Chapter 11
Re-thinking the Integration of Socioscientific Issues in Life Sciences Classrooms Within the Context of Decolonising the Curriculum

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11.1 Background

During recent decades, the global science education landscape has reverberated with the call to integrate socioscientific issues (SSIs) into science education as a way towards responsible citizenship. This was embedded in a shift towards a humanistic science education, which witnessed a departure from a technicist towards a dynamic, democratic, socially responsive science education. This was marked by a disruption of strong (Bernsteinian) curriculum boundaries which insulate "pure" science as a separate entity, which occupies a superior position in the knowledge repository. The notion of being a value-free scientist who is ensconced in a university laboratory, and whose discourse is permeated purely with reductionist processes, is being criticised. The need for a science education which troubles social issues and generates uncertainty and discomfort, in a quest to locate opportunities for substantive, helpful social change, has paved the way for interdisciplinary studies. Increasingly, a transformative epistemology has underpinned ways in which science education and society intersect. Within the South African context, complicated conversations (Pinar 2004) about transformative epistemology in general, and curriculum transformation in particular, has dominated debates in public and private spheres. The exclusion of knowledge systems of indigenous people from mainstream education, and the role of education in reproducing knowledge hierarchies which are dominated by Euro-Western frameworks, permeated arguments for Africanising education. The principles of the National Curriculum Statement, which underpin the school curriculum, are imbued with civil, economic, cultural and social human rights, which are enshrined in the Constitution. However, although South Africa is in its third decade of a post-apartheid political order, Euro-Western

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epistemic traditions persist as a resilient feature of school and post-school curricula. The lack of transformation in Basic and Higher Education Institutions is evident due to their continued marginalisation of non-Western ideological frameworks (Heleta 2016; le Grange 2016).

Researchers such as le Grange (2018) emphasise that colonial and apartheid margins of division continue to influence curricula. University and school science curricula have been complicit in promoting Euro-Western worldviews as universal. In the face of this social reality, the constitutional pillars of social justice, human rights and equity become ideological rhetoric. Within this context, South African society has witnessed unprecedented protests by students, who have become increasingly disconnected from, and discontented with education, and this has precipitated calls for decolonising the curriculum. The broad social challenge, then, is the lack of articulation between the principles of social justice contained the National Curriculum Statement, and the implemented curriculum, the latter which drills students "with en vogue epistemologies" (Magill and Rodriguez 2014, p. 209) and reproduces the unequal social order.

In this study, ways in which teachers embed SSIs into a unit of work in the curriculum, towards a more just and socially relevant epistemology, are explored. First, a rationale for SSI-based instruction is offered. Next, the argument for drawing on theoretical constructs from critical pedagogy is presented. This is followed by a description of the qualitative methodological approach, the results and analysis thereof, and finally, the concluding remarks.

11.2   Rationale for Integrating SSI into the Curriculum

The interdependence between (science) education and society is summed up succinctly by Magill and Rodriguez (2014, p.210) who cite Dewey and Durkheim's perspective of education as including "classroom experience, reflective thinking, further interaction with the curriculum, and rethinking based on what is encountered…" They conclude by asserting that "a student's curriculum is their life and life is a student's curriculum." Giroux (2011, p.3) adds: "Education is fundamental to democracy and no democratic society can survive without a formative culture shaped by pedagogical practices capable of creating the conditions for productive citizens who are critical, self-reflective, knowledgeable, and willing to make moral judgements and act in a socially responsible way". The marginalisation of alternative knowledge systems, the national call to decolonise the curriculum, and ideas about the role of democratic education within society are interconnected, and provide the rationale for SSI-based instruction as a response.

Integrating socioscientific issues into the science curriculum has the potential to connect science to humanity (Talens 2016). Engaging learners in science education which is interrelated with social issues increases the personal meaningfulness and relevance of science to learners (Mnguni 2017; Mudaly 2011; Onwu and Kyle 2011; Talens 2016; Zeidler and Nichols 2009). However, relatively few teachers incorpo-

rate SSI in their curricula (Klosterman et al. 2012). Many teachers retreat to the default pedagogy of transmission of science content because of the pressure of completing the syllabus (ibid, 2012). Others find teaching SSI controversial and exhibit negative attitudes to it (Osbourne et al. 2002).

In South Africa, professional development of teachers is linked to school curriculum documents. Specific aims are stipulated in the Curriculum Assessment and Policy Statement (CAPS) for Life Sciences document (Department of Education [DoE] 2011). The third aim is to enhance learners' understanding of the relevance of school science to their lives, and how science can enrich their lives. It promotes the teaching of science in an integrated way to enhance the "relationship between the (science) subject and society" (DoE 2011, p.17). Certain social challenges with substantive connections to science, for example, HIV/AIDS, the green economy, indigenous knowledge systems and sustainability (Lotz-Sisitka et al. 2015; Mnguni 2017; Mudaly 2011) have been explored among South African scholars. Mnguni (2017), who analysed the curriculum to explore the infusion of SSIs in the curriculum, found that the integration of two SSIs, namely, the green economy and HIV/AIDS, was poor.

