmental-impact topics in the curriculum, and alignment in documents used by teachers and learners (such as past examination papers and textbooks) could encourage learners to act in order to address environmental issues.

In addition, teacher development is important. John, Mei and Guang (2013) suggest that, in order to successfully introduce a curriculum innovation such as environmental education, teachers need to be carefully and systematically prepared for, and guided during, such changes. For example, they could conduct impact research to support, monitor and

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evaluate the changes. Furthermore, there is a need for research and development projects to examine issues such as organisational capacity and curriculum integration. It is on this latter aspect that this study has aimed to make a contribution.

Conclusion

The results show that environmental-impact topics are indeed covered in South Africa's Grade 12 CAPS curriculum, but to varying degrees. The level of coverage of environmental-impact topics in the examination question papers also fluctuates, sometimes to levels below those stipulated in the CAPS documents. The variable coverage of environmental-impact topics in the examinations may have a negative effect on the way teachers address the topics in the classroom. This is based on the observation that teachers tend to focus on topics they regard as important in order to prepare learners for the end-of-year examinations. This paper argues that there can be more coverage of environmental-impact topics in some subjects, because there is much more in the policy compared with what is being offered with regard to examinations.

It is recommended that further studies be conducted to analyse the impact of environmental-impact topics in the curriculum, as well as to evaluate the extent to which the actual content that learners are exposed to is adequate in changing patterns of behaviour with respect to environmental issues. Furthermore, studies can be conducted to evaluate the actual practices of key agents such as teachers and other curriculum implementers. The final recommendation is that policy developers should ensure that coverage of environmental issues in textbooks and summative assessments are aligned with the policy documents.

Notes on the Contributor

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References

Archer, M.S. (1995). *Realist Social Theory: The morphogenetic approach*. New York: Cambridge University Press.

Birdsall, S. (2013). Reconstructing the relationship between science and education for sustainability: A proposal framework of learning. *International Journal of Environmental and Science Education*, 8, 451–478.

Creswell, J.W. (2011). *Qualitative inquiry and research design. Choosing among five approaches.* New Delhi: Sage.

DBE (Department of Basic Education). (2016). CAPS Curriculum. http://www.education.gov.za/Portals/0/CD/National%20Curriculum%20Statements%20and%20Vocational/CAPS%20FET%20_%20AGRICULTURAL%20SCIENCE%20_%20WEB_1CC4.pdf?ver=2015-01-27-153938-370, visited 8 June 2016.

De Souza, D.E. (2013). Elaborating the context-mechanism-outcome configuration (CMOc) on realist evaluation: A critical realist perspective. *SAGE*, 19(2), 141–154.

Dreyer, J. & Loubser, C. (2014). Curriculum development, teaching and learning for the environment. In C.P. Loubser (Ed.), Environmental education and education for sustainability. Some South African perspectives. Pretoria: Van Schaik. (pp. 145–175)

Erdogan, M., Bahar, M., Ozel, R., Erdas, E. & Usak, M. (2012). Environmental education in 2002 and 2006 early childhood curriculum. *Educational Sciences: Theory and Practice*, 12(4), 3259–3272.

Fundisa for Change Programme. (2013). *Introductory core text*. Grahamstown: Environmental Learning Research Centre, Rhodes University.

Hartas, D. (2010). *Educational research and inquiry: Qualitative and quantitative approaches*. London: Continuum International Publication Group.

Hill, J., Alan, T. & Woodland, W. (2006). *Sustainable development*. Hampshire: Ashgate.

John, L.C.K., Mei, W.S. & Guang, Y. (2013). Environmental education policies in three Chinese communities. In Stevenson *et al.* (Eds), *International handbook of research on environmental education*. New York: American Educational Research Association. (pp. 178–188)

Kyburz-Graber, R. (2013). Socioecological approaches to environmental education and research. In Stevenson *et al.* (Eds), *International handbook of research on environmental education*. New York: American Educational Research Association. (pp. 23–32)

Lotz-Sisitka, H. (2013). Curriculum research in environmental education. In Stevenson *et al.* (Eds), *International handbook of research on environmental education*. New York: American Educational Research Association. (pp. 191–193)

Ministry of Education. (1995). *White Paper on Education and Training. White Paper 1 of 1995*. Pretoria: Ministry of Education.

Richards, L. (2005). *Handling qualitative data*. Thousand Oaks: Sage.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, III, F.S., Lambin, E., … Foley, J. (2009). Planetary boundaries: Exploring the safe operating space for humanity. *Ecology and Society*, 14(2), 32. URL: http://www.ecologyandsociety.org/vol14/iss2/art32/.

Schulze, S. (2014). Paradigms, ethics and religion in environmental education. In C.P. Loubser (Ed.), *Environmental education and education for sustainability. Some South African perspectives.* (2nd edition). Pretoria: Van Schaik Publishers. (pp. 65–79)

Sitarz, D. (1994). *Agenda 21. The earth strategy to save our planet*. Boulder: Earth Press.

Stanišić, J. & Maksić, S. (2014). Environmental education in Serbian primary schools: Challenges and changes in curriculum, pedagogy, and teacher training. *The Journal of Environmental Education*, 45(2), 118–131.

Stevenson, K.R. (2007). Ten trends shaping school planning and design. National Clearinghouse for Educational Facilities. http://files.eric.ed.gov/fulltext/ED495952.pdf, visited 11 May 2016.

Togo, M., Zhou, L. & Khan, A. (2015). Climate change education in South Africa. In G. Nhamo & S. Shava (Eds), *Climate change education in the SADC school curriculum*. Pretoria: African Institute of South Africa.

UN (United Nations). (2016). *Sustainable Development Goals.* www.un.org, visited 20 March 2016.

Young, M. (2008). *Bringing knowledge back in from social constructivism to social realism in the sociology of education*. New York: Taylor & Francis.

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Perceptions of Climate Change among Grade 11 Learners in the Tshwane Metropolitan Municipality, South Africa

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Abstract

Of all the environmental problems facing humankind today, anthropogenic-induced climate change is regarded as one of the most damaging in its potential repercussions. For this reason, the perceptions of climate change among high-school learners, who represent future decision-makers and stand as a proxy for the next generation, are of importance. This study was designed so as to gain insight into the nature of perceptions and associated determinants among Grade 11 learners in the Tshwane metropolitan municipal area. Specifically, it probed dynamics between the content in the formal curriculum (Curriculum and Assessment Policy Statement or CAPS) and learners' exposure to electronic media, their peers and parents (their arenas of social interaction) in forming these perceptions. The study involved a qualitative analysis of 68 questionnaires completed by learners from two high schools. Findings include misconceptions regarding climate change among learners, as they conflate climate change and the greenhouse effect. The learners' perceptions seem to be shaped by the cumulative outcomes of dynamics between different arenas of exposure and influence (formal education, peers, parents and the media). It is argued that learners' perceptions about climate change fostered in formal education should also be understood in the context of their potential exposure to: (1) alarmist framings of climate change in the media; (2) conceptual disagreements in the climate change research community; and (3) the influence of peers and parents. Rather than avoiding the dynamics from contesting and diverging 'arenas of exposure', future climate change education planning should accommodate and align contending views that might influence the learning process.

Keywords: Climate change, school curriculum, learner perceptions, media, peers.

Introduction

Climate change is a worldwide issue that is discussed in print and electronic media, as well as on social media. In both the developed and developing world, there is an abundance of often contradictory information about this environmental problem from many different sources, most of which is inconsistent with scientific studies (Ho, 2009). At the same time, the local impacts of climate change, and the causal and consequential factors as well as coping strategies, are still not easy to fathom and comprehend. The way in which the science of

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climatology describes and explains this complex phenomenon, and the scientific viewpoints that differ when attempting to identify the causes and consequences of climate change, exacerbates chances of misunderstandings developing among the public and learners.

Boyes and Stanisstreet (2001), Boyes, Chuchran and Stanisstreet (1993), and Liarakou, Athanasiadis and Gavrilakis (2011), who conducted studies in the United Kingdom (UK) and Greece, argue that misunderstandings about climate change are a worldwide phenomenon. There have also been concerns in recent years that sections of the public appear to have lost faith in climate science and scientists, and that the public and experts may increasingly be diverging in their assessments about climate change. Vujovic (2013) observed a growth in public scepticism about climate change (however defined) since the late 2000s. This has been attributed to a range of factors, including climate fatigue, misleading media representations, the global financial crisis of 2008, and social attenuation of risk (Capstick, Whitmarsh, Poortinga, Pidgeon & Upham, 2015).

Vujovic (2013), for example, contends that the media have used sensationalism to draw the public's attention to climate change, resulting in many lay individuals forming extreme and alarmist perceptions of such change. In addition, the media's alarmist framing of climate change has resulted in individuals feeling overwhelmed by the magnitude of the issue (Swim *et al.*, 2009). As a consequence, some have become apathetic concerning climate change, believing that they cannot meaningfully contribute to mitigating the issue owing to its perceived severity and enormity (Swim *et al.*, 2009).

Teaching learners about climate change at all levels of formal education is a response designed to reduce misconceptions and levels of apathy in society (Anyanwu, Le Grange & Beets, 2015). Ojala (2015) contends that climate change education at primary- and secondary-school level has the potential to develop awareness and improve understanding of this important issue. Wibeck (2014:391) asserts that this approach tends to frame climate change education in terms of the 'information deficit model', which treats formal education as the remedy for public distrust and lack of interest in climate change.

To date, research conducted in South Africa on learners' knowledge and perceptions of climate change has concentrated on a range of issues regarding the dynamics between learners and the content of the learning material (Vujovic, 2013) and between learners' knowledge and the teacher's capacity and understanding (Anyanwu *et al.*, 2015). In this paper, it is argued that the nature of the perceptions or understanding of learners about climate change fostered in the formal education environment should also be understood in the context of their potential exposure to: (1) alarmist framings about climate change in the media; (2) conceptual disagreements in the climate change research community; and (3) the influences of their peers and parents. The main aim of this study is thus to establish how Grade 11 learners perceive and understand climate change, and then to try to unravel how these perceptions were formed, given learners' exposure to these different arenas of influence. The paper argues that learners' perceptions about climate change need to be understood as a cumulative outcome of contesting dynamics from diverging 'arenas of exposure'. This argument is aligned with the constructivist theory of learning as framed by Vygotsky, who emphasised that learning happens not only in the classroom context, but also through social interaction.

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Literature Review

While the introduction of the phenomenon of climate change in the formal education context is seen as an important remedy in eliminating misconceptions about, and apathy regarding, such change, research is, however, painting a fairly gloomy picture about the outcomes of the educational approach to climate change in formal education. Studies conducted in both developed and developing countries consistently find that young people still have misplaced views about climate change in the main. For example, learners think that air pollution and ozone depletion cause climate change, that reducing nuclear power diminishes global warming, or that the greenhouse effect causes skin cancer (Boyes & Stanisstreet, 2001; Boyes *et al.*, 1993; Liarakou *et al.*, 2011; Sherpadson, Niyogi, Choi & Charusombat, 2009). Learners also believe that global warming could be reduced by using unleaded petrol (Boyes & Stanisstreet, 2001).

The UNICEF 2011 report entitled, *Change through the eyes of a child: South African children speak about climate change*, presented findings from focus-group discussions with children aged 14 to 17 in KwaZulu-Natal and Limpopo. The report concluded that the children were generally aware of the future impacts of climate change – many of them indicated that they would probably have to deal with serious diseases as a result of climate change when they become doctors. The children anticipated some economic impacts that climate change might have and were also able to mention strategies that could be deployed to mitigate the impacts of climate change. However, the report also concluded that the children's actual understanding and perception of climatic change was still somewhat distorted. A Gauteng-based study conducted by Vujovic (2013) makes a compelling argument that the nature of perceptions and misconceptions about climate change among South African learners could be the result of 'inconsistencies, misconceptions and gaps in the knowledge and perceptions of the teachers who instruct the learners'. Vujovic (2013) concludes from her analysis of 32 semi-structured interviews with high-school geography teachers that the majority of the teachers had a correct understanding of climate change-induced risks, but only a few had deeper scientific knowledge and understanding of these risks. Anyanwu *et al.* (2015) argue that the success of climate education requires teachers who are fully literate as regards climate change science so that they can explain the concepts underlying the causes and impacts of, and solutions to, climate change as accurately as possible. Their study of the literacy of geography teachers in the Western Cape showed that the teachers they interviewed displayed a moderately higher level of climate change literacy, but that misconceptions in all three categories of climate change science, as represented in their survey instrument, were evident (Anyanwu *et al.*, 2015).

The physio-cultural milieu of learners also seems to affect their conception of climate change. Leftridge and James (1980), Bogner and Wiseman (1997), Ho (2009), and Pruneau, Gravel, Bourque and Langis (2003) all suggest that learners' physical closeness to a cultural environment (as in rural or urban settings) has a great impact on their environmental perceptions and attitudes, and on pro-environment behaviour in general. According to Bogner and Wiseman (1997), learners in rural milieus usually differ from those in urban milieus not only in their perception of the environment, but also in their behaviour and attitudes towards the environment. For example, 'while urban learners are more conservative and preservative

about environmental issues, rural learners are more exploitative towards the environment due to the nature of their livelihoods and demand for human utility of natural resources' (Bogner & Wiseman, 1997). Thus, if learners in different environments have different environmental views, they will perceive, understand and act differently concerning climate change, because one's immediate surroundings in which one might have lived since childhood usually influence one's perception of that place and of environmental issues in general (Ho, 2009; Lutz, Simpson-Housley & De Man, 1999).

It could thus be anticipated that Grade 11 learners would perceive and understand climate change differently within the context of their age cohort as a result of different locational contexts. Other influences could be access to electronic media, especially television and the Internet. Indeed, Boyes and Stanisstreet (2001) and Liarakou *et al.* (2011), who studied learners' ideas about climate change in the UK and Greece, respectively, argue that young people with an open culture characterised by the accessibility of electronic-media facilities and by good education, and who reside in urban areas, are better informed about climate change than those who reside in rural areas characterised (in these instances) by less access to electronic-media facilities and by inferior education. Young people within the same age cohort who had less access to media and who had experienced inferior education showed – although at a low occurrence level – comprehension of some scientific concepts related to climate change, such as the fact that carbon dioxide is a greenhouse gas. In contrast, those who had greater access to electronic-media facilities showed an understanding of complex issues, including concern for sustainability and the different alternative methods of conserving the environment (e.g. through energy-efficiency practices, recycling paper, and decreasing industrial and vehicular emissions) (Boyes & Stanisstreet, 2001). The reason advanced for this rural–urban dichotomy is that an open culture characterised by accessibility to media facilities encourages the acquisition of more knowledge, skills and values in matters relating to the environment (Boyes & Stanisstreet, 2001; Daniel, Stanisstreet & Boyes, 2004).

It is on the basis of these broader observations that a study was designed to establish whether or not Grade 11 learners in the City of Tshwane in South Africa perceive climate change differently as a result of exposure to differently configured arenas of influences (physio-cultural milieu, media, peers and parents).

Case Study: Two Schools in the Tshwane Metropolitan Area

The students sampled in this research project were all in Grade 11 in 2015 in the public-school system in Gauteng, South Africa. The study was conducted in the Tshwane Metropolitan Municipality (see Figure 1) and involved two high schools: Willowridge High School, which is situated in an urban area; and Wozanibone Secondary School, which is located in a peri-urban/rural area. Dividing education provision into rural or urban is problematic, since the criteria normally used (e.g. population density, provision of services, land use, employment, etc.) are ever-changing (Statistics South Africa, 2003). But, for the purposes of this paper, the rural–urban distinction is based on the distinction as applied by the Gauteng Department of Basic Education in which land use and nature of employment are defining characteristics. In the present case,

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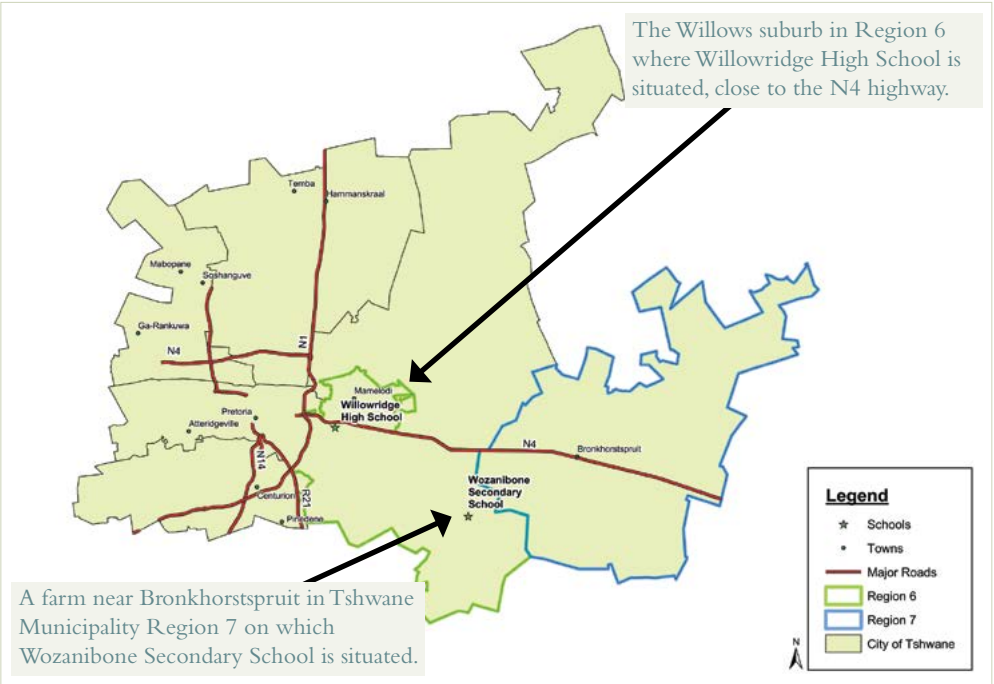
therefore, 'rural/peri-urban' refers to areas where land use is extensive and buildings are dispersed, whereas 'urban' refers to areas in which land use is intensive, with nucleated built-up areas.

The school curriculum in South Africa is standardised for the country as a whole, irrespective of whether residences are in urban or rural areas (excluding private schooling, which is not included here). Further, education in the country is unified around one curriculum policy called the Curriculum and Assessment Policy Statement (CAPS). According to the CAPS, by the end of Grade 5, learners are expected to know and explain: the difference between weather and climate; the different climates in South Africa; the climate of their own area; as well as factors that influence both of these systems, namely temperature, wind, air pressure and precipitation (South Africa, 2012). This is taught in Geography or Social Sciences, but also in Natural Sciences and Life Sciences subjects.

The study of weather and climate in the CAPS runs from Grade 5 through to Grade 11 at different levels, with the exception of Grade 7. In Grade 10, in particular, learners learn about: the impact of the greenhouse effect on people and the environment; global warming – evidence, causes and consequences, with reference to Africa; and the impact of climate change on Africa's environment and people, with reference to deserts, droughts, floods and rising sea levels. In Grade 11, learners learn about: Africa's weather and climate; Africa's climatic regions; subsidence and convergence, and the links to rainfall; the role of oceans in climate control in Africa; the El Niño and La Niña processes and their effects on Africa's climate; and reading and interpreting synoptic weather maps (South Africa, 2012).

Figure 1. Map of the areas where the two schools are located



Source: Department of Geography, Unit for Geoinformatics and Meteorology, University of Pretoria

From a total population of 2 400 learners in 2015, the researchers purposefully sampled 30 learners doing Geography in Grade 11 at Willowridge, and 50 learners doing Geography at Wozanibone. Among the subjects, Geography offers the greatest opportunity for understanding climate change concepts because of its emphasis on place, spatial processes, spatial distribution, society and the environment. Geography is taught as a subdiscipline of Social Sciences in Grades 4 to 9 of the General Education and Training band, and as a specific subject in the Further Education and Training band (Grades 10 to 12) (DBE/RSA, 2011). Of the 30 learners sampled at Willowridge, 25 participated, whereas 43 of the 50 learners sampled at Wozanibone participated.

Conceptual Framework

If we are to understand how learning takes place, especially with regard to complex environmental issues such as climate change, an appreciation of how learner perceptions are formed and of the associated epistemology or understanding of knowledge, is needed. The learning theory of social constructivism posits that learning is the construction of knowledge, and that learning can only take place within a context of social interaction characterised by culturally based beliefs that, for example, both the teacher and the learners bring to the classroom. Learners' perceptions about environmental issues stem, therefore, not from scientific, logical processes, but from social interaction with others. For Wibeck (2014), the social-constructivist perspective is the ideal learning theory to assist educators to help learners not only to perceive but also understand climate change. Social constructivism promotes the significance of culture and context in comprehending how society operates, thereby constructing knowledge (Palincsar, 1998). In other words, it is when one understands his or her culture and the immediate surroundings that one will be able to construct meanings in respect of the situations and, in the process, learn about reality (Kim, 2001; Wibeck, 2014).

Palincsar (1998) considers Lev Vygotsky to be the key proponent of social constructivism and its perspective on the role of socio-cultural processes as a mechanism for learning. According to Vygotsky, as elucidated by Palincsar (1998), social interaction plays a fundamental role in the process of cognitive development, a process in which development is believed not to precede learning but rather that learning (and, specifically, social learning) precedes development. In other words, a child's cultural, cognitive development appears twice: first on the social level and, later, on the individual level, that is, first between people and then later inside the child. Therefore, individual development, including higher mental functioning, has its origins in social sources (e.g. interaction with peers, parents and the media).

According to Kim (2001), social constructivism emphasises the importance of culture and context in understanding what occurs in society and in constructing knowledge based on this understanding. Social constructivism, therefore, 'generally regards learning as the appropriation of socially derived forms of knowledge that are not simply internalised over time but are also transformed in idiosyncratic ways in the appropriation process' (Palincsar, 1998:365). Whitmarsh (2011:59) contends that 'there has been a shift away from seeing scientific literacy as defined by knowledge of abstract scientific 'facts', towards investigating the contextual meanings of science applied in everyday life'. There is some debate about how much the context in which learning

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takes place matters and about the variety of ways in which we can make sense of the world, based on what we already understand (Wibeck, 2014). Nonetheless, we can conclude that there is a need for anyone looking to facilitate learning to consider the communicative context for climate change education, and also to explore learners' already existing perceptions of climate change (Wibeck, 2014). From the social-constructivist perspective, it is thus anticipated that Grade 11 learners, while in the formal education system, are also exposed to influences arising from (1) alarmist media framings of climate change; (2) conceptual disagreements in the climate change research community; and (3) their peers and parents – all of which serve in 'constructing' their understanding of, and ideas about, climate change.

Methodology

The study is exploratory and descriptive in nature. Findings are not purported to be confirmatory. Instead, the researchers hope to contribute to conversations about climate change education based on the findings from this small sample of learners. To this end, semi-structured questionnaires consisting of both closed-ended questions (to assess factual and conceptual understanding) and open-ended questions were administered to 68 learners at the two schools concerned.

The following assumptions informed the research design: (1) that the quality of teaching at the two study sites might differ; (2) that the number of learners in class could influence learning outcomes; and (3) that socio-economic differences between the two schools would influence not only the knowledge of the learners but also their inclination towards translating awareness into action and behaviour.

Data collection and analysis

Since any study of education inevitably entails ethical considerations, especially if children are involved, ethical issues such as the following were identified and considered during the planning and other stages of the present study: protecting privacy and confidentiality; harm and risk; honesty and trust; ownership of data; and the offering of reciprocity where possible (Hammersley & Traianou, 2012; Shenton, 2004). A request for permission to conduct research in the two schools was submitted to the Gauteng Department of Education, which granted approval. Such request was also submitted to the principals and the school governing bodies of the two participating schools, and, after initial approval by them, the parents/guardians of the learners sampled were also asked for permission to interview learners. All respondents, including the teachers, signed a letter of informed consent agreeing to help with the study. Questionnaires were numbered, rather than named, to protect the identity of the learners. Learners, teachers and parents were reminded that participation was completely voluntary.