Many studies on SSI focus on teachers' motivation, views and beliefs about incorporating SSI (Lee and Witz 2009). There is a dearth of studies which explore practices of teachers who do incorporate SSI into their curricula (Klosterman et al. 2012). This study responds to this paucity in research by exploring the integration of SSIs by three novice, practicing Life Sciences teachers. The following question is central to this study: *How do novice Life Sciences teachers integrate SSIs into the curriculum, within the context of decolonising the curriculum?* Critical theory, and more specifically, critical pedagogy, framed the study.

11.3 Critical Pedagogy

Critical theory contests the existing state of affairs in contemporary (science) education (Weston 2015). Science teacher pedagogy is based on external interactions, which include what teachers understand through their interaction with the curriculum, their professional development, and requirements based on curriculum policy. However, teachers can produce knowledge differently, by being agents of self-production, and this involves internal interaction in teacher pedagogy (Degener 2001; Magill and Rodriguez 2014; Oestereicher 1979). Although the curriculum, which is imbued with innocuous forms of oppression, is "reproductive and often culturally disparaging", this can be changed by teachers "asserting their self-determination" (Magill and Rodriguez 2014, p. 220). A critical pedagogue considers different socially constructed forces, such as racism, ethocentrism and classism, used to subordinate learners (Degener 2001). According to Giroux (2004), critical pedagogy is crucial in the struggle for democracy. Critical pedagogy underscores the role of critical reflexivity, creates connections between what is taught and daily life experiences, provides an understanding of the interrelatedness between knowl-

edge and power, and uses resources in history to advance people's democratic rights (Giroux 2004). Critical pedagogy involves teaching which considers the backgrounds and worldviews of learners, and transforms the school and curriculum into a democratic site, and teachers and learners as agents of change (Giroux 2011).

11.4   Teachers, Learners and the Curriculum

Advocates of critical pedagogy express concern about how teachers become enslaved in a neoliberalist capitalist framework by education departments, which prescribe textbooks and materials which normalise dominant (Euro-Western) values (Maistry 2015; Magill and Rodriguez 2014). Lacan (2006), cited by Magill and Rodriguez (2014, p.215), challenges teachers not to accept the curriculum as "objet petit a", that is, with passivity, devoid of internal consciousness, about the what, how and why of teaching. Magill and Rodriguez (2014) assert that the most potent in-school factor which influences learners is an effective teacher. Teachers should be critical of a curriculum which is underpinned by dominant ideals of particular groups of people. This type of curriculum reduces learners to "cheerful robots" by adopting pedagogies which claim to be value-free and eschews issues related to epistemic justice, knowledge and power, and ethics (Giroux 2011, p. 3).

Learners encounter "null spaces" which are what transpires between the planned and experienced curriculum, and these mould learners to internalise and accept a curriculum of domination and their subaltern status in society. Ultimately, learners become compliers of ideologies which they had imbibed through the curriculum (Heleta 2016; Motta 2013). Motta (2013) adds that learners experience forced enculturation and silencing of alternative knowledge systems and discourses when curricula reproduce epistemological blindnesses. These curricula perpetuate social stratification by excluding learners who are in "subordinate" race, gender, etholinguistic, and cultural settings (Heleta 2016; Motta 2013). Teachers can position themselves as key actors in a curriculum for human agency which can "relate to diverse cultural needs within a pluralistic society" (Magill and Rodriguez 2014, p. 218).

11.5   Methodology

A qualitative, case study methodology was adopted to explore novice Life Sciences teachers' preparation for and implementation of SSI-based instruction. The methodology was appropriate because a variety of methods were adopted to achieve a deep understanding (Cohen et al. 2011) of how teachers prepared for and taught SSI-based lessons. An illustrative case study was central to this design. Yin (2009, p.18) stated that "a case study is an empirical inquiry that investigates a contemporary phenomenon in-depth and within its real-life context". For Hayes et al. (2015), an

illustrative case study involves a detailed description of and reasons for activities and events related to a phenomenon (in this study, the phenomenon of how teachers prepare for and implement science lessons which are connected to social issues). The study involved activities in an Honours module which encouraged teachers to transcend boundaries of familiar ways of preparing for and teaching science lessons. The study was embedded in the critical philosophical paradigm, and encouraged teachers to become critical social agents (le Grange 2016; Magill and Rodriguez 2014) by entering a transdisciplinary space, which focussed on SSIs within the context of decolonising the curriculum.