The questionnaires were handed out to the learners in the first term of the 2015 academic year. It should be noted that the Grade 11 learners would have done much of the climate change work in the previous year, as per the CAPS curriculum for Grade 10. Before the interviews were conducted, the researchers confirmed with the teachers that the learning units covering the climate change content had already been covered for the Grade 11 academic year.

The first part of the questionnaire generated a profile consisting of answers to general demographic questions. Here, the learners were also asked about their 'social-interaction' networks. This included the type and the frequency of conversations learners would have with parents and peers about socially or environmentally relevant issues. The learners were also probed about their exposure to media sources, the nature of the content they would browse, the time they would spend reading environmentally related content, and the types of programmes they would watch on TV or download from the Internet. Learners were also asked whether they read newspapers and which parts of the newspapers they would read.

The second part of the questionnaire sought to gain insights regarding the knowledgeability of the learners. A range of questions was adapted from existing climate change literacy questionnaires (e.g. Anyanwu *et al.*, 2015) in order to assess the learners' knowledge and understanding of basic concepts and terminology associated with climate change, specifically: (1) how climate change happens; (2) what the natural causes of climate change are; (3) the human activities that exacerbate the climate change process; and (4) what the enhanced greenhouse effect is. For the factual components, learners' responses were awarded a mark out of 20 (2 marks for each correct response).

The next part of the questionnaire dealt with conceptual items, that is, it assessed the learner's understanding of the processes and causes, impacts and solutions related to addressing climate change. For this part of the questionnaire, learners were also awarded a mark out of 20 (2 marks for a correct response). Procedural items assessed the learner's awareness of methods for solving problems relating to climate change. This part of the questionnaire was assessed by means of open-ended questions, and, here, a mark out of 20 was allocated to the thinking and application processes the learners were able to display.

The final section of the question paper asked learners about their personal perceptions concerning climate change – its causes, impacts and potential solution. These questions were carefully framed to try to gain perspective on learners' underlying thoughts/feelings (here called perceptions) about what they had been taught. This part was analysed by means of thematic coding and content analysis geared to flagging articulations that could represent perceptions/feelings of 'apathy' or 'despondence' on the hand, compared with articulations reflecting 'optimism' and 'confidence' about humankind's prospects of achieving solutions for climate change-related problems, as well as their own role in achieving these outcomes, on the other. Learners who displayed a level of reasonable optimism and confidence were awarded the full ten marks. Those who expressed disinterest or apathy were awarded a mark of zero, with a mark of five being awarded in instances where the learners' perception of future prospects seemed a bit more 'mixed'. Each of the questionnaires thus received a final score out of 70.

Once the marks were allocated for the questionnaires, subgroupings were identified. Learners who obtained fairly low scores ranging between 0 and 34 were labelled as the grouping with a 'low climate change literacy'; learners who scored between 35 and 50 were deemed to have 'moderate climate change literacy'; and learners who scored between 51 and 70 were regarded as respondents with 'high climate change literacy'. Once the subgroupings were identified, the demographic and other determinants were identified for key trends in describing these subgroupings. Before unpacking the results, the following section provides a short, descriptive overview of the profile of the respondents involved in this study.

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Respondents' profile

The Grade 11 learners generally ranged in age from 15 to 18 years. Table 1 indicates that the majority of the learners involved in the study were 17 years old. Moreover, the majority (58%) of the respondents were male. Willowridge had more male respondents (66.7%) than Wozanibone (45.5%).

Willowridge also had a higher proportion of younger learners when compared with Wozanibone. It was noted during the interviews that nine learners (27%) from Wozanibone were repeating their grade. This could account for the differences in the age groups between the two schools. The reasons for this could be that, in urban areas, which is where Willowridge is situated, most if not all learners finish school without interruptions, whereas in peri-urban areas, which is where Wozanibone is situated and which comprise predominantly farmland, many learners do not finish school. In fact, some start school when they have already past school-going age. In these farming communities, learners' school programmes are interrupted more often due to the need to look for work in order to supplement or generate household income. Such learners then return to school some years later, if at all.

In terms of race, black learners formed the majority of the respondents from both schools. The respondent profile for Wozanibone was more homogenous, consisting of 3.1% Coloured and 96.9% black learners. Willowridge had a more mixed profile of 18.8% white learners, 75% black learners, 4.2% Coloured learners, and 2% Indian learners.

Table 1. Respondents' profile, with socio-economic status estimated based on devices and amenities

Variables	Wozanibone Secondary School		Willowridge Secondary School	
	Number of learners	Percentage (%)	Number of learners	Percentage (%)
Gender				
Male	15	45.5	32	66.7
Female	18	54.5	16	33.3
Age group				
15–17	11	33.3	38	79.2
18–20	15	45.5	8	16.7
20+	4	12.1	0	0
Unknown	3	9.1	2	4.1
Race				
Black	32	96.9	36	75
Coloured	1	3.1	2	4.2
White	0	0	9	18.8
Indian	0	0	1	2
Socio-economic status				
Low-income	22	66.7	7	14.6
Middle-income	7	21.1	8	16.7
High-income	2	6.1	28	58.3
Unknown	2	6.1	5	10.4

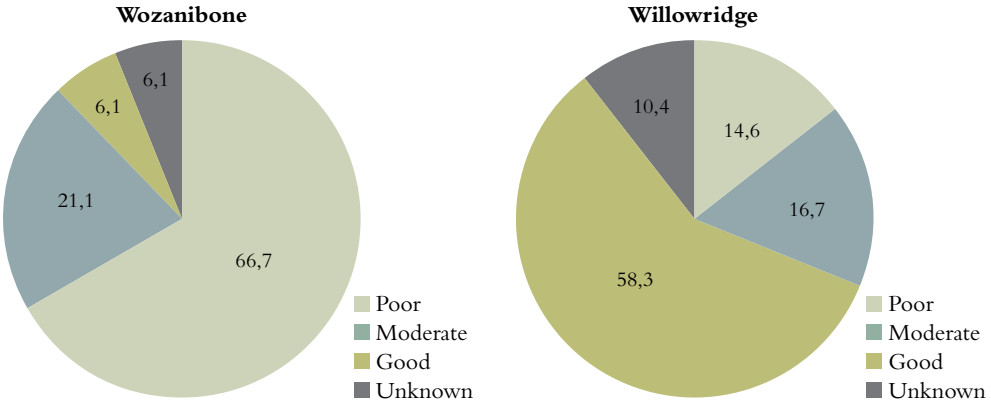
To gain a sound understanding of the profile of the respondents, their access to, and use of, electronic-media devices were also quantified, with the following 'ranking' system being used to distinguish between learners with 'good', 'moderate' and 'poor' access to electronic devices. The number of devices and electronic amenities the learner had access to at home was also given a score to stand as proxy for the 'socio-economic' status of the learner's household. Table 2 provides a summary of the calculations used to rank the learners' 'socio-economic income status' (indicated in Table 1) and their level of 'access to electronic media'.

Table 2. Ranking system for quantifying electronic-media use among the Grade 11 learners

Mobile phone	**Score**	**Actual score**	**Access to electronic media**	
Ordinary mobile	1	(Score allocated for each device)	1–3	Poor
Mobile with some applications	2			
Mobile with all applications	3			
Television	**Score**	**Actual score**	4–6	Moderate
TV set at home	1	(Score allocated to stand as proxy for the socio-economic income status of the learner)		
TV with satellite dish	2			
Computer at home	3		5–6	Good
Computer with printer	4			
Computer with Internet service	5			

The study also sought to identify learners' access to electronic media. The two charts in Figure 2 show the level of access to electronic media based on the calculations detailed in Table 2. Figure 2 shows that the level of access to media in Wozanibone is quite poor when compared with that of Willowridge.

Figure 2. Level of access to electronic media in Wozanibone and Willowridge



Learners were mostly exposed to electronic media such as mobile phones, television sets and computers. Respondents from Willowridge had a high level of access to electronic media but were not necessarily inclined to read articles related to climate change or the environment.

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A small percentage (22%) of the total number of learners from both Willowridge and Wozanibone did, however, indicate that they (1) streamed climate- and environment-related media, and (2) talked to their peers and parents about environmental issues.

Table 3 provides a short summary of the key differences found between the two schools, thereby providing important background information for the analysis of the data.

Table 3. Determinants of climate change perception

	City of Tshwane Region 7 (predominantly rural)	**City of Tshwane Region 6 (Urban)**
	Wozanibone Secondary School	**Willowridge High School**
1. Class size	Grade 11 in 2015	Grade 11 in 2015
	50 learners in 1 class	50 learners in 2 classes
2. Socio-economic conditions	Low population density; low education levels; high unemployment (26% of individuals were unemployed); income from farming activities; about 22% of dwelling units were informal. (City of Tshwane, 2014)	High population density; high education levels; high unemployment (22% of individuals were unemployed); income from tertiary and quaternary activities; about 22% of dwelling units were informal. (City of Tshwane, 2014)
3. Electronic media	Not all respondents owned smartphones. Of the sampled respondents, 33% had their TVs connected to a satellite dish. Only 23% had access to computers at home, but these were not connected to any Internet service. Poor access to electronic media.	While all respondents sampled owned smartphones and computers (with Internet service) at home, not all had their TVs connected to a satellite dish. Respondents had adequate access to electronic media.
4. Subject combination	• 2 languages • Geography/Business Studies/ History • Physical Sciences/Accounting/ CAT • Life Sciences/Economics/ Tourism • Mathematics/Mathematical Literacy • Life Orientation (LO)	• 2 languages • Geography/Accounting • Physical Sciences/Business Studies • Life Sciences/Economics • Mathematics/Mathematical Literacy (or vice versa) • Life Orientation (LO)

Results

This section provides a summary of the key findings resulting from the research. As far as possible, the data was disaggregated and correlated with the learners' age, race and gender. The association between race and the scores obtained by learners was inconclusive, especially since

the majority of the sample consisted of black learners. However, the level of association between the gender of the learners and the scores obtained by them was quite revealing.

Figure 3 shows that females from both schools generally scored higher than their male counterparts in terms of the climate literacy criteria used in this study. Even more interestingly, when looking at the browsing activities of the learners (Figure 4), it is noted that female learners were more likely than male learners to read articles on climate change and the environment.

Figure 3. Average score of learners by gender (percentage)

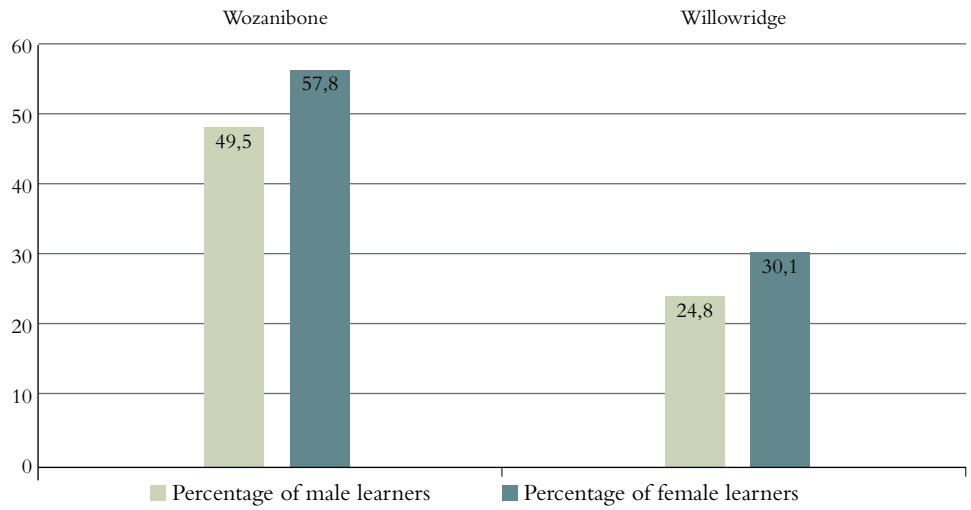
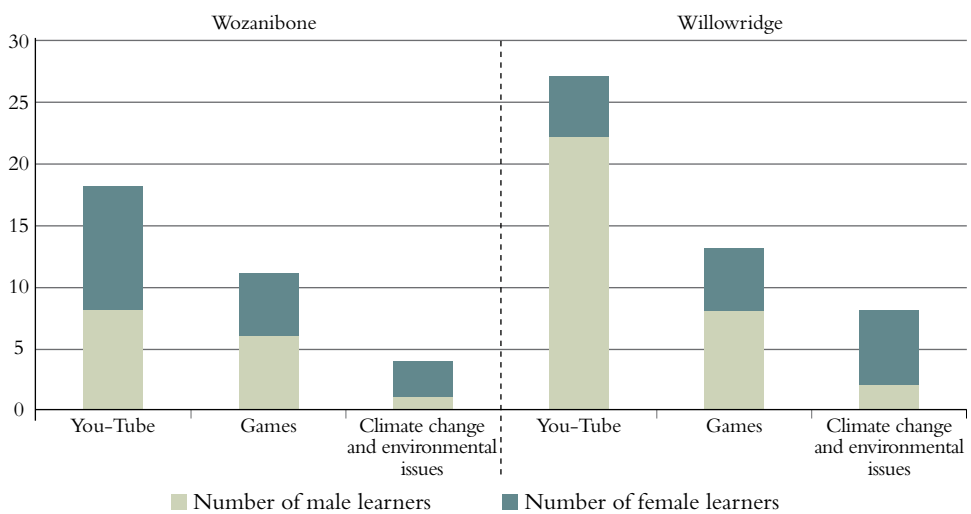


Figure 4. Browsing interests of learners



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The strong association depicted in Figure 4 between the learners' exposure to electronic media and their scores (performance) hints at the potential importance of exposure to media as an avenue of influence in learners' perceptions and understanding of climate change. In this instance, the nature of the content being browsed is also of key importance: the results show that access to media is not automatically translating into higher levels of climate change literacy. Although learners from Willowridge all had access to cell phones, they reported not normally streaming clips or articles on climate change and the environment.

Knowledge of greenhouse gases, the greenhouse effect and global warming

The majority of the respondents who knew what the greenhouse effect and greenhouse gases are, and who also understood the connection between greenhouse gases and climate change, were from the peri-urban school, Wozanibone (83%). Only 33% of the learners from the urban school, Willowridge, performed well in this part of the questionnaire, which largely required rote responses with regard to acquired content knowledge. While the learners seemed aware of the relationship between greenhouse gases and global warming (see Table 4), they tended to confuse the greenhouse effect with climate change. Some suggested that cigarette smoke also contributes to the greenhouse effect and to climate change.

Conceptualisation and application of climate change knowledge

Learners were also asked to explain the linkages between natural and human activities in both causing and mitigating climatic variation, how causing such variation could entrench climate change impacts even further, and how a warming climate might influence farming, the oceans, the biomes and people's health (conceptualisation questions). This required a bit more application of knowledge and, in this instance, the urban learners tended to outperform their peri-urban counterparts in that they were better able to reflect the linkages between various processes and the impacts of climate change. In this case, 83% of the learners at the urban school, compared with 50% of the learners at the peri-urban school, depicted these linkages fairly accurately.

With regard to the ability to depict their understanding of climate change graphically, only 40% of the learners from the urban school and 39% of the learners in the peri-urban school were able to draw fairly accurate graphic representations of climate change. It was also noted that the representations by 60% of the total number of learners seemed to conflate climate change and global warming, with many of the learners actually drawing the process of global warming.

By means of two open-ended questions, the procedural items assessed the learners' own understanding of suitable responses to climate change. A mark out of 20 was allocated to the thinking and application processes that the learners displayed. Only 28% of the urban-based learners and 16% of the learners in the rural/peri-urban context performed well in this part of the questionnaire.

Interestingly, during the initial analysis of the data, it seemed as if 100% of the rural/peri-urban learners had a firm grasp of suitable methods for solving problems related to climate change. But, in a second round of analysis, the responses were weighed more critically and

Table 4. Summary of results

		Wozanibone (peri-urban)	Willowridge (urban)
Reproduction of factual content	Knowledge of the greenhouse effect and of global warming	Of the sampled respondents, 83% showed a good understanding of the greenhouse effect and of global warming.	Of the sampled respondents, 33% showed a good understanding of the greenhouse effect and of global warming.
	Knowledge of the sources of greenhouse gases and of their contributions to global warming	Of the sampled respondents, 100% showed a good understanding of the sources of greenhouse gases and of their contributions to global warming.	Of the sampled respondents, 33% showed a good understanding of the sources of greenhouse gases and of their contributions to global warming.
	Knowledge of the effects of excessive CO^2 and of climate change in general	Of the sampled respondents, 50% showed a good understanding of climate change.	Of the sampled respondents, 16% showed a good understanding of climate change.
Conceptualisation	Knowledge of the causes and effects of climate change (i.e. understanding of the linkages)	Of the sampled respondents, 50% showed a good understanding of the causes and effects of climate change.	Of the sampled respondents, 83% showed a good understanding of the causes and effects of climate change.
Application ability of respondents	Ability to depict climate change graphically	Only 39% of the sampled respondents were able to illustrate their understanding of climate change.	Of the sampled respondents, 44% were able to illustrate their understanding of climate change.
Procedural ability	Knowledge of possible solutions	Of the sampled respondents, 16% showed a good understanding of possible strategies to curb climate change.	Of the sampled respondents, 28% showed a good understanding of possible strategies to curb climate change.

judged to be variations of the same wording used to articulate recommended responses to climate change. This suggested to us that the learners in the peri-urban context were merely reproducing recommendations as presented by the teacher when she introduced the concepts to them. This was confirmed when we verified that the recommendations provided by the rural/peri-urban learners were also listed in the CAPS material. By contrast, the responses

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of the urban-based learners revealed attempts at demonstrating their own interpretation of the CAPS content by trying to draw on their own lived experiences. We decided to discount the responses which merely reproduced the conceptualisations framed by the teacher and the CAPS material, as this part of the questionnaire was aimed at gaining insights into the ability of the learners to translate new knowledge into practical application.

The surprisingly poor performance of the urban learners was also explained by the high number of non-responses (n = 10) in this part of the questionnaire. It would seem that, when the urban learners encountered the question, '*What recommendations would you make to combat climate change-related challenges?*', they rightly assumed that they were expected to come up with their own recommendations, but were then unable to provide an answer. This was confirmed by one of the respondents asking why they were not allowed to google the answer to this question.

Learners' perceptions of climate change

As already mentioned, once a score was allocated for each of the questionnaires, subgroupings were identified. These are presented in Table 5.

Table 5. Climate change literacy and perception

	Wozanibone	**Willowridge**
'High climate change literacy'	7 (16.2%)	7 (28%)
'Moderate climate change literacy'	26 (60.4%)	15 (60%)
'Low climate change literacy'	10 (23.2%)	3 (12%)
Total	**N = 43**	**N = 25**

Willowridge performed slightly better in terms of the number of learners in the 'high climate change literacy' segment, with 28% of its respondents falling into this subgroup, compared with 16% of the learners from Wozanibone (seven learners in each school). It is interesting to note that all 14 learners in this subgroup mentioned that they would download climate- and environment-related articles and information booklets. They also mentioned their excitement about talking to others (peers and parents) about their passion for the environment and that they enjoyed learning about environmental matters in the class context. They generally also articulated their perceptions of climate change and their role in mitigating its impacts in a fairly positive tone. The respondents used framing such as '*We are empowered*', '*We have the technology to solve this problem*', '*It is up to our generation*', '*We should care*'. So, interestingly, these respondents generally had high climate change literacy scores, despite the possibility that they might have read about misconceptions and disagreements in the media.

An assumption underlying the study was that the physio-cultural milieu of learners (as detailed in Table 3) would affect their perceptions of climate change. The conjecture was that, in peri-urban contexts where class sizes are bigger and resources might be more restricted, with lower levels of access to electronic media, learners would show lower levels of climate change literacy, resulting in ill-informed notions and perceptions of climate change. From the results obtained, however, the performance of the learners in both schools seems to cluster in the 'moderate climate change literacy' segment (with both schools being in the 60% range). In this subgroup, only a small

portion of the learners mentioned that they would download or read additional information on the environment or climate change. In addition, they rarely talked to their peers or parents about contemporary societal issues and generally did not enjoy class participation or discussions regarding these matters. The level of 'apathy' and disinterest is quite evident among this grouping of learners. Four of these learners made statements basically engendering fear about climate change. One respondent reflected: '*They don't really seem to know what is going on… . There is so much [disagreement] amongst these scientists… . How must I know what to do, or my role in it? They need to figure things out first*'. Another wrote: '*Well we will be dying in any case, right? Either from drought or heat or new diseases!*'

Finally, the 'low climate literacy' segment comprised learners who admitted to complete disinterest in the topic. Their perceptions regarding climate change and its impacts signalled a clear message of apathy and disconnect. Responses ranged from '*I really don't care*' to '*Who cares*'. One respondent wrote: '*I would never waste valuable data on downloading stuff about the environment. I am not crazy.*'

Discussion

The study found that the Grade 11 Geography learners were aware of climate change and had knowledge of it, but misconceptions did occur. More than 60% of all the respondents (in both schools) had misconceptions about the occurrence of climate change. For example, learners thought that ozone-layer depletion, cigarette smoking and air pollution exacerbated climate change, and that unleaded petrol also contributed to global warming. More than 60% of the respondents indicated that an increase in temperature would be a consistent phenomenon manifesting itself uniformly over the planet, with all areas of the land surface becoming drier and unsuitable for farming. There were also misconceptions directly linking ozone-layer depletion and climate variability. In the graphic representations, the learners' conflation of greenhouse impacts and climate change impacts was informative, especially when a teacher explained that a sequential approach is used in the curriculum and that the students tend to remember only the graphic representation of the greenhouse gas effect.

The results were actually contrary to what we had expected to find. We had anticipated that the learners from the better-equipped (urban) school, where learners were in smaller classes and had greater access to electronic media, would have higher 'knowledgeability' scores on all aspects. This finding should, of course, be contextualised, as the study is in no way confirmatory of any representative sample. But the learners from the peri-urban school did perform better in answering questions on climate change that required the reproduction of facts taught in the formal curriculum. When it came to the conceptualisation questions, which are also covered in the curriculum but demand a bit more application, the learners in the urban context did in fact outperform their peri-urban counterparts: 83% of learners in the urban school performed well, while only 50% of learners in the peri-urban school also did well in these questions. When it came to knowledge of processes, or what could be done about climate change, the peri-urban learners far outperformed the urban learners. A mere 16% of the urban learners were able to perform well in the section of the questionnaire dealing with solutions to climate change and what they themselves could do.

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Since all the learners were exposed to the same content, one then needs to consider contextual factors such as the teaching methods used by different teachers, or, as in this study, the learners' interactions with peers, parents and electronic media. The findings suggest that greater access to electronic media did not always result in a greater understanding of the solutions to climate change. The urban learners had greater access to media, and were somewhat better than the rural learners at articulating their own solutions to climate change, but still struggled to answer the question (resulting in a 28% score as against 16%). When probed about the reasons for their relatively poor performance, one of the urban learners asked why they had not been allowed to google mitigation strategies.

The content covered in formal schooling is clearly important, but the relatively small group of learners who outperformed everybody else were those who, in addition to the information they received at school, 'constructed' their perception and understanding of climate change through their social interaction with peers, parents and electronic media. The research thus highlights the embedded nature of learners who are also exposed to different arenas of influence such as the media, parents and peers, ultimately helping them to shape their perceptions and understanding of climatic processes and to develop a positive sense of agency to address these.

Conclusion

In this paper, it has been argued that the nature of the perceptions or understanding of learners regarding climate change fostered in the formal education environment should also be understood in the context of their potential exposure to: (1) alarmist framings about climate change in the media; (2) conceptual disagreements among members in the climate change research community; and (3) the influences of their peers and parents. The study demonstrated that learners in the same education context constructed their learning and perceptions differently. The paper argued that learners' perceptions of climate change also need to be understood as a cumulative outcome of contesting dynamics from these diverging 'arenas of exposure' and, instead of avoiding this, future climate change education planning should make proactive attempts to align and accommodate contending views that might influence the learning process.

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References

Anyanwu, R., Le Grange, L. & Beets, P. (2015). Climate change science: The literacy of geography teachers in the Western Cape province, South Africa. *South African Journal of Education*, 35(3), 1–9.

Bogner, F.X. & Wiseman, M. (1997). Environmental perception of rural and urban pupils. *Journal of Environmental Psychology*, 17(2), 111–122.

Boyes, E., Chuchran, D. & Stanisstreet, M. (1993). How do high school students perceive global climate change; what are its manifestations, what are its origins? What corrective action can be taken? *Journal of Science Education and Technology*, 2(4), 541–557.

Boyes, E. & Stanisstreet, M. (2001). Plus ca change, plus c'est la meme chose? School students' ideas about the 'greenhouse effect' a decade on. *Canadian Journal of Environmental Education*, 6(1), 77–101.

Capstick, S., Whitmarsh, L., Poortinga, W., Pidgeon, N. & Upham, P. (2015). International trends in public perceptions of climate change over the past quarter century. *WIREs Climate Change*, 6, 35–61. doi:10.1002/wcc.321.

City of Tshwane. (2014). City of Tshwane: Regional integrated development plan (2014-2015). Retrieved from www.tshwane.gov.za, visited on 25 May 2017.

Daniel, B., Stanisstreet, M. & Boyes, E. (2004). How can we best reduce global warming? School students' ideas and misconceptions. *International Journal of Environmental Studies*, 61(2), 211–222.

Hammersley, M. & Traianou, A. (2012). Ethics and educational research. British Educational Research Association. https://www.bera.ac.uk/researchers-resources/publications/ethics-and-educational-research.

Ho, E. (2009). Children's ideas about climate change. Doctoral thesis, Department of Geography and Collaborative Program in Environmental Studies, University of Toronto.

Kim. (2001). Social Constructivism. In M. Orey (Ed.). *Emerging perspectives on learning, teaching and technology*. Retrieved from www.http://epltt.coe.uga.edu, visited on 13 June 2017.

Kollmuss, A. & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behaviour? *Environmental Education Research*, 8(3), 239–260.

Leftridge, A. & James, R.K. (1980). A study of the perceptions of environmental issues of urban and rural high school students. *Journal of Environmental Education*, 12(1), 3–7.

Liarakou, G., Athanasiadis, I. & Gavrilakis, C. (2011). What Greek secondary school students believe about climate change? *Internal Journal of Environmental & Science Education*, 6(1), 79–98.

Lotz-Sisitka, H. (2009). Sigtuna think piece 8: Piecing together conceptual framings for climate change education research in Southern African contexts. *Southern African Journal of Environmental Education*, 26, 81–92.

Lutz, A.R., Simpson-Housley, P. & De Man, A.F. (1999). Wilderness: Rural and urban attitudes and perceptions. *Environment and Behavior*, 31(2), 259–266.

Ojala, M. (2015). Climate change scepticism among adolescents. *Journal of Youth Studies.* http://dx.doi.org/10.1080/13676261.2015.1020927.

ISSN 2411-5959 | DOI 10.4314/sajee.v.33i1.5

Palincsar, A.S. (1998). Social constructivist perspectives on teaching and learning. Educational studies. *Annual Review of Psychology*, 49, 345–375.

Palinkas, L.A., Horwitz, S.M., Green, C.A., Wisdom, J.P., Duan, N. & Hoagwood, K. (2013). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health*, 42(5), 533–544.

Pruneau, D., Gravel, H., Bourque, W. & Langis, J. (2003). Experimentation with a socio-constructivist process for climate change. *Environmental Education Research*, 9(4), 429–446.

Pruneau, D., Khattabi, A. & Demers, M. (2008). Educating and communicating about climate change – challenges and possibilities. *Project ACCMA*.

Shahadu, H. (2012). Youth understanding of climate: Towards a theory of social adaptation to climate change in Africa. Masters dissertation, Department of Media and Communications, London School of Economics and Political Science.

Shenton. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, 22, 63–75.

Shepardson, D.P., Niyogi, D., Choi, S. & Charusombat, U. (2009). *Student conception about global warming and climate change.* National Science Foundation, Purdue University.

South Africa (Government of the Republic of South Africa). (2011). *The National Development Plan (NDP)*. Pretoria.

South Africa (Government of the Republic of South Africa). (2012). *Curriculum and Assessment Policy Statement (CAPS)*. Pretoria.

Statistics South Africa (2003). *Census 2001: Investigation into appropriate definitions of urban and rural areas for South Africa*. Discussion document. Pretoria: Statistics South Africa.

Stewart, C.T. Jr (1958). The urban-rural dichotomy: Concepts and uses. *The American Journal of Sociology*, 64(2), 152–158.

Swim, J., Clayton, S., Doherty, T., Gifford, R., Howard, G., Reser, J., … Weber, E. (2009). Psychology and global climate change: Addressing a multifaceted phenomenon and set of challenges. http://www.apa.org/science/about/publications/climate-change-booklet.pdf, visited 13 August 2012.

Vujovic, J. (2013). FET geography teachers' knowledge and perceptions of climate change and an evaluation of the textbooks used for climate change education. Unpublished masters dissertation, University of the Witwatersrand.

Whitmarsh, L. (2011). Scepticism and uncertainty about climate change: Dimensions, determinants and change over time. *Global Environmental Change*, 21, 690–700.

Wibeck, V. (2014). Enhancing learning, communication and public engagement about climate change: Some lessons from recent literature. *Environmental Education Research*, 20(3), 387–411.

Assessing Wetland Health Using a Newly Developed Land Cover Citizen Science Tool for Use by Local People Who Are Not Wetland Specialists

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Abstract

More than half of the wetlands in South Africa have been degraded or lost due to economic activities, urban developments and poor wetland management. Reversing the trend would require the participation of a wide range of actors in addition to scientists. A case has been made for a citizen science approach in order to empower the public with skills and knowledge that would enable them to understand environmental issues without depending on specialists. However, the wetland health assessment tools used in South Africa are highly technical, rendering them largely inaccessible to non-specialists. Recently, Kotze (2015) developed a tool which seeks to address this gap by involving the wider community in monitoring the health of wetlands in South Africa. The aim of the present study was to test the extent to which the new wetland health tool can be used by local people to better understand their surrounding wetlands. The study's findings indicated that the tool enabled non-specialists to generate information about wetlands that was not significantly different from that produced by specialists.

Keywords: Environmental education, citizen science, public engagement, environmental management, wetland assessment tools.

Introduction

Since the 1960s, there has been growing interest in educating the public about the environment. Environmental education and education for sustainable development have both become prominent in recent years (McKeown, Hopkins, Rizi & Chrystalbridge, 2002). Whereas environmental education focuses on a public that is environmentally literate (Ehrlich, 2011), education for sustainable development also aims to empower the public to participate in decision-making (Hopkins & McKeown, 2002). Both approaches are designed to ensure the well-being of society and the environment, and require behaviour change among members of the public towards better environmental management (Kopnina, 2013). Studies (e.g. Stevenson, Peterson, Bondell, Mertig & Moore, 2013) have shown that environmental education and education for sustainable development can result in the desired behaviour change and in better environmental outcomes.

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In the southern Africa context, education for sustainable development has not replaced environmental education, but aspects thereof have been incorporated in environmental education processes as being relevant to the socioecological context (Lotz-Sisitka, 2004). Environmental education is not only critical for the school curriculum, but can also address community concerns by exploring and implementing solutions to environmental problems through practical actions (Hungerford, Volk, Ramsey & Bluhm, 1994). As most of the population in southern Africa resides in rural areas, natural resources are important for their livelihoods. Environmental education in the region therefore needs to have a strong focus on enabling people to sustain livelihoods and on reducing poverty.

Since environmental education and education for sustainable development are both informed by many different disciplines, the knowledge passed on to learners as well as the general public has been broad and extensive (McKeown *et al.*, 2002). This is important, as it allows the public to be well informed regarding environmental management and contributes to their resilience to environmental shocks (climate change and related natural disasters), which, along with population growth, can result in declining natural, social and economic assets (Telfer & Sharpley, 2015).

For effective environmental management and better environmental outcomes at the local level, several studies (e.g. Hochachka, Fink, Hutchinson, Sheldon, Wong & Kelling, 2012) have highlighted the need for the public to be able to gather their own information and make sense of it without depending on environmental specialists. Citizen science, which refers to research in which local volunteers and/or stakeholders play a prominent role as participants in promoting sustainability, has become a popular approach (Silvertown, Buesching, Jacobson & Rebelo, 2013). Citizen science combines environmental research with environmental education and observation (Dickson, Shirk, Bonter, Bonney, Crain, Martin & Purcell, 2012). Scientific information which would otherwise be too complex for non-specialists to understand may then be simplified, thereby empowering a wide range of locals (the elderly, the youth, the non-educated, women, and others) to participate in local programmes (Merenlender, Crall, Drill, Prysby & Ballard, 2016).

The benefits of citizen science include employment creation through skills passed on to volunteers, as well as broader and increased participation in, and understanding of, environmental policies and science projects (Conrad & Hilchey, 2011; see, also, Dickinson *et al.*, 2012). A recent study by Ballard, Dixon and Harris (2017) demonstrated that involving local people in information gathering for the purpose of conservation initiatives capacitates them for future conservation efforts. The tools developed can enable communities to act; hence people must be able to understand them with minimal input from the specialists, and must be able to produce reliable data (Thornhill, Ho, Zhang, Li, Ho, Miguel-Chinchilla & Loiselle, 2017). Citizen science is an approach to environmental education that allows the public to be on par with the specialists with regard to the data collected (Ghilardi-Lopes, 2015).

The use of citizen science in enabling environmental education has been increasing in developed countries such as the United States of America (USA) and the United Kingdom (UK) (Sullivan *et al.*, 2014). According to Sullivan *et al.*, (2014), it is also slowly being adopted in the rest of the world, including South Africa.

A few caveats concerning the citizen science approach in environmental management have been highlighted in the literature, with the poor quality of data being the principal challenge. Data collected by volunteers who lack the requisite skills are likely to be fraught with measurement errors. In addition, local volunteers may prefer certain sites more than others, resulting in selection bias (Cooper, Dickinson, Phillips & Bonney, 2007). In most cases, citizen science requires coordination of a high number of volunteers, which brings with it logistical challenges. The volunteer participants in citizen science programmes usually do not start with an understanding of the objectives of the programmes, thus requiring the specialists to clearly explain and define these objectives (Silvertown *et al.*, 2013). Although these negative aspects of citizen science have been noted, the consensus is still that it is an empowering approach that can lead to better environmental management, and to better wetland management, if it is implemented appropriately.

Wetland Health Assessments

A wetland is defined as 'land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil' (DWAF, 1998:9; SANBI, 2013). Wetland health is defined as the difference between the wetland's current structure and function, and the wetland's natural structure and function (Ollis, Ewart-Smith, Day, Job, Macfarlane, Snaddon & Mbona, 2015). Wetlands are a crucial ecosystem, as they are irreplaceable. They perform many ecosystem functions and services. These functions are the processes that take place within a wetland, such as water storage, water purification, the transformation of nutrients, and supporting the growth of living matter and wetland plants. These processes work together to maintain the wetland. Wetlands are involved in recharging groundwater, in the attenuation of flood peaks and in erosion control. They are also widely used for recreation purposes and food security. Wetlands supply rivers with water during the dry season, help in reducing desertification, combat droughts, and reduce flooding (Russi *et al.*, 2013; SANBI, 2013).

More than half of the wetlands in South Africa have already been degraded or lost (Jogo & Hassan, 2010; Nel, Colvin, Le Maitre, Nobula, Smith & Haines, 2013). Even though wetlands cover only 2.4% of South Africa's land, their destruction has a ripple effect far beyond the land which they cover (SANBI, 2013). According to Nel *et al.* (2013), our wetlands are threatened by a number of practices, such as large-scale crop cultivation, and especially mono-cropping. Wetlands can also become contaminated with soil and fertiliser runoff as a result of poor land management in crop agriculture. Poorly managed plantations of pine and wattle also lead to the degradation of wetlands; as a source of alien vegetation, they use more water than natural vegetation, thus reducing the amount of water available in the aquatic systems.

Wetland management plays a crucial role in conservation and the wise use of wetlands (Farrier & Tucker, 2000). One of the major challenges for wetland management is that a vast amount of data over a large spatial area is required to clearly understand the state of wetlands (Bonney, Cooper, Dickinson, Kelling, Phillips, Rosenberg & Shirk, 2009; Thornhill *et al.*, 2017).

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Environmental managers and practitioners are always looking for ways in which wetlands could be better understood and better protected (Allison, 2012). Many people do not value wetlands as much as they should owing to a lack of understanding of the importance of their ecosystem functions and their value to society (Lambert, 2003). One way of both educating people and involving them in the management of wetlands is citizen science (Ballard *et al.*, 2017). In line with the citizen science approach, Kotze (2015) has developed a rapid health assessment tool for wetlands. This tool seeks to empower participants to assess and monitor the state of local wetlands.

Previously, there were two main wetland assessment tools in South Africa, the WET-Health assessment tool and the Wetland Index of Habitat Integrity (IHI) assessment tool. These tools examine the different characteristics of wetlands, but neither of them promotes the participation of locals, as people who are not wetland specialists find the tools difficult to understand (Kotze, 2015). The new method seeks to examine all the ecological factors that affect wetlands, but in a simplified format based on WET-Health and Wetland IHI. This is a rapid-assessment tool that combines aspects of WET-Health and Wetland IHI and then focuses on land cover types/disturbance units in wetlands and their upslope catchments. This tool was specifically designed for the citizen scientist. The ecological units that are assessed using WET-Health and the Wetland IHI have been simplified and assigned values that can easily be understood by the citizen scientist. The simplified values mean that citizen scientists do not have to know the four components that are being assessed, namely hydrology, geomorphology, water quality and vegetation.

New wetland monitoring tool

The newly developed wetland health tool is aimed at enabling people who are not wetland specialists to conduct assessments and determine wetland health. This tool or method assesses ecological conditions based on four components: hydrology, geomorphology, water quality and vegetation. The water quality component examines the physical, chemical and biological characteristics of water that are controlled or influenced by substances either dissolved or suspended in the water (Kotze, 2015). The tool works by determining the extent of land cover types present within the wetland and its catchment area. This is based on a comprehensive list of land cover types, with pre-assigned intensity scores based on expert judgement, peer review and scientific literature. The fact that these impacts have all been pre-assigned by an expert is a key difference between this tool and the other two used in South Africa (i.e. WET-Health and Wetland IHI).

The newly developed tool uses a scoresheet in an Excel spreadsheet which determines the health of the wetland using land cover type impacts. Once the impact is determined, the tool works out the Present Ecological State (PES) category of the wetland. This PES category ranges from A to F, with A being 'No impact on wetland integrity (health)', and B being 'Modification of wetland integrity is small'. C is used when modification of wetland integrity is clearly identifiable but limited. D is employed when approximately 50% of wetland integrity has been lost. E is assigned when more than 50% of wetland integrity has been lost. Finally, PES category F is used when the ecosystem processes of wetland health have almost been destroyed, or have in fact been totally destroyed and the wetland can no longer provide ecosystem services and value.

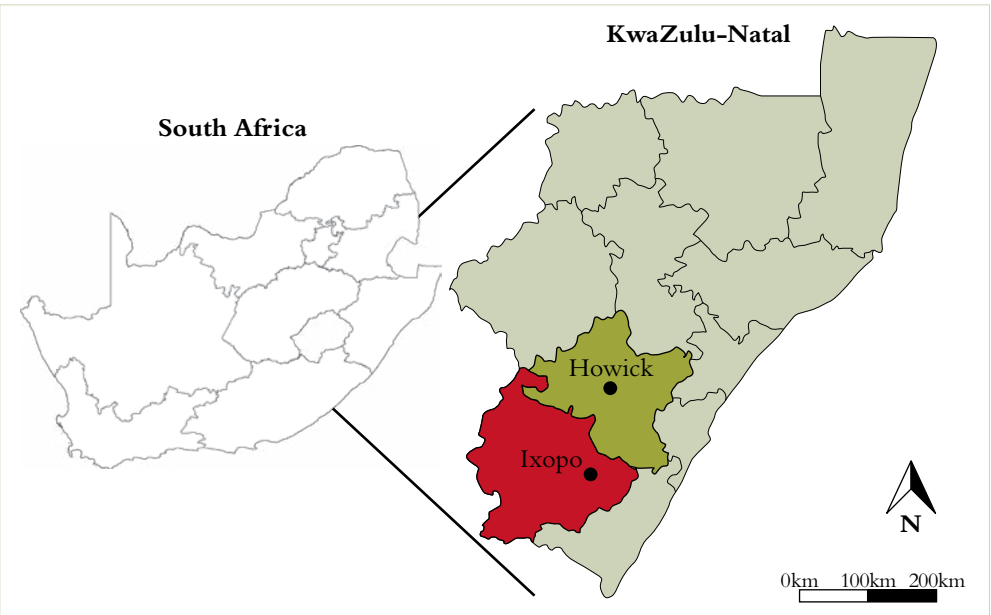
The present study was aimed at testing the extent to which the newly developed citizen science wetland health tool can be easily and effectively used by local people who are not wetland specialists in order to better understand their surrounding wetlands. The accessibility of the tool to non-specialists would make it an important element of environmental education that could: engage all citizens, regardless of their socio-economic and demographic characteristics; allow one to move beyond awareness and enable people to make informed decisions on environmental issues; and facilitate changes in the ways in which people view and act concerning the environment (Wals, Brody, Dillon & Stevenson, 2014). The study therefore seeks to ascertain whether the new citizen science tool addresses some of these pertinent aspects of environmental education, as well as whether any changes need to be made to the tool to improve accessibility and usefulness.

Methodology

Study area

Two wetlands were studied (see Figure 1): Siphumelele wetland at Howick and the Ixopo Golf Course wetland at Ixopo. The sites were chosen because they had most of the disturbance units that could be identified using the tool. Before the assessments were made regarding these wetlands, participants were trained in one-day workshop sessions, which introduced them to the tool. The two wetlands were assessed over a day each, since this is a rapid wetland assessment tool. A total of 56 participants took part. Ten participants carried out the assessment at Siphumelele wetland, and the other 46 assessed the Ixopo Golf Course wetland. The participants were

Figure 1. The study areas at Ixopo and Howick, KwaZulu-Natal, South Africa



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from different backgrounds and were purposively selected to represent the various groups of people who would be potential users of this tool, including: landowners, government officials, field technicians, environmental practitioners, wetland practitioners, educators, people who had completed only secondary education, university students, people from non-governmental organisations and conservancy forums, and other interested and affected parties. Wetland specialists also conducted the assessment in order to act as controls.

Data generation

The present study was conducted using mixed methods, as it was important, from both a qualitative and quantitative point of view, to understand participants' views on the tool that was being tested. The qualitative and the quantitative approaches were used for triangulation purposes (Creswell, 2013). Table 1 summarises the study objectives, the data collected, the data-collection tools, and the analysis methods that were applied in the study. A scoresheet was assigned to participants to fill in independently, and the results of participants were then compared. Focus-group discussions and questionnaires probed the perceptions of the participants after using the tool.

Table 1. Summary of the study objectives, data collected, the data-collection tools and the analysis methods

Research objectives	Data to be collected	Data-collection tool	Data analysis
To test whether the participants could use the tool	How easy it was to collect data, give scores accordingly and interpret data correctly	Questionnaire; scoresheet	Descriptive statistics
To identify factors that might affect the variability of the scores	Gender; level of education and experience; scores	Scoresheet; questionnaire	Analysis of variance
To determine perceptions regarding use of the tool	Views of participants	Questionnaire; key-informant interviews; focus-group discussions	Content analysis

The procedures followed in conducting the present study were based on a mixed-methodology triangulation design as described by Creswell and Clark (2007). The purpose of the design was to interpret the findings of the quantitative method using the qualitative findings.

A workshop was held with participants prior to them testing the tool. In the workshop, the participants were given an introduction to, and background information on, wetlands. They were then introduced to the newly developed tool. A trial run on how to use the tool was done. Clarity regarding the maps used as part of the tool and the field exercise was provided. After the workshop, the participants had to go into the field and apply the tool on their own. On conclusion of the field exercise, the participants submitted their independent assessments for comparison. They were then asked to complete the questionnaire by reflecting on the experience.

The instruments that were used to collect data in this study were: the land cover-based tool/scoresheet; the questionnaire; the scoresheet that the participants had to use in the field; the focus-group discussion guide; and the key-informant guide for post-session feedback. The tool/scoresheet was used to assess the wetlands and collect the quantitative scores. The scoresheets were analysed for missing data to investigate the extent to which the participants had understood how the tool works. The questionnaire was used to collect both quantitative and qualitative data. The questionnaire included demographic information of participants (such as gender, education level, type of qualification and job, and their organisations) as well as Likert scale-type questions to rate the level of satisfaction in using the tool.

The quantitative data were collected using the newly developed tool and a questionnaire. After assessing the wetland using the tool, the participants completed a questionnaire. The total number of assessors who began participating in the assessment of the two wetlands was 60 participants, but only 56 managed to participate throughout the study.

The qualitative methods were used to assist in generating rich, detailed data that left the participants' perspectives intact. Focus-group discussions were held to ascertain the participants' views on the tool after using it to assess the wetlands. This helped in identifying the gaps in the tool as well as the understanding of the participants. The groups were separated according to age, namely mainly young adults (16–35) and adults (above 35 years). A total of five focus-group discussions were held at the Golf Course wetland in Ixopo, with the 50 participants divided into groups of ten. Three of the five groups comprised young adults, and the remainder consisted of adults. Only one focus-group discussion was held in Siphumelele. The focus-group discussions had a time limit of 30 minutes each. The discussions were recorded on paper.

The limitations of the study were that the participants and stakeholder groups were confined only to those who had at least completed secondary-school education. Moreover, only two wetlands could be tested, thus limiting the types of wetland and range of wetland health which could be included in the study. Only valley bottom wetlands were studied, as these were the only ones accessible at the time of the study. Wetlands are classified into five different types, namely channelled valley bottom, unchannelled valley bottom, floodplain, hillslope seepage and pan wetlands (DWAF, 2007).

Data analysis

The quantitative analysis for this study focused on a quantitative comparison of the independently assessed condition scores for the wetlands by different participants. The comparisons were made with regard to the participant's scores and these scores were then compared with an expert's score (indicated as a control in tables and graphs). For the questionnaire analysis, information from the questionnaires was captured in an Excel template that had been created. The captured data were then transferred to the SPSS (Statistical Package for Social Sciences) where a few data manipulations and analyses were carried out. The qualitative analysis was conducted in order to guide interpretation of the results from the quantitative analysis, and to determine whether participants could use the tool. This included visually comparing participant's scoresheets with those of the experts.

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Results and Discussion

The Siphumelele wetland was assessed by ten participants. All the participants were compared with Participant 2 (control), who is a specialist on wetlands and has over 20 years' experience in working with wetlands. The overall results (indicated in Figure 2 and Figure 3) in this case are the combination of the results from the assessment of the impact on the wetland of land cover types present within the wetland, and an assessment of the impact on the wetland of land cover types present within the wetland's upslope catchment. The overall score is calculated by using a weighted score of combined impact scores derived from the scores for 'Hydrology', 'Geomorphology', 'Water quality' and 'Vegetation'. This score is weighted as 3:2:2:2, as recommended by Macfarlane, Kotze, Ellery, Walters, Koopman, Goodman and Goge (2009) (Kotze, 2015).

Figure 2. Overall scores combining land cover type impact on wetland and land cover type impact on catchment for the Siphumelele wetland

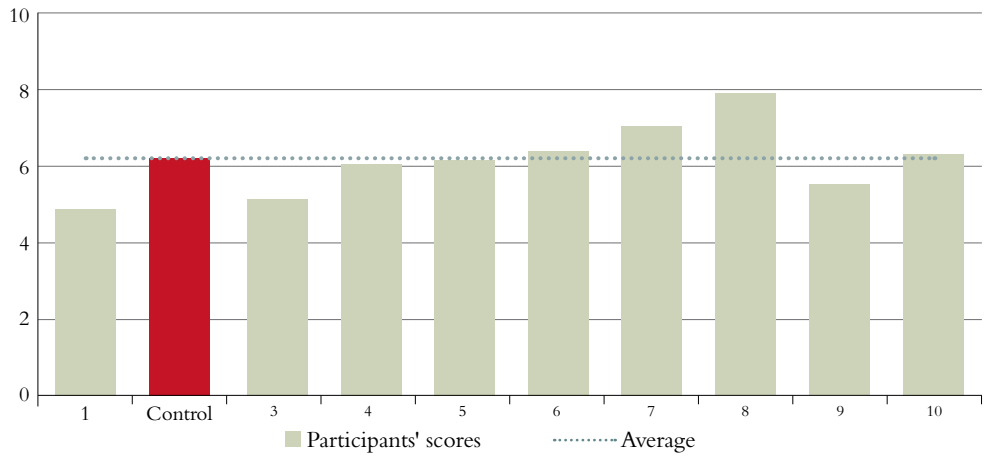
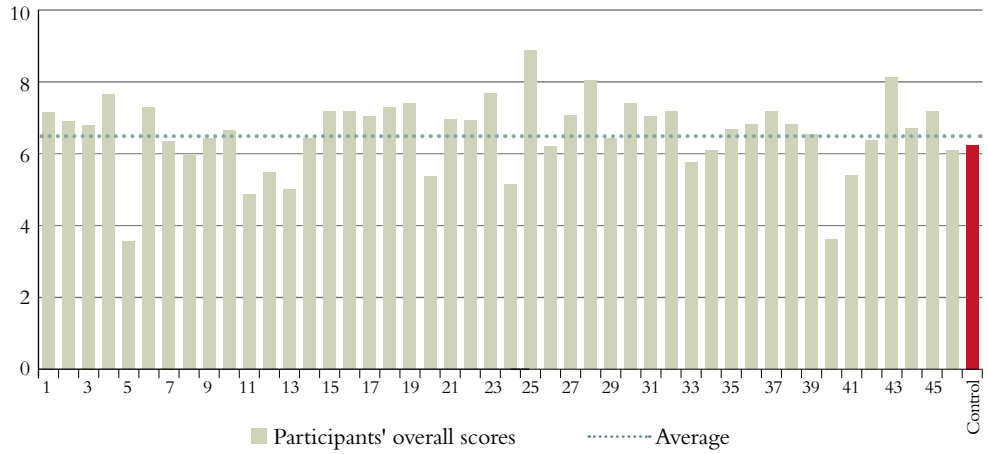


Figure 2 indicates that the control's overall score was 6.4 for the Siphumelele wetland, and that the scores of the other participants assessing this wetland ranged from 5.0 to 7.9. This translates into an overall PES of D and E, meaning that at least 50% of this wetland is modified. The significance of the variance, using Levene's Variance Comparison, was only 0.59, meaning that the scores were *not significantly different* between the specialist (control) and the non-specialists. For instance, Participant 6 had exactly the same overall scores as the control, even though it was the first time that this participant was using any wetland health assessment tool.

In the Ixopo Golf Course wetland health assessment, Participant 5 from the Siphumelele assessment was used as the control owing to this participant being part of both assessments and having had experience in working on wetlands. Figure 3 shows the overall scores that the participants arrived at for the second wetland. Of the 46 participants assessing the Ixopo Golf Course wetland, 37 arrived at the same PES category (E) as an overall result, which was the same category as that for the control's results. The remaining nine participants arrived at D category overall results.

Figure 3: Overall scores combining land cover type impact on wetland and land cover type impact on catchment for the Ixopo Golf Course wetland



For this wetland, the variance when using Levene's Test of Significance was 0.51. This indicates that there was equal variance between those participants who had experience with using other wetland health assessment tools and those who had none.

The variation in the overall scores at both wetlands was mainly due to the difference in the identification of land cover types by the different participants in both the wetland and the catchment.

These results show that the participants' scores did not vary much from those of the control, which implies that most of the participants understood what was required of them and could use the tool on their own. Furthermore, utilising this tool did not require previous experience in working with wetland tools. This also means that participants using this tool could produce quality data, as they were able to arrive at results that were statistically comparable with the control's results. This tool could also enable communities to act in the interest of protecting wetlands, as participants now understand the impact each land cover type has on a wetland and can identify and categorise the different land covers. In addition, minimal training was needed by the specialists in order for the citizen scientists to understand the impact each land cover type has on a wetland.

In the questionnaire, the participants were asked if they would ever use this tool again. The majority (84%) indicated that they would use the tool in future (see Table 2). Participants who were not sure whether they would use the tool again explained that they were mainly employed to deal with administration. The perception of 70% of the participants after utilising the tool was mostly that it was easy to use. Only 20% of the participants had difficulties in using the tool, with 10% of the participants indicating that they were not sure whether it was easy or difficult to use the tool. Based on the overall perception of the participants, as well as the data (scores) obtained, one could say that it is not difficult to use this tool. The majority of participants who utilised this tool (88%) thought it would help them to better understand wetlands.

Table 2 summarises the demographic data in respect of the participants in both the Siphumelele and Ixopo Golf Course wetland assessments, including their prior experience and their perceptions concerning use of the tool.

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Table 2. Summary of the participants' demographic data, their experience in wetlands assessment and their perceptions concerning the new tool [n = 56] – Siphumelele and Ixopo Golf Course wetlands

Variable	Indicator	Percentage (%)
Education level	Secondary	46
	Undergraduate	39
	Postgraduate	15
Gender	Female	59
	Male	41
Occupation	Environmental services	56
	Other	44
Experience in working with wetlands	Less than a year	52
	1 year to 2 years	34
	3 years and more	14
Use of wetland tools	Have not used wetland tool before	79
	Have used wetland tool before	21
Level of expertise perception with regard to wetlands	Participants with experience with wetlands	70
	Participants without experience with wetlands	30
Likelihood of using tool in the future	Likely	84
	Not sure	12
	Unlikely	4
Ease of using the tool	Easy	79
	Difficult	21
Improvement of understanding	Likely	88
	Not sure	7
	Unlikely	5

Conclusion and Recommendations

It is indeed possible to develop tools for citizen science that can be utilised for both environmental education and for environmental monitoring and management. This study showed that the wetland health assessment tool developed by Kotze (2015) is practical and suitable both for creating awareness and greater understanding of wetlands, and for supporting citizen-based monitoring of wetlands. It can be used by people who are not wetland specialists. It is evident that citizens can actively participate in scientific wetland research once they have been exposed to the subject and given suitable tools. In this way, more wetlands can be assessed and monitored than can be done by scientists on their own.

It is recommended that this tool be adopted and used by people with different levels of education in order to enhance the understanding of wetlands and wetland health, and to

broaden the base of people contributing to wetland monitoring and research around South Africa. It is also recommended that other citizen science tools be tested and developed to assist in better environmental management. Of course, it is always important to test tools carefully and to proceed with caution when drawing conclusions from the results.

Notes on the Contributors

Nondumiso Dumakude is studying towards a masters in Environmental Science at the University of Free State, South Africa. She is also an environmental officer working with schoolchildren and the community to better manage their environment.

Dr Mark Graham is an aquatic ecologist with over 30 years' experience in terrestrial and aquatic ecosystem functioning and management. He is currently the director at GroundTruth in South Africa, a biomonitoring services and environmental consultancy.

References

Allison, S.K. (2012). *Ecological restoration and environmental change: Renewing damaged ecosystems*. Routledge.

Ballard, H.L., Dixon, C.G. & Harris, E.M. (2017). Youth-focused citizen science: Examining the role of environmental science learning and agency for conservation. *Biological Conservation*, 208, 65–75.

Bonney, R., Cooper, C.B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K.V. & Shirk, J. (2009). Citizen science: A developing tool for expanding science knowledge and scientific literacy. *Bioscience*, 59 (11), 977–984. (Available from: Jennifer Lynn Shirk)

Conrad, C.C. & Hilchey, K.G. (2011). A review of citizen science and community-based environmental monitoring: Issues and opportunities. *Environmental Monitoring Assessment*, 176, 273.

Cooper, C.B., Dickinson, J., Phillips, T. & Bonney, R. (2007). Citizen science as a tool for conservation in residential ecosystems. *Ecology and Society*, 12(2), 11.

Corcoran, P.B., Weakland, J.P. & Wals, A.E. (Eds) (2017). *Envisioning futures for environmental and sustainability education*. Wageningen, Netherlands: Wageningen Academic Publishers.

Creswell, J.W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage.

Creswell, J.W. & Clark, V.L.P. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage.

Davis, J. (2009). Revealing the research 'hole' of early childhood education for sustainability: A preliminary survey of the literature. *Environmental Education Research*, 15(2), 227–241.

DWAF (Department of Water Affairs and Forestry). (1998). National Water Act (Act No. 36 of 1998). Pretoria, South Africa.

DWAF (Department of Water Affairs and Forestry). (2007). Manual for the assessment of a Wetland Index of Habitat Integrity for South African floodplain and channelled valley

ISSN 2411-5959 | DOI 10.4314/sajee.v.33i1.6

bottom wetland types. Report no. N/0000/00/WEI/0407. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Dickinson, J.L., Shirk, J., Bonter, D., Bonney, R., Crain, R.L., Martin, J. & Purcell, K. (2012). The current state of citizen science as a tool for ecological research and public engagement. *Frontiers in Ecology and the Environment*, 10(6), 291–297.

Ehrlich, P.R. (2011). A personal view: Environmental education – its content and delivery. *Journal of Environmental Studies and Sciences*, 1(1), 6–13.

Farrier, D. & Tucker, L. (2000). Wise use of wetlands under the Ramsar Convention: A challenge for meaningful implementation of international law. *Journal of Environmental Law*, 12(1), 21–42.

Ghilardi-Lopes, N.P. (2015). Citizen science combined with environmental education can be a powerful tool for coastal-marine management. *Coastal Zone Management*, 18, 407. doi: 10.4172/2473-3350.1000407.

Hochachka, W.M., Fink, D., Hutchinson, R.A., Sheldon, D., Wong, W.K. & Kelling, S. (2012). Data-intensive science applied to broad-scale citizen science. *Trends in Ecology and Evolution*, 27(2), 130–137. http://ec.europa.eu/science-environment-policy.

Hopkins, C. & McKeown, R. (2002). Education for sustainable development: An international perspective. *Education and sustainable development. Responding to the global challenge.* Cambridge: IUCN Commission on Education and Communication. (pp. 13–26)

Hungerford, H.R., Volk, T.L., Ramsey, J.M. & Bluhm, W.J. (1994). A prototype environmental education curriculum for the middle school (revised). A discussion guide for UNESCO training seminars on environmental education. Paris, France: UNESCO-UNEP International Environmental Education Programme.

Jogo, W. & Hassan, R. (2010). Balancing the use of wetlands for economic well-being and ecological security: The case of the Limpopo wetland in southern Africa. *Ecological Economics*, 69(7), 1569–1579.

Kopnina, H. (2013). Evaluating education for sustainable development (ESD): Using ecocentric and anthropocentric attitudes toward the sustainable development (EAATSD) scale. *Environment, Development and Sustainability*, 15(3), 607–623.

Kotze, D.C. (2015). A method for assessing wetland ecological condition based on land-cover type. Version 1.0. February 2015. Jointly funded through the WWF Resilient Landscapes Project and the Water Research Commission.

Lambert, A. (2003). Economic valuation of wetlands: An important component of wetland management strategies at the river basin scale. Ramsar Bureau. http://www. ramsar. org/features/features_econ_val1. html.

Lotz-Sisitka, H. (2004). *Positioning southern African environmental education in a changing context.* Howick, South Africa: Share-Net.

Macfarlane, D.M., Kotze, D.C., Ellery, W.N., Walters, D., Koopman, V., Goodman, P. & Goge, C. (2009). WET-Health: A technique for rapidly assessing wetland health. Water Research Commission Report TT, 340(09).

McKeown, R., Hopkins, C.A., Rizi, R. & Chrystalbridge, M. (2002). Education for sustainable development toolkit. Knoxville: Energy, Environment and Resources Center, University of Tennessee.

Merenlender, A.M., Crall, A.W., Drill, S., Prysby, M. & Ballard, H. (2016). Evaluating environmental education, citizen science, and stewardship through naturalist programs. *Conservation Biology*, 30(6),1255–1265.

Nel, J., Colvin, C., Le Maitre, D., Nobula, S., Smith, J. & Haines, I. (2013). An introduction to South Africa's water source areas; the 8% land area that provides 50% of our surface water. WWF-SA. www.wwf.org.za/media_room/publications, visited 30 September 2015.

Ollis, D.J., Ewart-Smith, J.L., Day, J.A., Job, N.M., Macfarlane, D.M., Snaddon, C.D. & Mbona, N. (2015). The development of a classification system for inland aquatic ecosystems in South Africa. *Water SA*, 41(5), 727–745.

Russi, D., Ten Brink, P., Farmer, A., Badura, T., Coates, D., Förster, J., ... Davidson, N. (2013). *The economics of ecosystems and biodiversity for water and wetlands*. London & Brussels: IEEP.

SANBI (South African National Biodiversity Institute). (2013). *Life: The state of South Africa's biodiversity (2012).* Pretoria: SANBI.

Silvertown, J., Buesching, C.D., Jacobson, S.K. & Rebelo, T. (2013). Citizen science and nature conservation. *Key Topics in Conservation Biology*, 2, 127–142.

Stevenson, K.T., Peterson, M.N., Bondell, H.D., Mertig, A.G. & Moore, S.E. (2013). Environmental, institutional, and demographic predictors of environmental literacy among middle school children. *PloS One*, 8(3), e59519.

Sullivan, B.L., Aycrigg, J.L., Barry, J.H., Bonney, R.E., Bruns, N., Cooper, C.B., ... Fink, D. (2014). The eBird enterprise: An integrated approach to development and application of citizen science. *Biological Conservation*, 169, 31–40.

Telfer, D.J. & Sharpley, R. (2015). *Tourism and development in the developing world*. Routledge.

Thornhill, I., Ho, J.G., Zhang, Y., Li, H., Ho, K.C., Miguel-Chinchilla, L. & Loiselle, S.A. (2017). Prioritising local action for water quality improvement using citizen science: A study across three major metropolitan areas of China. *Science of the Total Environment*, 584, 1268–1281.

Wals, A.E., Brody, M., Dillon, J. & Stevenson, R.B. (2014). Convergence between science and environmental education. *Science*, 344(6184), 583–584.

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Students' Attitudes to Paper Consumption in relation to Carbon Emissions and the Impact of Electronic Course Documents

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Abstract

The purpose of this study was to assess the impact, in relation to carbon emissions, of electronic course document use and attitudes to paper consumption levels among third- and fifth-year environmental engineering students (N = 78) enrolled in two courses during the 2015/2016 academic year at the Copperbelt University in Kitwe, Zambia. Data were collected through an online survey, to which 40 students provided complete responses, as well as through semi-structured interviews and observations. Overall, 80% of the students in the sample reported that they read electronic course materials. They also indicated that they 'know a lot' about sustainable development, climate change, greenhouse gases and global warming, and agreed that efficient paper use is an important aspect of achieving sustainability. Importantly, the study found that the lecturer's mode of delivery of course materials influenced the students to develop responsible environmental behaviours such as reading and sharing e-course documents and reusing paper.

Keywords: Climate change, paper consumption, education for sustainable development, higher education.

Introduction

The increase in global carbon emissions due to human activities such as deforestation and the burning of fossil fuel has become an issue of worldwide concern. As a result, many organisations and institutions, including universities, are striving to increase their environmental performance and responsibility. This includes efforts to reduce their carbon emissions, promote sustainability and combat climate change (IFL, 2016; IPCC, 2007; PBL, 2016; UNFCCC, 2007). In general, factoring sustainability in higher-education institutions focuses on greening the different aspects of campus activities in order to reduce carbon emissions, for example by reducing paper consumption (Robin, Potter & Yarrow, 2002; Robin, Potter & Yarrow, 2008). Paper is widely used in academia (EPN, 2015). Its production, consumption and disposal are known to have significant impacts on the environment – deforestation, high water consumption (in plantations), water pollution (during production), and carbon emissions, among others (Conservatree, 2015; Counsell & Allwood, 2007; WWF, 2016).

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Reducing paper consumption on a global scale is important in lowering carbon emissions and, in turn, mitigating climate change. The Copperbelt University can make a small but important contribution in this regard by reducing its paper consumption, which would possibly also influence its students to adopt responsible environmental behaviours. To engender change in students, lecturers' actions must be consistent with the type of behaviour change they wish to encourage, such as utilising technology or methods in their teaching that benefit the environment (Lozano *et al.*, 2011; Stir, 2006).

The Copperbelt University, which was established in 1987 and is located in Kitwe in the Copperbelt Province, is Zambia's second-largest public university. In its 2014–2018 Strategic Plan, the university has committed itself to supporting environmental sustainability (CBU, 2014). It has since initiated various projects such as tree-planting, an online admissions system, and a student portal for course registration and for accessing course materials.

A study at the Copperbelt University to assess the university's paper consumption over a period of five years (2010–2014) found that a significant amount of A4 paper was consumed for both academic and administrative purposes (Mwanza, 2014). Paper was the main mode of information dissemination and it was found that students used a lot of paper when printing or photocopying course materials. This contributed substantially to the university's carbon footprint (Mwanza, 2014). However, with the coming of the digital age, the use of e-documents (an electronic version of a printed document that can be read on a computer or a handheld device) has become prevalent, especially among university students (Falc, 2013; Hannon, 2008; Hobsons, 2010; McKiel, 2011). A number of researchers argue that replacing paper with its electronic equivalent can reduce paper consumption and its associated carbon emissions (Chowdhury, 2012; Counsell & Allwood, 2007; Hannon, 2008; Hekkert, Reek, Worrell & Turkenburg, 2002; Iqbal & Ahmed, 2015; Tenhunen & Penttinen, 2010).

The purpose of the present study was to assess the impact, in relation to carbon emissions, of electronic course document use and students' attitudes to paper consumption levels in two environmental engineering courses during the 2015/2016 academic year.

Literature Review

Trees, paper, carbon emissions and climate change

Forests provide the Earth's climate with critical stability through carbon storage. The process of photosynthesis enables trees to absorb carbon dioxide, a greenhouse gas, and offset its effect on the atmosphere (EDF, 2016). Globally, indigenous forests are either used directly for paper production or are cleared to make way for plantations in which pine and other trees are grown for paper production. Such plantations use large amounts of water, destroy indigenous ecosystems and, after harvesting, leave behind denuded areas unless replanted. Over 900 million planted trees are consumed for paper each year (EPN, 2015) and the world's annual pulp and paper production is around 400 million tons a year (WWF, 2016).

Approximately 36 billion tonnes of carbon emissions are generated globally from fossil-fuel and other industrial processes (PBL, 2016), and paper and pulp production is a large consumer of energy. Some three billion tonnes of global carbon dioxide (CO_2) emissions

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are the result of deforestation (UCS, 2013), while tropical forests absorb 1.4 billion metric tonnes of carbon dioxide out of a total global absorption of 2.5 billion (Buis, 2014). During the production of paper from pulp, more water is used and the emissions and discharge from paper mills typically contain high levels of pollution. Every paper consumer is connected through the supply chain to the land where trees are harvested and processed to make paper (Gagliardi, 2007) – and, if fossil-fuel energy consumption and the resulting CO_2 emissions associated with paper manufacture and transportation are added, the connection to climate change becomes even more apparent.

Over the last four decades, scientists have presented evidence that the rising concentration of carbon emissions has been driving changes in the Earth's climate patterns, resulting in catastrophic weather events in the form of floods in increased number and intensity, heatwaves and droughts. This poses a threat to human survival and sustainability (IPCC, 2007; NPCC, 2016). Zambia, like many other African countries, experiences climate-related hazards such as floods and droughts, which have adversely affected water availability, food security, energy supply, and the livelihoods of communities (NPCC, 2016).

Sustainability and climate change awareness in universities

A sustainable university is a whole or a part that addresses, is involved with and promotes, on a regional or a global level, the minimisation of negative environmental, economic, societal and health effects generated in the use of resources in order thereby to fulfil its functions of teaching, research, outreach, and partnership with society (Zhang, 2011). Environmental sustainability has become a priority for many tertiary institutions and different initiatives have been formulated through declarations so as to foster sustainable-development guidelines on how to incorporate sustainability into the university system (Adomßent, Fischer, Godemann, Otte, Rieckmann, Timm & Herzig, 2014; Lozano *et al.*, 2011; Robin *et al.*, 2002; UNESCO, 2009).

Lozano *et al.* (2011) identified some of the factors that contribute to resistance on the part of universities to engage with sustainability. These factors include: lack of awareness concerning sustainable development; the insecurity of lecturers and threats to academic credibility; overcrowded curricula; lack of support; views that sustainable development has little or no relevance in certain study disciplines; and uncertainty regarding the effort required to incorporate sustainable development into curricula. Universities that promote sustainability have been shown to be ones that have rethought their missions and have streamlined their research programmes and lifestyles on campus (Adomßent *et al.*, 2014).

The Copperbelt University has conducted various studies aimed at understanding the university's carbon footprint as formed by different aspects such as water, refrigerants and paper (Mapulanga, 2013; Mulebeka, 2013; Mwanza, 2014). These studies have stressed the importance of education for disseminating climate change information, as well as education's central role in understanding, mitigating and adapting to climate change (UNESCO, 2009). For example, a survey of students in two hostels at the Copperbelt University designed to assess their awareness of climate change found that they had some awareness of climate change but very little knowledge of the carbon footprint of paper consumption (Mwanza, 2014). It

would seem, from this, that they required more information. Researchers have also shown that awareness of climate change among students is influenced by access to information, by media coverage of the issue, by advocacy, and by the level of environmental concern (Carr, 2015; Christensen & Knezek, 2015; Ojomo, Elliott, Amjad & Bartram, 2015). At the Copperbelt University, it was therefore important to explore the awareness and attitudes of students regarding climate change. Bello (2015) showed the importance of this in a case study exploring students' green computing attitudes. In the present study, an online survey was designed to determing environmental engineering students' awareness and practices with reference to paper consumption and electronic course resources.

Electronic and print course document use in universities

The digital revolution has allowed documents to be accessed electronically. This is achieved using portable devices such as laptops, tablets and smartphones, which is a viable way of reducing carbon emissions and the costs incurred when printing or photocopying documents (Chowdhury, 2012; Counsell & Allwood, 2007; Iqbal & Ahmed, 2015; Tenhunen & Penttinen, 2010). Around the world, universities that have shifted their academic activities and processes online have recorded good results in reducing costs (CSU, 2015; Hobsons, 2010; OrgSync, 2014). For instance, within one year of implementing such a project, Lamar University in the United States of America (USA) had a 51.2% reduction in copier machine usage and printing costs (OrgSync, 2014).

In 2011, a survey was conducted on e-book penetration and use in academic libraries in the USA. The survey showed that nearly half of the students preferred using e-resources to print, with 30% sometimes preferring them, and only 20% always preferring print (McKiel, 2011). Other surveys on e-book use showed that 53% (Ebrary, 2008) and 71% (Lenares, 2012) of student respondents reported having used an e-book. However, one major constraint in reducing paper consumption is that some lecturers provide print course documents. Lecturers may even reject electronically submitted assignments, preferring assignments to be submitted as double-spaced or single-sided hard copies (Smyth, Fredeen & Booth, 2010).

Purpose of the Study

The purpose of the present study was to explore students' attitudes to paper consumption levels, their awareness of climate change, and the impact of electronic course documents. The study involved third- and fifth-year environmental engineering students at the Copperbelt University who were enrolled for courses delivered electronically by their lecturers. The following research questions were explored in the study:

- What is the impact of electronic course document use among third- and fifth-year environmental engineering students enrolled in two courses: Solid Waste Management (EN 340) and Principles of Toxicology (EN 510)?
- What are the students' attitudes to paper consumption levels in relation to carbon emissions?
- How aware are students of the link between paper consumption and climate change?

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Theoretical Framework

Answering the aforementioned research questions is important in the light of what we know from Albert Bandura's (1977) social-learning theory and from the results of studies that explore the application of tenets of the theory of planned behaviour, which refines the reasoned action theory (Ajzen & Fishbein, 1980; Bandura, 1977; Njaura, 2013). Bandura's theory stresses learning by observing and modelling what others do. The theory of planned behaviour explains environmentally responsible behaviour as a result of environmentally friendly behavioural intentions. In turn, environmentally friendly behavioural intentions are influenced by pro-environment attitudes, the social pressure to act, and perceived behavioural control. The theory of planned behaviour informed a study designed to examine the gap between the environmental attitudes and the actual behaviour of young people. In this study, it was found that the relationship between their behaviour and intentions was substantially stronger than the relationship between their behaviour and attitudes (Njaura, 2013). Theories such as these are relevant to the present study. It is expected that the behaviour of a role model – in this case, the course lecturer – in using, or demanding the use of, e-course documents will influence the learners' behaviour and encourage them to use e-documents as well, resulting in a reduction in paper consumption. Further, the students' attitudes would be expected to influence whether or not they develop intentions or actually act in ways to reduce paper consumption by adopting e-documents. This, in turn, would probably be influenced by how aware they are of paper consumption contributing to carbon emissions on a global scale, thereby causing climate change. The present study, in a modest way, raises awareness of one important course of action that a university can embark on, and of the appropriate attitudes which it can encourage, in order to reduce its carbon footprint, while simultaneously reducing operating costs resulting from course delivery. At the same time, the study is informed by an understanding that the adoption of environmentally responsible behaviour is not a simple process but includes the development of knowledge, attitudes and a locus-of-control belief, as well as the development of intentions to act among students and their lecturers. The relationship between the action of introducing e-documents and the awareness of the impacts of paper on global climate change can also work in multiple directions.

Methodology

A qualitative case study approach was used to investigate the impact, in relation to carbon emissions, of electronic course document use and attitudes to paper consumption levels among third- and fifth-year environmental engineering students. The number of students in each class was 33 and 45 (N = 78) during the 2015/2016 academic year. Yin (2009) defines a case study as an in-depth exploration of a particular context, such as a classroom or a group of individuals, which allows for the collection of extensive qualitative data employing multiple sources of data such as surveys, interviews and observations (Yin, 2009).

The rationale for selecting third- and fifth-year environmental engineering students as the study population was twofold. Firstly, the sample met the research criteria for a case study

because the lecturers taking the two courses were committed to delivering the course content electronically. Secondly, the student researcher involved in the present study was taking one of the courses. As an 'insider', the student researcher was thus able to undertake in-depth exploration of the issues via interviews or observations.

Online questionnaire

With a view to cost-effectiveness, maximum convenience and the reduction of paper consumption, a self-administered online survey was designed. The semi-structured questionnaire was created on the SurveyMonkey platform. It consisted of two parts: students' attitudes to paper consumption and electronic course document usage; and awareness of climate change concepts. The questions were designed to explore the students' attitudes and were based on a three-point Likert scale ranging from 'Agree' to 'Disagree', with additional open-ended questions/responses. The survey also took less than 20 minutes to complete. Three faculty members validated the items for the survey. A pilot survey was administered to fourth-year environmental engineering students to check for clarity, relevance of the items for the purpose, and the accuracy of statements in the survey. The suggestions and comments provided regarding the survey helped to improve the final survey that was sent to 65 participants in January 2016. A total of 47 responses were received, of which 40 were complete responses.

Interviews and observations

After completion of the survey, semi-structured, one-to-one interviews were conducted using an interview schedule with seven open-ended questions in order to gain valuable and complete information regarding students' printing habits, their use of electronic documents and their awareness of the carbon footprint of paper. During the interviews, the students described their attitudes concerning electronic and paper course documents, their printing habits and the factors that enabled or constrained sustainable paper usage. This data was corroborated using observation data in respect of all the students' printing and electronic document use behaviour during the research period.

Data collection and analysis

The survey results were filtered for completeness of response and the data trends were then analysed. The desired sample size was N = 78, and 65 survey e-mails were returned. The response rate was thus 73.8% (n = 47), of which 85.1% (n = 40) were complete responses and 14.9% (n = 7) were partial responses. Verbal and email follow-up measures were put in place. Unfortunately, the indefinite closure of the 2015/2016 academic year affected the student response rate. The results for all closed-ended survey questions were summarised and analysed automatically in SurveyMonkey as charts, data tables and basic statistics.

Data was also gathered through observation and interviews. A case study with multiple data sources allows for assessing complex phenomena by considering the interrelationships among the data from the different sources (Yin, 2009). Interview responses were organised into categories and themes in line with the structured questions in order to interpret areas that were common and had similarities or contrasting views, and were then triangulated with data drawn from observations.

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Findings and Discussion

Observation, interview and survey findings indicating the students' self-reported attitudes to paper consumption and electronic course documents and their awareness of climate change, are now presented and discussed.

Part 1: Students' attitudes to paper consumption and electronic course document usage

A4 paper consumption

Students were asked to indicate the approximate amount of paper they had used to print course materials for the two courses. Figure 1 shows the percentage breakdown of the responses for the items in the survey. The results show that only 40% (n = 18) of the students used less than 100 sheets of paper, while 60% (n = 27) used more than 100 sheets. Interview and observation data in respect of the students' paper consumption revealed that students did not accumulate a lot of paper in the two courses, compared with other courses for which they were enrolled. We hypothesise that the lecturer's mode of delivery of course materials influenced the students to reduce their paper consumption in line with the lecturer's observed actions (Bandura, 1977; Bandura, 1986)

Preferred mode of viewing course materials

The students were asked about their preferred mode of reading course materials and the results in Figure 2 show that 36% (n = 17) preferred electronic course documents, 34% (n = 16) preferred print documents, and 30% (n = 14) preferred both electronic and print documents. During the interviews, students gave various reasons in support of their preferred mode. Those preferring electronic documents argued that e-documents save paper and money and prevent the accumulation of large amounts of paper in their rooms. These students also expressed an intention to act – they believed that their actions were beneficial and contributed to reducing paper consumption and its associated emissions. Conversely, students who preferred print indicated that they concentrated more and felt more engaged when reading a print document.

Factors affecting preference

The main factor affecting the students' preferred mode of viewing course materials was the ease with which they were able to obtain or share documents. As shown in Figure 3, 58% (n = 26) of the students considered the ease with which documents could be shared or obtained an important factor, followed by portability (53%) (n = 24). Another 7% (n = 3) commented that electronic documents do not cost anything and reduce paper consumption substantially. In interviews, however, the majority of the students alluded to the fact that electronic course documents are easy to share and do not cost anything, unlike printed course documents that come at a price. Furthermore, students were observed sharing e-course documents using email, WhatsApp and portable drives. With regard to portability, students expressed varying views, with some asserting that carrying one print article is more convenient than carrying a laptop, while others said e-course documents are convenient because a large number of documents can be carried on a portable device such as a laptop or tablet when compared with printed textbooks.

Figure 1. Students' number of A4 sheets consumption (n = 45) (percentage responses)

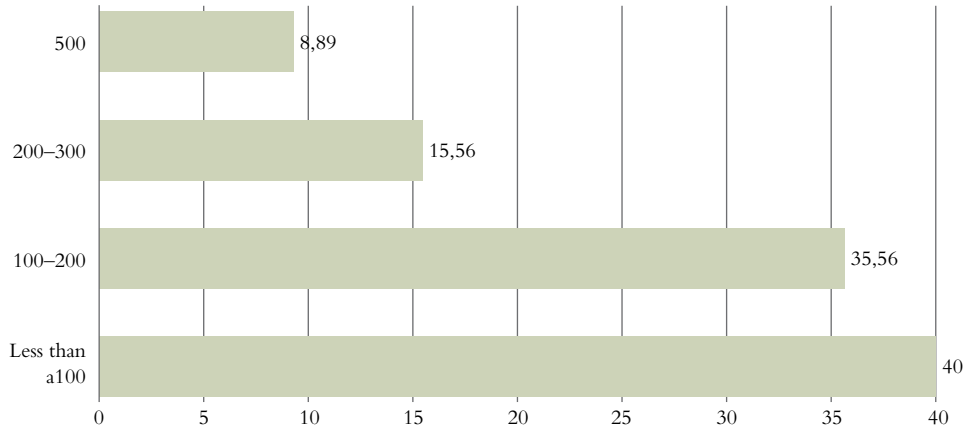


Figure 2. Preferred mode in respect of course materials (n = 47) (percentage responses)

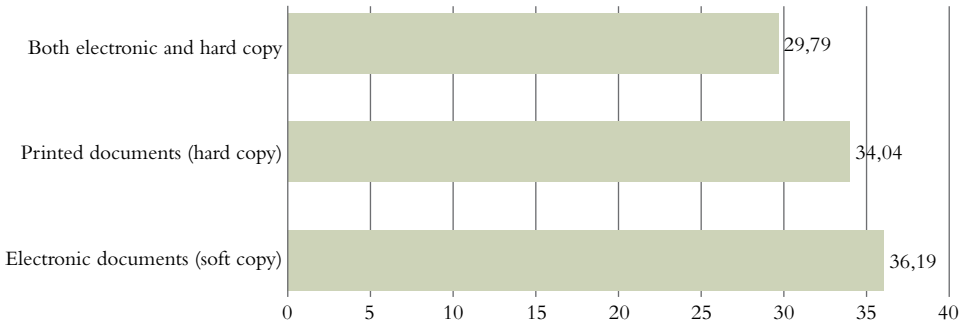
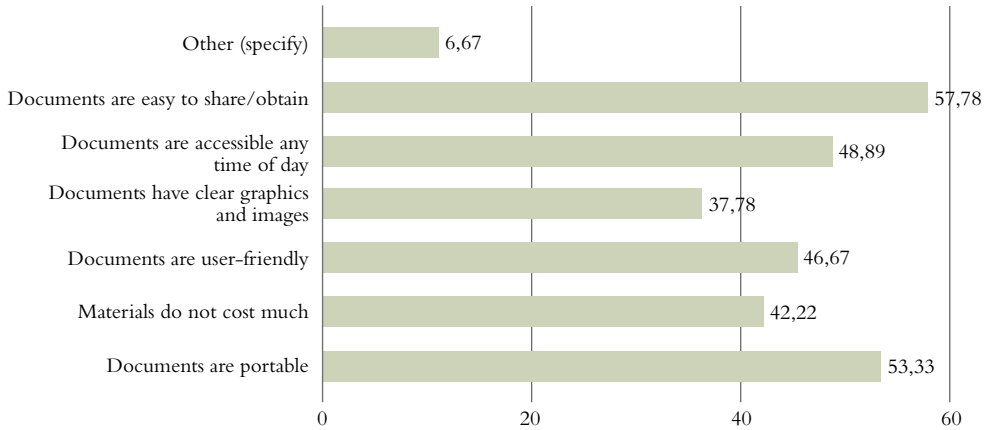


Figure 3. Factors affecting students' preferences (n = 45) (percentage responses)



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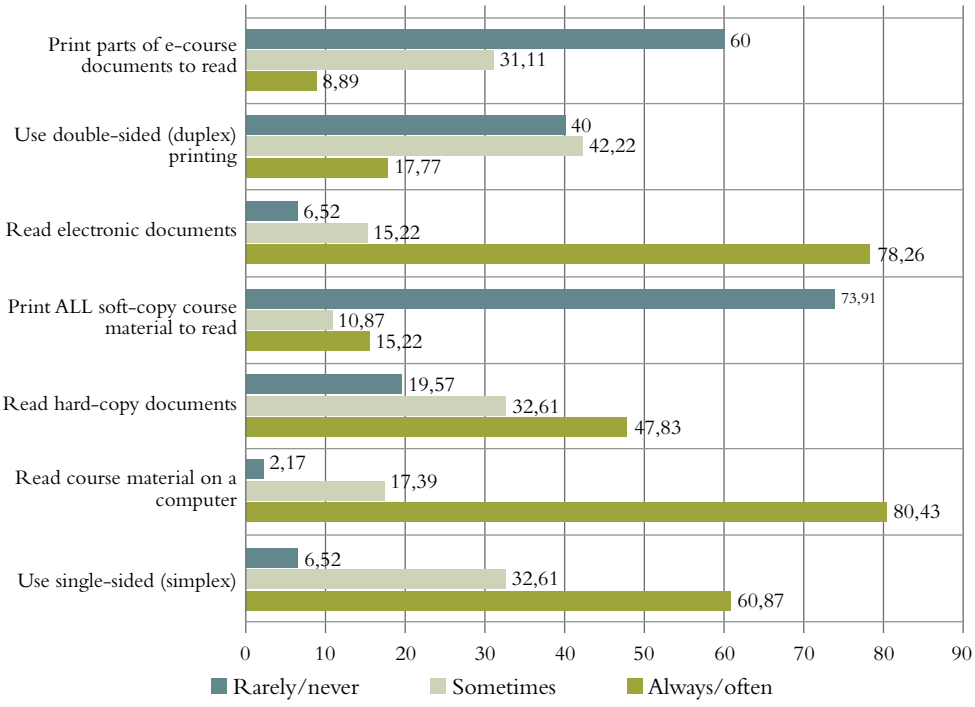
Students' electronic course document use and printing habits

With regard to students' printing behaviours and their attitudes to electronic course documents, between 78 and 80% of them indicated that they read course materials electronically. Of special note is that only a small percentage of the respondents (between 8 and 15%) printed out parts or all the electronic course materials in order to read them. The observed positive attitude to reading e-documents may be attributed to increased ownership of laptop computers and to the electronic mode of delivery of course documents used by the lecturers.

Single-sided (simplex) printing was the most frequently used method of printing among students, with 61% of them reporting that they always used it. An examination of the printed course documents also showed that the majority of students' printed documents were printed single-sided. Most of the printers owned by the students did not have the automatic duplex (double-sided printing) function, while some students said it was not their concern whether duplex printing was used.

Figure 4. Students' electronic document use and printing habits (n = 46) (percentage responses)



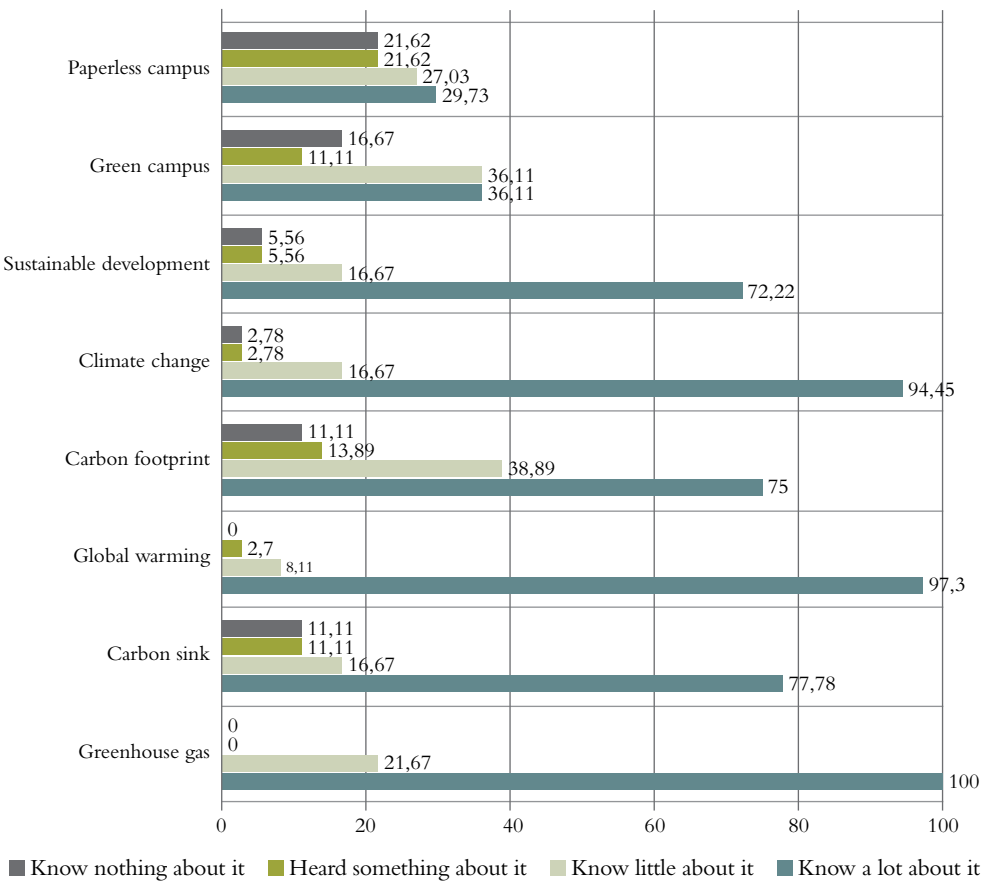
Part 2: Students' knowledge and awareness of the carbon footprint of paper and of climate change concepts

Awareness of climate change and related concepts

When students were asked about their awareness and knowledge of climate change concepts, over 70% of them indicated that they knew a lot about the concepts of greenhouse gases,

global warming, climate change, carbon sinks and sustainable development. In contrast to the high levels of awareness of the concepts of greenhouse gases, carbon footprint and climate change, relatively few (29% and 36%) reported knowing a lot about the concepts of a paperless and green campus, respectively. During the interviews, students admitted that they were not knowledgeable about the concepts of a paperless and green campus, while others said they had heard about them but did not know what they entailed. Therefore, there were notable knowledge gaps regarding the concepts of a paperless and green campus. An open-ended question in the survey that asked students to comment on the link between paper manufacturing and use, on the one hand, and any of the concepts detailed in Figure 5, on the other, showed that over 60% of them were able to relate paper manufacturing and use to climate change. Some remarked that unsustainable paper consumption contributes to deforestation, which, in turn, leads to climate change due to an increase in greenhouse gases, thus hindering sustainable development. One student commented that the use of more electronic devices could help the university become green and paperless, as this would assist in bringing about a reduction in greenhouse gases resulting from paper consumption.

Figure 5. Students' awareness of climate change (n = 35) (percentage responses)



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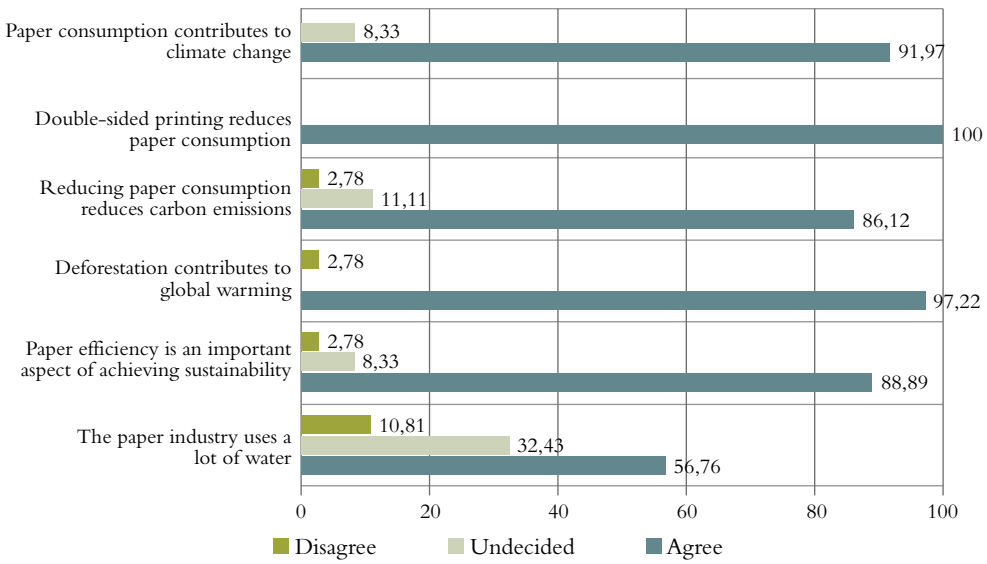
Awareness of the carbon footprint of paper

Almost all the students who answered questions on this were aware of the carbon footprint of paper. All 36 students who responded concerning this aspect knew a lot about the carbon footprint of paper and that efficient paper use is an important aspect of achieving sustainability (see Figure 6). Interviewee data suggests that the carbon footprint of the paper manufacturing industry was well understood. Students remarked that the planting of trees and the recycling of paper could also help to offset the carbon emissions associated with paper. The surveyed students therefore had a high awareness of climate change and of paper's carbon footprint. One could argue that this knowledge enabled them to reduce their paper consumption.

Figure 6. Awareness of the carbon footprint of paper (n = 36) (percentage responses)



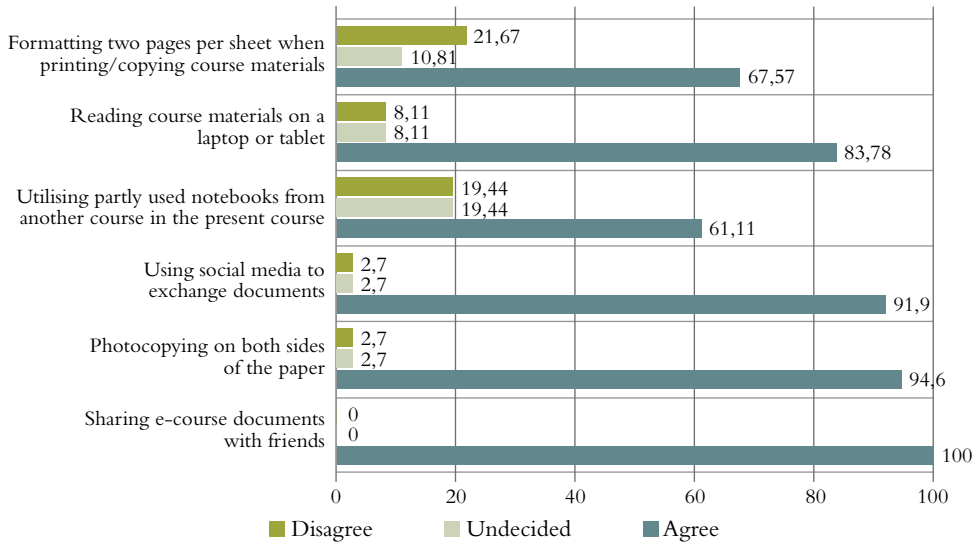
Students' sustainable paper use practices

When asked to indicate which of the sustainable paper use practices listed in the survey they applied, between 61% (n = 22) and 100% (n = 37) of the respondents indicated resorting to the sustainable paper use practices as shown in Figure 7. Interview and observation data confirmed that students employed most of the sustainable paper use practices described in the survey question, except that of duplex printing – despite being aware that duplex (double-sided) printing reduces paper consumption. Utilising both sides of a sheet of paper reduces the amount of paper consumed by half (Counsell & Allwood, 2007) and seems to be the easiest solution for achieving reduced paper consumption. However, such printing is not popular among students because not all students' printers have the automatic duplex function. Nevertheless, it should be borne in mind that the manual method is time-consuming and that the cost of simplex or duplex printing is the same (Mwanza, 2014).

This would suggest that, despite high levels of awareness of climate change-related issues and an ability to link climate change and sustainability to paper consumption, this understanding

may not always feature in students' paper consumption behaviour. Instead, factors like cost and convenience may, in some instances, be more important in shaping their consumption behaviour.

Figure 7. Students' sustainable paper use practices (n = 35) (percentage responses)



Conclusions and Recommendations

Overall, the majority of the students in the sample displayed environmentally responsible behaviours such as printing fewer documents, reusing paper, and reading and sharing electronic course documents. The students themselves attributed their reduced paper use in the two courses to reading electronic course documents and to reduced printing. To engender change in students' attitudes to paper consumption, lecturers must be consistent in exemplifying the type of behaviour change they wish to promote, such as the use of electronic course documents, and should demonstrate a belief in students' capacity to promote changes in their environment, for example by printing less and using e-course documents more often. This would be in line with the social- and behaviour-change theories informing the present study (Ajzen & Fishbein, 1980; Bandura, 1977; Hungerford & Volk, 1990).

With the rising cost of paper and printed textbooks, the use of electronic documents offers academia a cost-effective and efficient way of disseminating, accessing and viewing information. It can reduce the costs associated with purchasing paper and address environmental problems such as carbon emissions and waste-paper management (Counsell & Allwood, 2007; Hannon, 2008; Iqbal & Ahmed, 2015). However, a major constraint in reducing paper consumption is the fact that some lecturers provide hard-copy course documents and reject electronically submitted assignments, preferring instead to have assignments submitted in the form of double-spaced or single-sided hard copies (Smyth *et al.*, 2010). Such an approach may be sending mixed messages to students.

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References

Adomßent, M., Fischer, D., Godemann, J., Otte, I., Rieckmann, M., Timm, J-M. & Herzig, C. (2014). Emerging areas in research on higher education for sustainable development: Management education, sustainable consumption and perspectives from Central and Eastern Europe. *Journal of Cleaner Production*, 62, 1–7.

Ajzen, I. & Fishbein, M. (1980). *Understanding attitudes and predicting social behaviour.* Englewood Cliffs, N.J.: Prentice Hall.

Bandura, A. (1977). *Social learning theory.* Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ.: Prentice Hall.

Bello, A. (2015). Assessing university students' attitude toward green computing practices. International Conference on Future Computational Technologies, Singapore.

Buis, A. (2014). NASA. http://www.nasa.gov/earthrightnow, visited 13 June 2016.

Carr, P. (2015). *Climate change awareness amongst secondary level students and teachers in a Dar es Salaam university college of education (DUCE) affiliated school in urban Tanzania.* Ireland: Trinity College Dublin/University College Dublin.

CBU. (2014). The Copperbelt University Strategic Plan 2014–2018. Kitwe: The Copperbelt University.

Chowdhury, G. (2012). How digital information services can reduce greenhouse gas emissions. *Emerald Insight*, 36(4), 489–506.

Christensen, R. & Knezek, G. (2015). The climate change attitude survey: Measuring middle school student beliefs and intentions to enact positive environmental change. *International Journal of Environmental & Science Education*, 10(5), 773–788.

Conservatree. (2015). *Trees into paper.* http://conservatree.org/learn/EnviroIssues/TreeStats.shtml, viewed 6 August 2015.

Counsell, T. & Allwood, J.M. (2007). Reducing climate change gas emissions by cutting out stages in the life cycle of office paper. *Resources, Conservation and Recycling*, 49(4), 340–352.

CSU. (2015). Cleveland State University paperless campus. http://www urban.csuohio.edu, viewed 3 December 2015.

Ebrary. (2008). *Global students' ebook usage.* s.l.: s.n.

EDF. (2016). Environmental Defence Fund. https://www.edf.org/climate/redd, visited 2 August 2017.

EPN. (2015). The Environmental Paper Network. http://c.environmentalpaper.org/baseline, visited 22 September 2015.

Falc, E. (2013). An assessment of college students' attitudes towards using an online e-textbook. *Interdisciplinary Journal of E-Learning and Learning Objects*, 9.

Gagliardi, M.A. (2007). *The paper consumer's guide to climate change: How to reduce greenhouse gases with smarter paper choices*. Metafore & Gagliardi Group.

GRZ. (2016). *National climate change policy.* Lusaka: Government of the Republic of Zambia.

Hannon, C. (2008). E-texts in the classroom: E-text readers designed for use in higher education will reduce textbook pricing and address environmental concerns. *Educause Quarterly*, 1(11), 12–13.

Hekkert, M., Reek, J., Worrell, W. & Turkenburg, W. (2002). The impact of material efficient end-use technologies on paper use and carbon emissions. *Resources, Conservation and Recycling*, 36(3), 241–266.

Hobsons. (2010). *Pushing paper out the door: Making paperless admissions a campus reality*. Hobsons.

Hungerford, H. & Volk, T. (1990). Changing learner behaviour through environmental education. *Journal of Environmental Education,* 21(3), 8–21.

IFL. (2016). *Intact forest landscapes.* http://intactforests.org/, viewed 3 April 2016.

IPCC. (2007). *Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report.* Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.

Iqbal, H. & Ahmed, F. (2015). Paperless campus: The real contribution towards a sustainable low carbon society. *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)*, 9(8), 10–17.

Lenares, D. (2012). *E-book use and acceptance in an undergraduate institution*. Massachuttes: Springer.

Lozano, R. *et al.* (2011). Declarations for sustainability in higher education: Becoming better leaders through university systems. *Journal of Cleaner Production*, 1–10.

Mapulanga, N. (2013). *Assessing the carbon footprint of refrigerants at CBU.* Kitwe: The Copperbet University.

McKiel, A. (2011). *2011 global e-book students' survey.* Oregon: Western Oregon University.

Mulebeka, D. (2013). *Assessment and quantification of economic losses of water leakages in CBU.* Kitwe: The Copperbelt University.

Mwanza, P. (2014). *Assessing the Copperbelt University students' paper consumption practices and attitudes towards associated carbon emission levels.* Kitwe: The Copperbelt University.

Njaura, A. (2013). Using the theory of planned behaviour to investigate the determinants of environemental behaviour among youth. *Environmental Research Engineering and Management*, 1(63), 74–81.

NPCC. (2016). *National policy on climate change.* Lusaka: Ministry of National Development Planning.

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Ojomo, E., Elliott, M., Amjad, U. & Bartram, J. (2015). Climate change preparedness: A knowledge and attitudes study in southern Nigeria. *Environments*, 2, 435–448.

OrgSync. (2014). *Your campus engangement network*. http://www.orgsync.com, visited 4 January 2016.

PBL. (2016). *Trends in global carbon dioxide emissions: 2016 report*. The Hague: PBL Nertherlands Environmental Assessment Agency.

Robin, R., Potter, S. & Yarrow, K. (2002). Factoring sustainability into the higher education product service. *Journal of Sustainable Product Design*, 2, 105–117.

Robin, R., Potter, S. & Yarrow, K. (2008). Designing low carbon higher education systems: Environmental impacts of campus and distance learning systems. *International Journal of Sustainability in Higher Education*, 9, 116–130.

Smyth, S., Fredeen, A. & Booth, L. (2010). Reducing solid waste in higher education: The first step towards 'greening' a university campus. *Resources, Conservation and Recycling*, 54, 1007–1016.

Stir, J. (2006). Restructuring teacher education for sustainability: Student involvement through a strengths model. *Journal of Cleaner Production*, 14(11), 830–836.

Tenhunen, M. & Penttinen, E. (2010). *Assessing the carbon footprint of paper vs. electronic invoicing.* Associated Information Systems.

UCS. (2013). Union of Concerned Scientists. http://www.ucsusa.org/global_warming/solutions/stop-deforestation/deforestation-global-warming-carbon-emissions.html#.WZ11n42Qy02, visited 17 August 2017.

UNESCO. (2009). *Learning to mitigate and adapt climate change.* Paris: United Nations Educational, Scientific and Cultural Organization.

UNFCCC. (2007). *Climate change: Impacts,vulnerabilities and adaptions in developing countries*. United Nations Framework Convention for Climate Change.

WWF. (2016). World Wildlife Fund. http://wwf.panda.org/about_our_earth/deforestation/forest_sector_transformation/pulp_and_paper/, visited 18 June 2017.

Yin, R.. (2009). *Case study research design methods.* CA: Thousand Oaks.

Zhang, N. (2011). *Greening academia: Developing sustainable waste management at UK higher education institutions.* Southhampton: University of Southhampton.

The Nature of Learning and Work Transitioning in Boundaryless Work: The Case of the Environmental Engineer

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Abstract

Transition is a common characteristic of our lives, particularly in a rapidly changing world. In this context, how careers are enacted has become increasingly varied, requiring new conceptual tools to study the transitions of learners and workers. This paper uses theoretical constructs from the literature on boundaryless career discourse as well as learning and on work transitioning in order to explore the learning pathways of environmental engineers. It thus contributes to empirical work that articulates ongoing transitions (beyond the first job) within 'occupational and organisational life', as well as to the understanding of learning pathways as educational and occupational progression. The career stories help us to understand how non-linear transitions emerge, the complexity of these transitions, and the need to attend to broader institutional arrangements within and across education and training, the labour market and the workplace. Through its focus on the environmental engineer, it helps us to understand the processes and outcomes of transitions in an important occupation in contemporary professional work in South Africa. Finally, in a field dominated by research on entry into a first job, the paper also provides much-needed insights into occupational transitions into specialised work.

Introduction

As societies grapple with the effects of environmental degradation, occupational and educational systems have had to find the means to comprehend the implications. Several recent studies (DEA, 2010; HSRC, 2009) have highlighted many skills and competence issues related to green careers. Provisioning for workplace learning and sustainability practices is poorly constituted and unresponsive to the dynamic nature of environmental work. The environmental 'sector' has relatively new occupations that often lack clear-cut pathways into jobs. At the same time, the occupational contexts surrounding these occupations are rapidly changing with evolving skill needs. The post-school sector thus needs to support pathways into specialist jobs that do not (yet) have clear-cut routes to follow. This complexity raises several challenges. To enable more seamless and responsive transitions into environmental careers, it is critical that we broaden insights into the learning and the work transitioning that underpin environmental-learning pathways.

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Theoretical Perspective

This paper analyses the transitioning processes of environmental engineers in South Africa, and the outcomes of these processes. The analysis suggests that environmental engineers are working in what can be characterised as 'boundaryless careers' (Arthur & Rousseau, 1996). Characteristically, boundaryless careers depict discontinuous career paths that typically go beyond the boundary of a single organisation with a defined career path.

Various authors have recognised a heightened occurrence of transitions in diverse professions (Evetts, 2009; Fenwick, 2013; Sawchuk & Taylor, 2010). Field (2012) reflected that the boundaries and expectations of transitions through the life course are changing, both among individuals and in wider society. An OECD (Organisation for Economic Co-operation and Development) report (2008) noted that transitions are increasingly fragile and exclusionary and that the number of 'stepping stones' required to secure a labour market position is multiplying. Within this, individual learning and work transitions are becoming more challenging (Sawchuk & Taylor, 2010). Individuals are being called on to manage transitions throughout their careers, beginning with the shift from initial post-school education to workplaces. All these observations underpin the critical need for education and work systems to pay attention to *experiences of transitions*.

The notion of *transitions* is also an important concept for understanding wider systemic articulation concerns, providing both structural and systemic insights. It can also provide empirical insights into how various qualifications may or may not articulate, and how changing contexts shape choices, needs and use related to available qualifications.

In reflecting on professionals' educational and occupational progression within environmental careers (Ramsarup, 2017), different dimensions of transitions emerge:

- From education to work (e.g. from a higher-education degree into a job);
- From work to education (e.g. from a job into further study);
- Within education and training systems (e.g. from a formal academic or professional degree course into an occupationally directed [short] course/s); and
- From occupational and work life into wider social processes (e.g. from engineering practice to societal processes providing normative assessments of the practice).

Against these dimensions of transitions, Sawchuk and Taylor (2010) asserted that learning and work transitions extend across the life course, and are increasingly complex, differentiated and differentiating across social groups. All these features raise questions about how transition-related processes can be more effectively managed by individuals, employers, education providers and national skills systems. This paper considers these factors, and how these need to be considered within changing societies and changing occupations, as well as what enables and constrains learning to work transitions in various contexts.

Understanding learning and work transitioning demands a focus on both the transition processes and outcomes, including stages of preparation, and actual transitions and outcomes in the labour market (Hannan, Raffe & Smyth, 1996). This raises the significance of not viewing learning and work transitioning as a 'single point in time event'. Fenwick (2006) found that transition processes are also a process of identity development, which Ecclestone (2009:19) further described

as a slow, subtle process of 'becoming somebody personally, educationally and occupationally'. This challenges more technical views of transitioning that are considered from the perspective of, say, access to education and training, or technical articulations and alignment between qualifications at the level of credits and/or credit transfer. Although these are vitally important as enablers within the broader processes of transitioning, the notion of transitioning processes provides a broader framework and lens through which such issues can be better understood.

Environmental occupations in South Africa typically do not have clearly defined institutionally or occupationally determined pathways (Ramsarup, 2017). The sector is characterised by professionals navigating their own non-linear pathway into a green job (Ramsarup, 2017). This has historical antecedents, most notably the recent emergence of such occupations on the national landscape and the lack of dedicated systems of education and training development for the environmental sector (DEA, 2010). Understanding learning to work transitioning into environmental occupations thus necessitates the use of theoretical ideas from boundaryless career discourse. This assists in more accurately describing and depicting the nature of the work and hence the transition experiences of environmental engineering professionals in these transitioning spaces, as described in this paper.

Boundaryless work is conceived of as the opposite of the organisationally determined career that is characteristically visualised to unfold in a single, pre-structured, vertical qualifications path or employment context. It is thus perceived as taking on many forms and has been described and depicted in various ways, such as:

- Movement across the boundaries of separate employers;
- Drawing validation from outside the present employer;
- Being sustained by networks and information external to the employer;
- Breaking traditional organisational career boundaries; and
- Perceiving a boundaryless future, regardless of structural constraints.
  (Arthur & Rousseau, 1996:6; Roper, Ganesh & Inkson, 2010)

Fenwick (2006) described boundaryless work as involving a sense of specialised expertise being developed and offered, with the career being marked by the development of specialised portable skills, knowledge and abilities. A second element is job mobility across multiple employers, erasing conventional boundaries defining job, workplace and employer. Other authors have added other characteristics of boundaryless work such as personal identification with meaningful work, on-the-job action learning, the development of multiple learning and peer-learning relationships, and individual responsibility for career management (Arthur & Rousseau, 1996; Ensher, Murphy & Sullivan, 2002).

The Context of the Environmental Engineer in South Africa

Internationally, environmental engineering is a recognised and established profession. In the United States of America (USA), it has a professional association in the form of the American Academy of Environmental Engineers and Scientists, founded as far back as 1967. The United Kingdom (UK), too, has the Society of Environmental Engineers. In Europe, the Confederation

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of European Environmental Engineering Societies has 12 member states and environmental engineering is offered as an undergraduate degree in several European countries.

In South Africa, a different scenario prevails, as a more integrative approach seems evident. The Engineering Profession Act (2000) states that the Engineering Council of South Africa (ECSA) will 'create an awareness amongst registered persons of the importance to protect the environment against unsound engineering practices', thus illustrating a policy framework that would appear to require all engineering disciplines to pay attention to environmental considerations.

There are no undergraduate qualifications in environmental engineering. The data informing the present paper (Ramsarup, 2017) shows that environmental engineering is a specialisation of certain engineering disciplines, especially civil and chemical engineering. Environmental engineering degrees are offered at several institutions in South Africa, but only at masters and doctoral level. These tend to specialise in water care, energy studies and environmental geography. Environmental engineering does not exist as a discipline independent of engineering. Thus, even after doing a masters degree, people 'cannot go around saying they are a professional in environmental engineering' (Trois, personal communication, 2013).

A demand for environmental engineers emerged in two national research processes. The Department of Environmental Affairs' national and provincial consultations during the development of the Environmental Sector Skills Plan for South Africa (DEA, 2010) and the scarce skills analysis of the Strategic Infrastructure Programmes (SIPs,[1]) (DHET, 2013) both identified environmental engineering as a scarce skill. The Department of Higher Education and Training (DHET) thus declared environmental engineers as 'significantly scarce' (20%–50%) and '*300 environmental engineers had to be trained in the short term*' (DHET, 2013, emphasis added). Five years ago, a study led by Du Toit and Roodt (2009:52) predicted that, 'with forthcoming environmental legislation and new emphasis being placed on environmental protection in South Africa, increased levels of graduation in environmental engineering will be necessary'. However, a coordinated sectoral response to this demand has not been articulated, neither within related engineering associations nor within the education and training system (National Qualifications Framework structures).

Surfacing the Experiences of Transitions in Boundaryless Work among Environmental Engineering Professionals

Methodological process

The present paper draws on an empirical study of career stories of environmental engineers. These career stories (Cohen & Mallon, 2001) were developed following in-depth interviews

1 The Strategic Infrastructure Programmes are the implementation mechanism for the National Infrastructure Plan of the South African government. This National Infrastructure Plan is overseen by the Presidential Infrastructure Coordinating Commission (PICC). Eighteen SIPs have been identified, which have five core functions: to unlock opportunity, to transform the economic landscape, to create new jobs, to strengthen the delivery of basic services, and to support the integration of African economies. One of the focus areas is greening the economy (PICC, 2012). The DHET (2013) is developing an integrated skills development plan for the next 20 years across all the SIPS.

and analysis of curricula vitae. The stories are drawn from a range of engineering consulting firms and an effort was made to interview individuals of diverse races and ages, for a diversity of stories and, therefore, wider views on the field.

The first layer of analysis focused on understanding the formal chronology of states and transitions in each of the environmental engineering professionals' lives, but also on the ways that they made sense of their transitions from learning to the work situation (i.e. development of the individual cases). This led to the construction of individually unique career stories that were then verified with the interviewees. Multiple layers of analysis of the career stories were then employed in order to deepen the analysis and unfold the underlying generative mechanisms in the individual cases. One layer of analysis focused on the key stages and transitions in the career stories. While people tell their stories very differently, this analytical process enabled the development of a framework for descriptive and analytical work related to the career stories. A further level of analysis using different analytical tools focused in more depth on the *transition processes* instead of on single events. This uncovered *the relational and multifaceted nature of the environmental engineers' learning pathways*. This multilayered analysis of the case stories was extended with a *system analysis* (e.g. analysis of the provisioning system of engineering qualifications, and of the operations and approaches of the professional associations, as briefly noted above in 'The Context… ' above). For the present paper, the wider systems analysis is not included, as the focus here is on the transition experiences of the sampled environmental engineering professionals. More comprehensive insights on how the career stories and systems analysis 'come together' within a systems development perspective can be found in the PhD dissertation by Ramsarup (2017), which brings all these dimensions of the study of environmental sector learning pathways into focus in relation to one another.

Table 1 presents snapshots of the learning trajectories of the interviewees identified in their firms as environmental engineers (despite some not starting out as engineers). Learning pathways within the context of this study were conceptualised as educational and occupational progression (Ramsarup, 2017). Table 1 also reflects the diverse processes that encompass the transition into a specialisation. It should be noted that, while significant progress towards racial equity has been made in the broader engineering sector, this is not evident within the environmental engineering specialisation. We made many attempts to engage with more black environmental engineers, including trolling LinkedIn, but had limited success. Despite the fact that these individuals entered from different qualifications and specialisation paths (including chemical engineering, civil engineering and landscape architecture), their career stories reflected a strong preference for and intention to work in an environmental context, combined with engineering work options. The stories also demonstrated that transitioning into a specialised environmental work role presented many challenges, like organisational fit and sectoral and professional identity. The findings further highlighted the role that professional learning and professional networks play as people forge occupational identities within specialisations.

The interview data revealed many differing opinions on how environmental engineers should be viewed and trained in South Africa. This is discussed next.

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Table 1. Overview of interviewees' career stories: Key educational and work transitions

Interviewee	Demographic	Story
EE1	White male	Did a BTech (Civil Engineering), a BCom part-time, a Diploma in International Project Management, and an MSc (Built Environmental Sciences). Currently doing a PhD. Always had an interest in human impact on the environment. Worked abroad in Lesotho, Botswana and Nepal. Getting involved with the Green Building Council gave him an opportunity to influence many technical advisory teams in diverse sectors. The transition from the engineering sector to the environmental sector took seven years. Currently a sustainability consultant focusing on Green Star energy-optimisation certification.
EE2	White male	Obtained a degree in landscape architecture from the University of Pretoria and was awarded a bursary by the Department of Water Affairs (DWA). Used short courses and work experience to develop his environmental career. Started off as a technician at the DWA in a unit for 'special tasks'. Worked closely with engineers at the DWA and created a new awareness about the environment. Team synergy and mentorship at the DWA allowed him to build on, and use, the environmental knowledge and experience of the team. Later became an environmental consultant and took on a different range of work, including spending six years on the Lesotho Highlands Water Project.
EE3	White male	Obtained an honours and a masters degree in Botany from Rand Afrikaans University. Worked at the Department of Agriculture for 12.5 years. Moved to the Department of Development Aid as Head of Nature Conservation, which was later absorbed into the Department of Environmental Affairs (DEA). Worked on legislation and policy, including the National Environmental Management: Biodiversity Act. Then left government and joined an engineering firm as a private consultant.
EE4	Black male	Always wanted to work in the environmental sector. Did a BSc (Chemical Engineering) at the University of Cape Town (UCT) because there were no undergraduate options for environmental engineering. In his fourth year, attended a course in environmental process engineering. Did his MSc (Environmental Engineering) at the University of KwaZulu-Natal (UKZN), which provided him with a broader environmental knowledge base. Decided that environmental chemistry was the field for him. First job was working with waste at a large engineering company. Then moved to an environmental consulting company, which was later taken over by a large engineering firm, which then sold off the energy services unit.

Interviewee	Demographic	Story
EE5	Indian female	Had an interest in mathematics and science in school. Obtained a BEng (Chem.) degree. In her fourth year, a talk on environmental legislation excited her. She worked for the DWA, as well as on a project dealing with acid mine drainage. This further ignited her interest in the environment and in doing something good for the planet. Next, she worked for a large oil company for two years, where she witnessed some engineers showing complete disregard for the environment in their planning and design. She then moved to an engineering company which carried out environmental-impact assessments and processed environmental permits, mining applications, etc. After ten years, she left and now works as an independent environmental engineering consultant on engineering projects.
EE6	Indian female	Obtained a BSc degree with honours in Medical Biochemistry and Genetics, and then an MSc in Biotechnology and a PhD in Civil and Environmental Engineering (focusing on organic degradation and bacterial populations) at the University of the Witwatersrand. She then worked at an engineering company involved in waste management. Thereafter, she left to pursue numerous researcher positions. Next, she worked as a process engineer/environmental scientist at an engineering company specialising in waste. She moved again and is now an environmental/waste engineer at an international engineering company.
EE7	White male	Did a BSc (Civil Eng.) at the University of Pretoria. He worked at a large national engineering company as a design engineer, then left to join an environmental consultancy where he became an associate. Next, he moved to an engineering company. He currently works at a large engineering company as an environmental engineer and auditor.
EE8	Black male	Is not a South African and did his schooling and undergraduate studies overseas. Originally from the Democratic Republic of Congo, he studied in the UK and then worked there for an engineering company focused on water issues. He became involved in mining work and came to South Africa through an international mining house. He currently works as an environmental engineer in a large mining company.
EE9	White male	Did his schooling in Europe and an undergraduate degree in environmental engineering in Italy. He was employed by a large international engineering consultancy, through which he came to South Africa to support environmental projects. He then did a masters degree in Environmental Engineering in South Africa. He currently works in a large South African firm as an environmental engineer.

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Insights into Occupational Mobility and Learning in the Transition to Specialised Work

The data reflected two main mobility patterns. Firstly, in all the stories, there was considerable intra-organisational movement, largely in the form of lateral movement caused by engineering workplaces needing an 'environment' person for various project-based assignments. Secondly, there were frequent job moves between two organisational types, engineering consultancies and environmental consultancies. All the stories show this occupational and organisational change, which involved internal and external lateral movement in order to facilitate the development of specialist competencies. Table 2 shows the job moves of one interviewee. While this story is individually unique, other cases show a similar pattern.

Table 2. Extract from a career story of occupational progression

Interviewee EE2		
Work after university study	**1**	Landscape architects and environmental planners Vacation work
	2	Environmental consultancy Environmental officer
	3	Engineering consultancy Landscape architect Associate
	4	Environmental consultancy Associate Senior associate Director
	5	Engineering consultancy Director and head of environmental division Leader for Environmental Work in Africa in international engineering company
Work during study		Landscape architects and environmental planners Vacation work

The mobility pattern in Table 1 clearly depicts non-linear occupational progression. This is in contrast to the official engineering learning pathway maps, consisting of parallel ascending movements from undergraduate to candidacy to specialisation (Engineering Council of South Africa and engineering careers literature, as reviewed in Ramsarup, 2017). The environmental engineering pathways in this study show more (time-consuming) sideways movement in order to attain the levels of specialisation needed for high-level environmental engineering work.

Furlong, Cartmel and Biggart (2006) describe non-linear transitions as involving breaks, changes of direction, and unusual sequences of events. Non-linear transitions can include extended or repeated experiences of unemployment, frequent moves between jobs, and returns to education and training after periods in employment. However, the experiences of the South

African environmental engineers detailed in this study do not match the Scottish experiences cited by Furlong *et al.* (2006), who conclude that people with high-level qualifications (especially a degree or equivalent) are more likely to follow linear, upward transitions. Rather, in the present study, it was found that South African engineers with high-level qualifications follow non-linear transitions in order to attain specialist competence in environmental engineering.

These mobility patterns challenge the idea of a linear developmental trajectory for environmental engineering professionals envisaged in the institutional pathway, as well as the normative pattern of an engineering pathway. There are complex lateral movements, catalysed by a growing need to address environmental issues and by an increase in environmental work noted by all interviewees, resulting in new needs in diverse and changing work contexts. These new needs and associated work experiences seem not to be adequately recognised within either the professional context *or* in the qualifications system. That more substantive attention needs to be given to the systemic dynamics of this occupation is borne out by the studies of the HSRC (2009), DEA (2010) and DHET (2013) which all found environmental engineering to be a scarce skill.

Within the career stories, the transition into the specialised field of environment-related work appeared to be 'unconscious' and somewhat ad hoc: one interviewee reflected that engineers 'stumble into this route in the workplace'. Only one of the interviewees had a deliberate intention to enter engineering and specialise as an environmental engineer. Nonetheless, all interviewees are currently regarded in their work contexts as practising environmental engineers. Interviewees were not able to pinpoint a turning point in their career trajectory into environmental work. Their stories illustrate that various exogenous factors prompted their deviation from their established career path, for example as a civil engineer. Labour market forces ultimately determine what work or project options are available, thus changing occupational configurations and creating new choices such as contract work. While supply and demand conditions were structural influences (Ibarra, 2004) on the transitioning process of these professionals, the personal adaption to this new work role can also be viewed as self-initiated, suggesting that agentive dynamics are also influential in the transitioning process. This work-role transition process is not guided by institutionalised transition processes but involves elements of separation and incorporation simultaneously. For example, a number of the engineers left engineering companies to work in environmental consultancies but subsequently returned to the engineering sector, and those who were in the engineering sector were seen as 'part outsiders', as their occupation was not a 'normal' version of engineering practices. Such occupational conditions make for a difficult transitionary process (Ibarra, 2004).

Another major issue was that the environmental engineers struggled to find their organisational fit, reporting that they did not have a clearly defined work role. As one interviewee reported, as 'the environmental guy' in the office he was always 'treading a fine line between being outspoken around environmental issues and maintaining the core business focus' of the engineering firm employing him. Several of the environmental engineers reported that they struggled to find a niche where they belonged. One interviewee, who also struggled with balancing business work and environment work, stated that it was 'difficult being an activist

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in a business'. Most of the engineers also had to wrestle with uncertainties and incomplete information, which are recognised features of a less-bounded organisation and of boundaryless work where people, contexts and processes are all always changing. Arthur and Rousseau (1996:21) noted that, in these instances of uncertainty: '[P]eople fill in the blanks […] people making sense of uncertainty enact a structure in which to work. Micro-level processes shape macro-level organising.' All of the career stories reveal a dual learning process: a realisation of their own fluidity in continually escaping the fixed subject position allotted by the 'normal' engineering workplaces, and an engagement with 'external concerns' such as environmental issues, both of which reflect a growing awareness of their own subjectivities and their role in producing these subjectivities in the organisational context (Fenwick, 2006).

Livingstone and Scholtz (2010) remind us that individuals cope with changing environments by learning – and this is apparent from the career stories, all of which illustrate the significant role of learning throughout the life course. As work practices started to change and new work roles emerged, the need for regular and continuous learning became evident. The career stories all demonstrated transitions between different forms of learning, including formal and informal learning.

Formality and informality in learning is a relational continuum (Colley, Hodkinson & Malcolm, 2003). However, for the sake of analytical discussion, it is necessary to make a distinction between these, as this enables elaboration on the full range of learning processes that these professionals engage in. Across the cases, work-based, experiential forms of learning were supplemented, largely by short course-based formal learning. The nine interviewees had, between them, completed 66 short courses. Of these courses, 44% were environment-related, 30% were engineering-related and 26% were general in nature (encompassing, for example, business writing, communication, computers, and power speaking). The dominance of environmental courses reflects their interest in and need to develop specialised environmental knowledge. The range of courses reflects different dimensions of an environmental specialisation, including: green building technologies; environmentally sustainable design; environmental law; integrated environmental management; energy efficiency technology; environmental-impact assessment; underground environmental control; and bioethics. The range of courses completed also reflects the consulting-work environments of the engineers and an articulated need for a diverse mix of environmental knowledge and skills. Some also reflected that they were reluctant to enter a postgraduate specialisation, as some of the masters courses were too specialised in one area (e.g. waste or water), which was not what they required for the more unfocused consulting industries in which they were working. Only two interviewees undertook a masters, in Environmental Engineering, and both indicated that it provided a 'language of interaction' but not the more in-depth knowledge they were seeking. The dominant, institutionally conceived pathway for formal learning and specialisation was not the preferred option of the practitioners interviewed.

The study illustrated that, in order to become environmental engineers, the engineers were of necessity and by choice actively engaging in upskilling and reskilling beyond organisational boundaries. They had taken active responsibility for their own learning and had subsequently crafted a path across and into a newly emergent field of practice.

Negotiating the Boundaries

The discussion above helps to contextualise the transitioning experiences of engineers into an environmental engineering specialisation in South Africa, and indicates that, as described by Fenwick (2006:23) in her work on boundaryless careers, there is a certain form of 'freedom evident in the new practices and spaces of subjectivity that open in their nomadic movements across organisations, knowledges and working relationships'.

In this section, we highlight some of the dynamics of negotiating boundaries that have emerged. The career stories developed and analysed for this research have illustrated that the professionals concerned engage in crossing boundaries between organisations and occupations and, in the process, are creating new vocational identities.

While most research on occupational transitions has focused on initial career choice (Sullivan, 1999), this paper has illustrated that adults make occupational choices throughout their working lives and that the occupational focus in their career is strengthened as their area of specialisation is concretised. Tolbert (1996) emphasises that, as organisations become less important in defining career pathways, occupations will become more important. This suggests an increasing centrality of occupations in career arrangements (and potentially also in skills development system planning and provisioning). This would mean that people's occupationally based careers provide a means for signalling their ability and competence to employers and the labour market more broadly. This, in turn, requires a social understanding of the clearly defined set of skills and knowledge, and, in the case of the environmental engineering occupation, values. This social understanding sets a distinctive set of tasks against which these skills and knowledge can be applied in an occupation, and against which an occupational group member can be held responsible. This, Tolbert (1996) argues, lays the foundation for the occupational labour market – something that needs to be more carefully considered in the case of environmental engineering. Although it is now designated as an occupation within South Africa's formal occupational system, no clearly accepted occupational tasks and understandings have been defined (Ramsarup, 2017).

Fenwick (2006) recognised that boundaryless workers continually struggle with, and balance, the boundaries defining knowledge and scope of practice. These struggles are clearly depicted in the evidence of reversible transitions and the extended transitioning in the career stories outlined in Table 1. All the interviewees indicated that they had combined work and study, and they all experienced 'reversible transitions' where they moved in and out of education and paid work, engaged in work and full-time study at the same time, and learnt in different ways and different places.

The stories contain accounts of extended transitioning where some had taken up to eight years to gain their specialist subjective positions. For some, this involved multiple entry attempts, spells of unemployment, and periods of underemployment. The data indicates numerous lateral movements as environmental engineering professionals chose to gain experience in different work environments that enabled the development of specialist knowledge.

Blurred boundaries between education and work traverse these career stories, indicating that work and learning are inseparable for understanding the fullness of occupational transitions.

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Learning-to-work transitions that occur after occupational entry are complex and diverse, and also show that the nature of work cannot be separated from analyses of learning-to-work transitions, especially in a context where the occupational/work systems are undergoing transformation.

These stories illustrate that transitioning into work is not a single event, as all of the environmental engineers sampled were all working while studying and the work experience gained during their studies was critical for their occupational progression. While engaging in work, especially within new projects, the need for diverse forms of expert knowledge and specialised skill was highlighted, for example regarding new legislative, compliance and ethical demands.

Critical to skill specialisation and the development of specialised knowledge were the interdependent roles of work and experience, complemented by various forms of specialist training. All raised new demands, with the result that employees engaged in learning informally, but also in formal learning through short courses. Because boundaryless workers are not being developed to work for a particular firm, there is therefore a need to support the development of transferable skills in order to enable movement across organisational and occupational boundaries.

The career stories all confirm that networks are important in boundaryless work where people take responsibility for their own career paths. Interviewees all sought to belong to common groups and associations and to cultivate networks that could help them in providing information and in identifying career opportunities. Although the environmental engineers in this study all belonged to relevant associations of engineering professions, they all *additionally* sought to belong to 'other' environmental networks (e.g. the International Association for Impact Assessment, the Green Building Council and the Institute for Landscape Architecture in South Africa). Sullivan (1999) noted that professional networks provide boundaryless workers with a competitive edge in relation to career advancement, mobility and learning, and Arthur and Rousseau (1996) argued that networks serve as learning systems: gaining access to a network in effect means gaining access to another's knowledge and resources. Fenwick (2006) would also argue that networks may help the environmental engineers to define their subjectivity and subject position. The ambiguity of transition is mitigated within networks where individuals in transition have 'role models' and guiding figures that embody future possibilities, give advice and 'believe in the dream'.

Highlighting the need to pay attention to new work structures, Fenwick (2013) draws attention to inter-professional work that requires collaboration, with specialist professionals bringing diverse forms of expert knowledge to collaborative practice. This new work structure challenges boundaries of professions as 'expert domains'; boundaries may be recreated in new ways as practitioners are positioned to each represent their area of expertise in collaborative work. This demands new capacities among professionals who need to 'patch together diverse knowledges' and quickly negotiate work infrastructure and governance (Fenwick, 2013).

The stories of the environmental engineers all reflect that their transitional experiences were made significantly more complex by the fact that, within consulting environments, their work was largely project based. Reflecting on the shift to project-based work in the

construction sector in Sweden, Ekstedt (2007) raised some pertinent points. Project-based work is characterised by tight deadlines and a focus on results and performance demands, which create stress. This was also reflected by one of the interviewees, who explained his experience of transitioning into project work as follows: 'Straight into consulting work was very difficult […] it meant you already had to be a specialist within, without having worked in the processes, so you [were] thrown in the deep end and you eventually [discovered] how [the] processes [worked].' Ekstedt (2007) explained that individuals are learning throughout the project based on tasks that are their responsibility, resulting in companies often forfeiting training outside project work in favour of 'on-the-job training'. This results in promoting a 'transition from organisation-based knowledge to individual-based knowledge' (Ekstedt, 2007). A critical consequence of this transition is that individuals must assume more responsibility for their careers. Project-based work is focused on expertise and people have to market and profile their competence. Thus knowledge development and the way knowledge is developed and circulated in professional communities are important for understanding learning and work transitions.

Some Implications for Organisations and Education and Training Systems

Workplaces and education and training systems, in their role of supporting transitions, need to acknowledge that the way people enact their careers is changing. Boundaryless career practices require us to envisage career development and career guidance differently. Pathways need signposts (entry; work-based; non-institutional as well as professional), and people must learn how to navigate these, especially when destinations are not clear. All of the interviewees experienced challenges finding a path to a specialisation in environmental engineering, and, with the exception of one, all had little information on how they could specialise in this field as they entered the workplace.

Understanding access to specialisms is a critical consideration for career-guidance systems, where the emphasis is currently on entry into generic occupations (Ramsarup, 2017). Access into specialisms is not easy to represent, as detailed by a career-guidance specialist (FN3) interviewed for this study:

> *… more than one basic area of expertise they need to get under the belt, then a postgraduate and then you still needed to add something like short courses, or work experience, etc., etc. On top of that … the researchers indicated that it was very difficult to plot and is not the advice you can give to a matriculant …* (FN 3)

However, we cannot ignore this need, especially when the demand for the skill has significant development implications. Messages about becoming an environmental engineer in South Africa are incomplete and mixed, as there does not appear to be a general systemic and clearly articulated understanding of what environmental engineering *is* in a South African context, of what work they do, and of what a candidate needs to study to become an environmental engineer. The study found inconsistencies in career information within the

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engineering sector and through the National Career Advice Portal. Universities are unable to give learners clear information on what to study, or how to get there. Within the Organising Framework for Occupations (OFO), environmental engineering has very recently been recognised as an occupation. However, observation data and field notes assembled for this study (Ramsarup, 2017) indicate that this recognition is not widely shared in the engineering sector. Some regard it as a specialisation of chemical engineering, some as a specialisation of civil engineering, and some (FN1, FN2) see it as an unnecessary job provision, indicating that civil-engineering teams can simply work with an environmental manager. This presents a challenge; if the labour market cannot clearly identify with the occupation, graduates are likely to struggle to get employment. This was reflected in one of the career stories that showed how a young graduate with a masters, in Environmental Engineering failed to secure a job for about eight months – despite it having being reported by national government as a 'scarce skill' occupation.

The following discussion by Breen (2005), reflecting on data from 27 OECD countries, is useful. He explains:

> *two key aspects determine how people fare once they leave education; the degree to which educational systems inculcate specific rather than general skill, and the extent to which there are direct links between education systems and employers … A greater emphasis on specific skills and a closer link between schools and employers lead to an easier transition from education to labour market, because they send a very clear signal to employers about the potential productivity of a given job seeker.*

For smoother transitions, people need information, guidance and 'systemic articulation' (i.e. joined-up systems) that would enable the education system to signal, to the labour market, the suitability of a particular jobseeker for a particular job (Breen, 2005; Sawchuk & Taylor, 2010). A further consideration would be the need for sector signalling into the education system. The present study could be seen as an example of how a sector may be signalling into the education system (e.g. via the DHET indicating a scarcity of 300 environmental engineers in a major developmental context, i.e. the SIPs skills planning processes). This case study also illustrates that the system has as yet not been able to respond to the demand for this occupation. It seems that the education system was unprepared and is now faced with trying to develop new skills with a pathway that is reliant on the agentic processes of individuals, without adequate systemic 'infrastructure' to respond to the substantive need.

The wider issue is that the education and training system in South Africa is *reactively* oriented to skills development for environmental work across a wide range of occupations and sectors, and thus requires substantive interventions to reorient to a more proactive orientation (DEA, 2010; HSRC, 2009; Lotz-Sisitka, Ramsarup, Gumede, Togo & Rosenberg, 2013).

Policy perceptions of, and associated research into, *educational transitions* remain of critical importance, as explained thus by Te Riele (2004:247): 'The way policy conceptualises educational transition affects the structures and practices available to young people (through imposed reforms and funding), thus enabling some forms of transition and hindering others.'

Conclusion

The transitioning experiences from these career stories illustrate how established engineering transition routes have become more protracted and unpredictable (Field, 2012). They are a reflection of how the emerging environmental discourse is being appropriated and assimilated into an established field of practice. The environmental engineers' career stories indicate the complexity of transitions and the need to pay attention to learning and work transitioning across organisational and occupational life. They thus also highlight implications for education and training system planning across subframework boundaries within the National Qualifications Framework. Transitioning provides a mechanism for researching coherence, collaboration, and possibilities for communication across a system and its subframeworks, each with their own differentiated form and function. The career stories thus demonstrate that assuming linearity ignores the complexity of transitions, as many students combine work and study, and engage in transitions between different forms of learning.

Raffe (2003) has emphasised that, to design effective education and training system policy (e.g. articulation policy), we need to understand the real pathway, as experienced in society, so that we can determine if the pathways on which policies are based correspond to it. If they do not, he argues, the policies could be flawed. He cautions that official pathways can become inaccurate when there has been rapid change. In the case of environmental engineers in South Africa, the experienced pathways (i.e. extended transitioning routes) may not be realistic in order to address the immediate demands of scarce skills and developmental priorities.

At a broader level, the present paper has demonstrated some of the problems with reactive approaches to skills planning that are linked to the emergence of new occupations and associated complexities. It raises the need for a review of the current supply platforms into environmental engineering, the need for more structured learning programmes for specialisms, and the need for extensive advocacy within the labour market so that these specialisms can be more broadly accepted.

Notes on the Contributors

Presha Ramsarup works in the Centre for Researching Education and Labour (REAL) at the University of the Witwatersrand, South Africa. Her recent PhD research focused on green skills learning pathways was aimed at investigating the nature of learning pathways for sustainable development and a green economy in South Africa.

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References

Arthur, M.B. & Rousseau, D.M. (1996). The boundaryless career as a new employment principle. In M.B. Arthur & D.M. Rousseau (Eds), *The boundaryless career*. New York: Oxford University. (pp. 3–20)

Baruch, Y. (2006). Career development in organizations and beyond: Balancing traditional and contemporary viewpoints. *Human Resource Management* Review, 16(2), 125–138.

Breen, R. (2005). Explaining cross national variation in youth unemployment: Market and institutional factors. *European Sociological Review*, 21(2), 125–134.

Case, J. Issues facing engineering education in South Africa. http://www.academia.edu/195145/Issues_facing_engineering_education_in_South_Africa, visited 24 April 2013.

Cohen, L. & Mallon, M. (2001). My brilliant career? Using stories as a methodological tool in careers research. *International Studies of Management and Organisation*, 31(3), 48–68.

Colley, H., Hodkinson, P. & Malcolm, J. (2003). Informality and formality in learning. A report for the Learning and Skills Research Centre. Lifelong Learning Institute, University of Leeds, London.

DEA (Department of Environmental Affairs). (2010). *Environmental sector skills plan for South Africa*. Pretoria.

DHET (Department of Higher Education and Training). (2013). *Meeting the demand for SIPS scarce skills*. Pretoria.

Du Toit, R. & Roodt, J. (2009). *Engineers in a developing country. The profession and education of engineering professionals in South Africa*. Pretoria: HSRC.

Ecclestone, K. (2009). Lost and found in transitions. In J. Field, J. Gallacher & R. Ingram (Eds), *Researching transitions in lifelong learning*. Hoboken, New Jersey: Routledge. (pp. 9–27)

Ekstedt, E. (2004). Paper presented at the EU–Japan Workshop on Corporate Social Responsibility and Changing Wage Systems – The role of trade unions, 26 & 27 November 2004. Hitotsubashi University, Tokyo.

Ekstedt, E. (2007). A new division of labour: The 'projectification' of working and industrial life. *Agire*, 31–54.

Ensher, E.A., Murphy, S.E. & Sullivan, S. (2002). The boundaryless career in the entertainment industry: Examining the employment experiences of executive women. In M.A. Peiperl, M.B. Arthur & N Anand (Eds), *Career creativity: Explorations in the remaking of work*. Oxford: Oxford University. (pp. 229–254).

Evetts, J. (2009). New professionalism and new public management: Changes, continuities and consequences. *Comparative Sociology*, 8, 247–266.

Fenwick, T. (2006). Escaping/becoming subjects: Learning to work the boundaries in boundaryless work. In S. Billet, T. Fenwick & M. Somerville (Eds), *Work, subjectivity and learning: Understanding learning through working life*. The Netherlands: Springer.

Fenwick, T. (2013). Understanding transitions in professional practice and learning. Towards new questions for research. *Journal of Workplace Learning*, 25(6), 352–367.

Field, J. (2012). Transitions and lifelong learning: Signposts, pathways, road closed? *Lifelong Learning in Europe*, 1, 5–11.

Furlong, A., Cartmel, F. & Biggart, A. (2006). Choice biographies and transitional linearity: Reconceptualising modern youth transitions. *Revista de Sociologia*, 79, 225–239.

Hannan, D.F., Raffe, D. & Smyth, E. (1996). Cross-national research on school to work transitions: An analytical framework. Paper commissioned by the OECD Secretariat to provide background for the Transition Thematic Review. http://www.oecd.org/dataoecd/39/59/1925587.pdf.

HSRC (Human Sciences Research Council). (2009). Guidelines towards a human capital development strategy in the biodiversity sector. Research report. Lewis Foundation & the South African National Biodiversity Institute (SANBI). Pretoria: HSRC.

Ibarra, H. (2004). Career transitions and career change. INSTEAD Working Paper Series. France: INSTEAD.

Livingston, D.W. & Scholtz, A. (2010). Work and learning in the computer era: Basic survey findings. In D.W. Livingston (Ed.), *Lifelong learning in paid and unpaid work. Survey and research findings*. New York: Routledge. (pp.15–57)

Lotz-Sisitka, H., Ramsarup, P., Gumede, M., Togo, M. & Rosenberg, E. (2013). Green skills development in South Africa. System perspectives for the shaping of learning pathway possibilities for sustainable development, the green economy and climate resilient development. Unpublished Discussion Paper. Grahamstown: Rhodes University.

Ng, T.W.H., Sorensen, K.L., Eby, L.T. & Feldman, D.C. (2007). Determinants of job mobility: A theoretical integration and extension. *Journal of Occupational and Organizational Psychology*, 80, 363–386.

OECD. (2000). *From initial education to working life: Making transitions work*. Paris: OECD.

OECD. (2008). Employment outlook 2008. Paris: OECD.

PICC (Presidential Infrastructure Coordinating Commission). (2012). *A summary of the South African National Infrastructure Plan*. Pretoria: Office of The Presidency.

Raffe, D. (2003). Pathways linking education and work: A review of concepts, research, and policy debates. *Journal of Youth Studies*, 6(1), 3–19.

Ramsarup. P. (2017). A critical realist dialectical understanding of learning pathways associated with two scarce skill environmental occupations within a transitioning systems frame. Unpublished PhD dissertation, Rhodes University, South Africa.

Roper, J., Ganesh, S & Inkson, K. (2010). Neoliberalism and knowledge interests in career discourse. *Work, Employment and Society*, 24, 661–679.

Sawchuk, P. & Taylor, A. (2010). Understanding challenging transitions in learning and work. In P. Sawchuk & A. Taylor (Eds), *Challenging transitions in learning and work*. The Netherlands: Sense Publishers. (pp. 1–25)

Sullivan, S.E. (1999). The changing nature of careers: A review and research agenda. *Journal of Management*, 25(3), 457–484.

Sullivan, S.E. & Baruch, Y. (2009). Advances in career theory and research: A critical review and agenda for future exploration. *Journal of Management*, 35(6), 1542–1571.

Te Riele, K. (2004). Youth transition in Australia: Challenging assumptions of linearity and choice. *Journal of Youth Studies*, 7(3), 243–257.

ISSN 2411-5959 | DOI 10.4314/sajee.v.33i1.8

Tolbert, P.S. (1996). Occupations, organisations, and the boundaryless career. In M.B. Arthur & D.M. Rousseau (Eds), *The boundaryless career.* New York: Oxford University Press. (pp. 331–349)

Wheelahan, L. (2009). Programs and pathway. A report prepared for the Pathways Project. School of Education and Professional Studies, Griffith University.

Websites

www.aaees.org, visited 24 April 2013.

www.ceees.org, visited 24 April 2013.

www.ecsa.co.za/about/SitePages/What%20Is%20ECSA.aspx, visited 24 April 2013.

www.engenius.org.za/Search.html?ordering=&searchphrase=all&searchword=environmental+eng, visited 24 April 2013.

www.environmental.org.uk/content.php?p_id=1&top, visited 24 April 2013.

www.gostudy.mobi/careers/View.aspx?oid=550, visited 13 December 2013.

Personal communication

Trois, C. (7 August 2013), Dean of Engineering, University of KwaZulu-Natal, South Africa.

Field notes

FN1: SIPS Meeting with Consulting Engineers South Africa (CESA) (September 2013).

FN2: SIPS Occupational Task Team meeting (30 September & 1 October 2013).

FN3: Discussion with Eureta Rosenberg on PACE career resources (4 October 2013).

Viewpoint

Environmental Education in Teacher Education: A Viewpoint Exploring Options in South Africa

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Abstract

Environmental knowledge is often regarded as difficult to define and position in education in general and in teacher education in particular. This presents challenges for both knowledge production and for curriculum development for teacher education programmes. While many 'traditional' disciplines have well-defined knowledge bases developed over time, environmental education does not, and is also less easy to integrate into teacher education programmes.

In this paper, the policy framework for teacher education in South Africa is explored so as to develop ideas for knowledge selection and inclusion in environmental education for professional (teacher) education in South Africa. The works of Short (2002) on mission/practical knowledge and of Ball, Sleep, Boerst and Bass (2009) on high-leverage practices in teacher education curricula are used as ways of doing in order to enable environmental education. It is contended that these processes can provide ideas to exploit the generative spaces that exist in national policy for inclusion of contextualised, issue-based knowledge for curriculum organisation and of practice-based processes in order that environmental issues and sustainability goals may be included in teacher education curricula in South Africa.

Introduction

South Africa has made progress, in both the policy and practice spheres of education, in including environmental issues in formal education curricula. The right to a healthy environment has been enshrined in the South African Constitution through the Bill of Rights, and directives for including environmental issues in formal education have been made in the *White Paper on Education and Training* (1995) as well as in the various curriculum iterations for schooling that have followed in its footsteps since 1997. This has had implications for teacher education, training and provision. The means by which educators achieve the goal of teaching learners about the environment and environmental issues are as important as the curriculum provisions themselves and have implications for pre-service and in-service teacher education.

In 1991, Fien noted that, if environmental education were to be one of the social agencies through which the transformation to an ecologically sustainable society is to be achieved, the role of teachers as change agents is vital. Tuncer, Tekkaya, Sungur, Cakiroglu, Ertepinar and Kaplowitz (2009) argued that teachers can play an important role in advancing the

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environmental literacy of future generations. Insufficient teacher preparation has been identified as one factor weakening environmental education efforts (Knapp, 2000). Cutter-McKenzie and Smith (2003) emphasised that adequate environmental education preparation of student teachers is essential for helping future teachers to implement effective environmental education. While the South African school curriculum policy does require the inclusion of the study of environmental topics in subjects like Physical Sciences, Life Sciences, Geography and Life Orientation, our teacher education policies do not, however, make explicit reference to environmental education.

In this paper, broad practices relating to environmental education in teacher education and the policy documents for Teacher Education Qualifications in South Africa, in particular the Minimum Requirements for Teacher Education Qualifications (MRTEQ), are reviewed with the aim of developing ideas and practices that could support the inclusion of environmental education in teacher education programmes. The constructs related to 'mission/practical knowledge' (Short, 2002) and 'high-leverage practices' developed by Ball *et al.*, (2009) are also explored as possible ways for environmental education to become a reality in teacher education programmes. Thereafter, possibilities for more inclusive practices for environmental education in teacher education in general, and particularly in the South African policy context, are highlighted.

Environmental Education and Teacher Education: A Brief Review of Practices

Various projects have been launched in South Africa to support environmental education implementation in schools in terms of the national curriculum for schools. The National Environmental Education Programme supported by the Danish Government was one of the first, while Fundisa for Change is a current initiative involving multiple institutional partners. Rosenberg (2009) developed a teacher education workbook linked to the national curriculum which saw widespread application in institutions both in South Africa and elsewhere in southern Africa.

While there have clearly been attempts to include environmental education and research ideas related to environmental education in teacher education, a number of studies from around the world suggest that environmental education is not easy to fit into general teacher education programmes.

Moore (2005) described 'barriers' encountered in British Columbia's attempts at implementing education for sustainable development (ESD) in teacher education. These included the problems of disciplinarity, the competitive environment of the university, misdirected criteria for evaluating students, and the setting of multiple priorities by the administration. The problem of disciplinarity relates to ESD and environmental issues being hard to give a 'home' in the traditional disciplines in university curricula and programmes and seems to be a significant impediment for environmental education and ESD.

Gough (2009) asserted that, while there have been calls and attempts to include environmental education in teacher education since the late 1980s, there is an almost universal lack of success in introducing consistent environmental education programmes in teacher

programmes. Although many of these programmes focused on increasing awareness about environmental issues and on the environmental content knowledge of pre-service teachers, few were concerned with pedagogy, a need for changing world views, or improving the expertise of the teacher educators (Gough, 2009).

Ormond, Zandvliet, McLaren, Robertson, Leddy and Metcalfe (2014) studied the inclusion of environmental education in Canadian institutions offering teacher education. They concluded that, while many programmes were attempted, 'including and supporting teacher candidates to develop the knowledge, skills and strategies and courage to enact change in schools through progressive practices related to environmental learning and experiential pedagogies is an ongoing challenge for teacher education' (Ormond *et al.*, 2014:176). They also found that, when trying to reconceptualise the dominant (hegemonic) approach to teacher education, many difficulties were experienced, difficulties that were related to policy imperatives.

Van Petegem, Blieck and De Pauw (2007) described attempts to include environmental education in two teacher education colleges in Belgium. Environmental education implementation, they indicated, needed to be prioritised in official policy statements and imperatives, the aim being to enhance future teachers' competencies in teaching and environmental education in their classrooms. The authors viewed environmental education to be action-oriented and interdisciplinary, involving more than one subject area. This, they stated, required collaboration between staff and between different college departments, which was then not current practice. The absence of such collaboration consequently hindered the development of environmental education in the teacher education programmes.

Mosothwane and Ndwapi (2012) surveyed students in Botswana who had been exposed to environmental education in the teacher education programmes that they had attended. A revised national policy on education required colleges of education to train teachers in environmental education using an infusion approach. The authors found, however, that the colleges had not been able to implement the desired programmes successfully, or at all, by the time that their survey was conducted.

McKeown-Ice (2000:10) reviewed the status of environmental education as a component of teacher education programmes in the United States of America. Her data led her to conclude that most of the institutions surveyed were not preparing pre-service teachers to be effective environmental educators. The main reason seemed to be that, generally, environmental education in pre-service teacher education programmes is not institutionalised. Similar findings were made by Gough (2009) regarding Australian institutions.

Yet Gough (2009) and Ormond *et al.* (2014) also referred to studies that indicated that policies may always leave spaces or opportunities for implementation by institutions, at least at the local level. Gough (2009:7) highlighted the UNESCO (United Nations Educational, Scientific and Cultural Organization) guidelines for teacher education (2005) as being a case in point. The Guidelines and Recommendations for Reorienting Teacher Education to Address Sustainability provided space for institutions to develop their own guidelines in order to enable education for sustainable development programmes for teacher education. From this it can be inferred that curriculum policy often offers generative spaces for teacher educators to include environmental education and education for sustainable development in their initial

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teacher education programmes. But how are teacher education programmes to be structured and how might adjustments and broadening of programme offerings (through the inclusion of environmental education) be made in terms of programme curriculum organisation in South Africa?

Environmental Education and Teacher Education: Policies and Practices

Pre-service teacher education has parameters generally associated with the accreditation requirements for these programmes (Ormond *et al.*, 2014). Teacher education is linked to qualifications and professional standards for teaching as a profession, and programmes are accordingly governed by policies that operate on various levels.

Grossman and McDonald (2008:192) highlighted three aspects of policy implementation that are particular to the contexts for teacher education. These are: (1) national and state policies, (2) institutional contexts, and (3) local districts and labour markets. At national or state levels, standards and requirements for accreditation are determined and these dictate the contours of teacher education programmes. According to Grossman and McDonald (2008), the institutional context plays a significant role in the implementation of teacher education programmes by enabling and constraining different aspects of the programmes and the work of teacher education. While the structure of programmes is determined by regulatory bodies, (tertiary) teacher education institutions can be as innovative and flexible as they wish, as long as their programmes are fully compatible with national guidelines. It is often left to individual institutions to determine how much emphasis is to be given to environmental or sustainability education (Ormond *et al.*, 2014).

Teacher education in South Africa is governed by the MRTEQ as developed by the Department of Higher Education and Training (DHET, 2011). These minimum requirements deal with the design and development of qualifications for teachers and other professionals working in education in schooling and other environments. The policy was developed to align teacher education policy with the National Qualifications Framework introduced in 2008 and with the Higher Education Qualifications Framework.

This MRTEQ foregrounds knowledge and describes teachers as 'knowledge professionals'. Knowledge is seen as active knowledge, as opposed to inert knowledge, and is linked to knowledge of the *what, how* and *why* in moments of practice (Green, 2012). This policy specifies a knowledge mix (DHET, 2011) related to the purpose of the qualification in which the organising 'umbrella' concept is knowledge-positioned actively as learning. This mix (see Table 1) includes:

- Disciplinary learning, i.e. academic disciplines and the foundations of learning;
- Pedagogical learning, i.e. general and specific pedagogies related to the discipline;
- Practical learning, i.e. learning in and from practice;
- Fundamental learning, i.e. language competence, information and computer technology, and academic literacies; and
- Situational learning, i.e. learning encompassing self, situations, contexts and environments.

Table 1. A knowledge mix for teacher education programmes (South Africa)

Integrated and Applied Knowledge				
Disciplinary learning	Pedagogical learning	Practical learning	Fundamental learning	Situational learning

Adapted from: DHET (2011), MRTEQ Appendix C, p. 15.

In terms of this policy, teacher education programmes need to prepare teachers as subject specialists in at least two school subjects (disciplinary learning) and to cover competencies and understandings in all the subsections of the knowledge mix in Table 1. Phase specialisms and the competencies and roles of teachers are also stipulated in the document.

Ball *et al.* (2009) suggested that teacher education programmes are largely based on subject matter or content teaching, and on ways of teaching the content. These are the two main determinants for developing a teacher education curriculum. This makes the task difficult for environmental education, given the nature and structure of environmental education 'knowledge'. It is our view, however, that the knowledge domains of practical learning (learning in and from practice) and situational learning (understanding contexts and environment) in Table 1 can provide space for teacher education programmes to include environmental education understandings, knowledges and practices in South Africa.

Next, we turn to exploring what constitutes environmental education practices and knowledge(s).

Environmental Education Practices, Knowledge and Processes

Environmental education content does not fit neatly into a disciplinary knowledge organisation. The subject boundaries are not easily defined, nor are the knowledge bases as clearly presented as in traditional school subjects such as Life Sciences or Geography, or course modules at post-school levels. Lee and Williams (2001:223) described environmental education as a broad-based area of study that does not have defined disciplinary boundaries. They argued that environmental education should be holistic and proposed that:

- Environmental education is not a subject in itself, but a function of education with content drawn from the whole of the school curriculum;
- Investigation of issues is important and should range from local to regional, national and global scales;
- Integration of education about, in and for the environment is required; and
- Environmental education should encompass the development of environmental awareness, knowledge, values, responsibility and action.

Corney and Reid (2007:34) expressed similar views on the content of environmental education or education for sustainable development. The subject matter, they stated, is complex: it typically focuses on interrelationships between environmental, economic and social factors, is value-laden, and the terms used are open to different interpretations. The spheres of sustainability, environment, society (including culture) and economy must be considered (Corney & Reid,

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2007:35), and can be studied at scales varying from local to global. The subject matter is furthermore constantly evolving, always remaining provisional and somewhat undefined, unlike most other subject matter and disciplinary knowledges, and thus creates a sense of uncertainty among learners and educators alike.

How might teacher education respond to the associated challenges of subject matter and pedagogy in order to make environmental education meaningful in education settings? And how might this be done in a manner which fits both the policy as well as practices of curriculum development in higher education? In the next section, we draw on the work of Short (2002) on mission and practical knowledge, which provides a framework or heuristic to discuss the possibilities for environmental education knowledge inclusion in the teacher education curriculum. We also draw on ideas from Ball *et al.* (2009) related to practices, and improvement of practices, for framing environmental education inclusion in initial teacher education in South Africa.

Practical Knowledge as an Educative Process for Environmental Education in Teacher Education

Subject matter or content knowledge for school subjects or for courses of study at other levels is derived from traditional disciplines that have developed as knowledge repositories over time (Short, 2002). Subject disciplines have enquiry and research histories which have developed knowledge bases through the decades, and research methods defined for the discipline are 'employed' to develop data which adds to the knowledge base of the discipline. School subjects are derived from the disciplines and knowledge bases developed by way of a downward design where particular knowledge 'fragments' are packaged in particular ways to develop the curriculum (Short, 2002). These would include ideas related to continuity and to progression from what are considered to be less cognitively demanding conceptual understandings to more advanced understandings, which are then formally presented as a curriculum.

Short (2002) developed conceptual distinctions for thinking about how best to organise the curriculum in universities and other higher-education institutions. He indicated that all universities have an educative function of providing opportunities for general and specific professional and vocational education. He argued that universities and agencies contribute to the repository of knowledge over time by way of disciplines. Disciplines, he stated have particular methods and ways of doing that lead to the production of knowledge. Conventionally, knowledge is generated by way of particular modes of enquiry and methods that suit the practices and questions common to the discipline. Teaching and research expertise influence courses offered rather than rational statements of curricular intent or purpose (Short, 2002).

Short (2002) developed the idea of *practical or mission* knowledge as another form of knowledge that can be developed in universities as an alternative, more flexible approach to knowledge production than disciplinary knowledge. Practical or mission-oriented knowledges are associated with human activities such as education, maintaining health, or

the construction of bridges and buildings. Practical knowledge is generated when a need arises in situations where such human activities pose questions that must be answered in order for successful action to be taken. These needs and questions arise in particular contexts, thus rendering general disciplinary knowledge alone inappropriate for dealing with such needs and questions. Short (2002) also argued that the practical intent of mission-oriented questions presupposes that questions that are generated in particular contexts need to be formulated and answered in ways commensurable with such contexts.

This kind of knowledge may be interdisciplinary, as it results from enquiry into questions that cannot be analysed or broken down into easily researchable parts. It is therefore not an answer to an intellectual question but to localised and contextualised questions and issues. So, practical knowledge comes into play in practical human activities, where it is used judiciously and appropriately in conjunction with other knowledge (from disciplines) in order to act in real situations considered relevant to the task of learning to act as a citizen or human being. The content is structured around facets of the actual tasks of a human being or citizen and draws on knowledge from disciplines that inform decisions of practice. It is appropriately selected and organised knowledge to fulfil educative functions in contexts.

Practical or mission knowledge seems to fit the more unconventional nature of environmental education content knowledge, as it can include *issues and problems* which occur in context and needs local 'research' or enquiry for knowledge production. Local communities, including students, can be involved in organised research processes focused on local issues and needs. This addresses many of the challenges highlighted earlier in relation to the lack of a disciplinary knowledge base for environmental education and to the fragmented, provisional and tentative nature of knowledge for environmental education.

What sort of competencies and skills would teachers need to enact pedagogies for such approaches to environmental education?

Environmental Teaching: Developing 'High-leverage Practices' for Environmental Education

It is contended that the MRTEQ document (DHET, 2011) further provides 'space' that can be used generatively to include environmental education practices and approaches in the teacher education curriculum in South Africa. In the recommended knowledge mix, the category of practical learning (learning from teaching) allows for the inclusion of varying approaches to, and reflection on and in, practice. This provides teachers with opportunities for what Ball *et al.* (2009) referred to as learning in context and through practice. Learning in and from practice is a space that allows for emergent pedagogies from situational issues and problems (as discussed by Short, 2002) to be practised in classroom situations.

Ball *et al.* (2009:460) developed a process for articulating the work of teaching mathematics, which can be regarded as being applicable to environmental education processes as well. They considered the development of a curriculum for teaching practice an important aspect of developing and scaffolding particular practices, especially for novice or pre-service teachers. They suggested the identification of core task domains of

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teaching, namely: planning, choosing and using representations, engaging in discussions of (mathematics) problems, and then analysing and '*decomposing*' these domains into teachable components. Grossman and Shahan (2005) described 'decomposition' of practice as the process of breaking it into smaller practices, with aspects that can be identified, studied, taught and rehearsed and then reintegrated into the actual work of teaching.

Ball *et al*. (2009:460) also referred to the identification and implementation of *high-leverage practices*, that is, practices in which the proficient enactment by a teacher is likely to lead to comparatively larger advances in student learning. They noted that choices must be made as to which aspects of teaching to emphasise over others during teacher education, and that, in making these choices, practices must be sought which will teach students the fundamental elements of professional work that are unlikely to be learnt on one's own through experience. We would argue that, in environmental education, these practices would be the issue-based approaches to local problems, discussions, debates and investigations that Corney and Reid (2007) described as suitable pedagogies for environmental education. It is therefore proposed that these practices be foregrounded in student teachers' practice learning and that they continually be reflected on and further developed as 'high-leverage practices'. In this way, practices that promote environmental education topics and ideas can be foregrounded and learnt by pre-service teachers, thus becoming integral to teacher education programmes.

Concluding Comments

Fien (1991) indicated that the attitudes and skills of teachers are central in determining the mix of different types of knowledge, skills and affective objectives in environmental education programmes. This paper has provided a viewpoint on how these attitudes and skills can be developed in environmental education programmes in education institutions.

Latta and Field (2005) suggested that teacher education needs to expand from the current ideas related to representative certainty and singularity in ways of seeing and doing in classrooms. Programmes need to develop capacity for relational thinking connected to the relational complexities of teaching in teacher education. This is similar to the ideas of Gore, Grifiths and Ladwig (2004:375) who called for a reassessment of teacher education priorities in order to focus more on the substance and purpose of teaching and include intellectual quality, relevance, social support and recognition of difference, an approach they referred to as 'productive pedagogies'.

The approaches related to the development of localised (practical) knowledge (Short, 2002) and to ideas for a teaching practice curriculum that supports high-leverage practices (as developed by Ball *et al.*, 2009) could be used to enable environmental knowledge and pedagogical competencies that currently seem absent from teacher education programmes. These ideas are suited to filling the generative spaces provided by the knowledge mix in the MRTEQ, namely situational learning and pedagogical learning. They could go a long way to making environmental education a reality in teacher education in South Africa and possibly other contexts as well.

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References

Ball, D., Sleep, L., Boerst, T. & Bass, H. (2009). Combining the development of practice and the practice of development in teacher education. *The Elementary School Journal*, 9(105), 458–474.

Corney, G. & Reid, A. (2007). Student teachers' learning about subject matter and pedagogy in education for sustainable development. *Environmental Education Research*, 13(1), 33–54.

Cutter-McKenzie, A. & Smith, R. (2003). Ecological literacy: The missing paradigm in environmental education. (Part one). *Environmental Education Research*, 9(4), 497–524.

DHET (Department of Higher Education and Training). (2011). National Qualifications Framework, Act 67 of 2008. Policy on the Minimum Requirements for Teacher Education Qualification. Pretoria: Government Gazette No. 34467.

Fien, J. (1991). Accepting the dual challenge for professional development in environmental education. *International Journal of Environmental Education and Information*, 10(1), 1–17.

Fien, J. & McLean, R. (2000). Teacher education for sustainability. II. Two teacher education projects from Asia and the Pacific. *Journal of Science Education and Technology*, 9(1).

Gore, J., Grifiths, T. & Ladwig, J. (2004). Towards better teaching: Productive pedagogy as a framework for teacher education. *Teaching and Teacher Education*, 20, 375–387.

Gough, A. (2009). Not for want of trying: Strategies for re-orientating teacher education for education for sustainable development (ESD). Keynote address made at the 12th UNESCO–APEID International Conference, Bangkok, Thailand, 24–26 March 2009.

Green. W. (2012). Policy on the Minimum Requirements for Teacher Education Qualifications. Presentation at a Bridge Teachers Upfront seminar, 7 February 2012. http://www.bridge.org.za/wp-content/uploads/2014/12/Teachers-Upfront-Presentation-W-Green-7-Feb-2012.pdf, visited 20 November 2017.

Grossman, P. & McDonald, M. (2008). Back to the future: Directions for research in teaching and teacher education. *American Education Research Journal*, 45(1), 184–205.

Grossman, P & Shahan, E. (2005). The anatomy of practice: The use of decomposition. Paper presented at the annual meeting of the American Education Research Association, Montreal..

Knapp, D. (2000). The Thessaloniki Declaration: A wake-up call for environmental education? *Journal of Environmental Education*, 31, 32–39.

Latta, M. & Field, J. (2005). Flight from experience to representation: Seeing relational complexity in teacher education. *Teaching and Teacher Education*, 21, 649–660.

Lee, C. & Williams, M. (2001). Researching environmental education in the school curriculum: An introduction for students and teacher researchers. *International Research in Geographical and Environmental Education*, 10(3), 218–244.

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McKeown-Ice, R. (2000). Environmental education in the United States: A survey of preservice teacher education programs. *The Journal of Environmental Education*, 32(1), 4–11.

Moore, J. (2005). Barriers and pathways to creating sustainability education programs: Policy, rhetoric and reality. *Environmental Education Research*, 11(5), 537– 555.

Mosothwane, M, & Ndwapi, G. (2012). Training pre-service teachers in environmental education: The case of colleges of education in Botswana. *International Journal of Scientific Research in Education*, 5(1), 26–37.

Ormond, C., Zandvliet, D., McLaren, M., Robertson, P., Leddy, S. & Metcalfe, S. (2014). Environmental education as teacher education: Melancholic reflections from an emerging community of practice. *Canadian Journal of Environmental Education*, 19.

Rosenberg, E. (2009). *Teacher education workbook for environment and sustainability education*. Grahamstown: Rhodes University.

Short, E. (2002). Knowledge and the educative functions of a university: Designing the curriculum of higher education. *Journal of Curriculum Studies*, 14(2), 139–148.

Tuncer, G., Tekkaya, C., Sungur, S., Cakiroglu, J., Ertepinar, H. & Kaplowitz, M. (2009). Assessing pre-service teachers' environmental literacy in Turkey as a means to develop teacher education programs. *International Journal of Educational Development*, 9(4), 426–436.

Van Petegem, P., Blieck, A. & De Pauw, J. (2007). Evaluating the implementation process of environmental education in preservice teacher education: Two case studies. *Journal of Environmental Education*, 38(2), 47–54.

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For personal communication: Moosa, V.M. (2003). Minister of Environmental Affairs and Tourism, Ministry of Environmental Affairs and Tourism, Pretoria, 16 June 2003.

For email: Nhamo, G. (2003). Request for official position and update on the Plastic Bags Regulation implementation. Email, 1 October 2003.

For website: DEAT (Department of Environmental Affairs and Tourism). (2003). Inspection of readiness of retailers on the eve of Plastic Bag Regulations effect. http://www.environment.gov.za, visited 8 May 2003.

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