Data was generated from portfolios of evidence and reflective journals. Singh et al. (2015) emphasise the suitability of portfolios in capturing evidence for tasks which are process-orientated. In this study, teachers recorded their preparation for and delivery of lesson in their portfolios. According to Tillema et al. (2011) reflective journals are useful because they provide insight into the cyclical process of professional growth. Themes were derived from the data set using content analysis. The credibility and accuracy of the data was ensured by triangulating data from multiple sources (Creswell 2012).

11.5.1   The Participants

The sample comprised three purposively selected practicing, fully qualified teachers. The criteria for their selection was that they taught Life Sciences, had less than 5 years of teaching experience, and were registered to study an Honours in Science and Mathematics Education module in curriculum development. A brief biography of the participants is provided in Table 11.1.

The participants were novice, practicing teachers who taught Natural Sciences (Grades 8 and 9) or Life Sciences (Grades 10, 11 and 12). Each teacher taught in a different school in an urban area in the province of Kwa-Zulu Natal. The average number of learners in the Life Sciences classroom was 35. Each school was under-resourced and none of these teachers had access to a science laboratory. They relied on innovating and improvisation to conduct practical work.

Table 11.1 Biography of participants

	Teacher A	Teacher B	Teacher C
Gender	Male	Female	Female
Number of years of experience	3	4	1
Subjects taught	Life Sciences	Life Sciences	Life Sciences
	English	Natural Sciences	Natural Sciences
Qualifications	Bachelor of Education (Majors: Biological Science, English)	Bachelor of Education (Majors: Biological Science, Sports Science)	BSc Environmental Science (Majors: Plant studies, Animal studies, Ecology and Resource management. Postgraduate Certificate in Education
	Bachelor of Education (Honours in Science and Mathematics Education)		
	Currently enrolled for Masters in Science Education		

11.5.1.1   The Task

Bearing in mind the perspective of Giroux (2011, p. 3) that critical pedagogy "also provides tools to unsettle common sense assumptions, theorize matters of self and social agency", and in an effort to integrate the call for decolonising the curriculum into the Honours in Science and Mathematics Education module, the following activity was developed:

> Preamble: *The Curriculum is viewed as a vehicle to achieve the aims of the Constitution, and, to this effect, the Curriculum Assessment Policy Statement (CAPS) includes the following principles: "Social transformation: ensuring that the educational imbalances of the past are redressed, and that equal educational opportunities are provided for all sections of the population" and "Human rights, inclusivity, environmental and social justice: infusing the principles and practices of social and environmental justice and human rights as defined in the Constitution of the Republic of South Africa. The National Curriculum Statement Grades R-12 is sensitive to issues of diversity such as poverty, inequality, race, gender, language, age, disability and other factors" (DoE 2011, pp.4-5). However, analysts argue that the curriculum continues to be embedded in colonial, apartheid and western worldviews.*

Task
- Critique a unit of work in the science curriculum to determine whether the social justice and social transformation ideology (as per policy document in the preceding preamble) underpin the work, given the call to decolonise the curriculum.
- Re-design the unit of work to address a social issue/challenge through the science lessons, and which addresses social transformation or social justice.
- Reflect on these activities and record your reflections in a journal.

The purpose of the task was to motivate teachers to consider the ethical implications of what and how they teach. Teachers were encouraged to design units of work in which science issues were linked to challenges encountered by the community. This was done to enhance teachers' "reflective judgement" and create meaningful, relevant science lessons (Burek and Zeidler 2015, p.425).

11.6   Results

The results are presented in three parts for each teacher, and comprised teachers' responses to the following questions:

- Why did you choose (topic) as an SSI which could decolonise the unit of work?
- How did you prepare to teach this SSI?
- Describe the lesson plan you designed which informed your teaching of the SSI.

Teachers A and B selected "Treatments for Cancer" as the topic. This is a sub-topic of the Cell Cycle in the Knowledge Strand titled *Life at the Molecular, Cellular and Tissue Level* (DoE 2011). According to the CAPS document, learners are required to research and write a report on causes, beliefs and attitudes and treatment (radiography, chemotherapy) on one type of cancer (DoE 2011, p. 26). Teacher C selected "Alien Invasive Plants" as a topic in the Knowledge Strand titled *Environmental Studies*. This is a minor part of the larger topic: "Human Impact on the Environment: Current Crises for Human Survival." Learners are expected to select an alien plant and write a report on it, using text-based resources (textbooks, reference books, ShareNet, reports in the media) (DoE, 2011, p. 51). The data is presented using following codes to describe data sources: Reflective Journal – (RJ), and Portfolio – (P).

11.6.1   Results from Teacher A

11.6.1.1   Reasons for Selecting Alternative Treatments for Cancer as an SSI

"There were some incidents of cancer in the community. But being a historically indigenous context many illnesses were dealt with mainly using indigenous ways. This served as a way to raise learners' awareness of other treatments that do exist. IK was a starting point." (RJ)

11.6.1.2   Preparing to Teach Alternative Treatments for Cancer as an SSI

The following entries were made in the reflective journal about how Teacher A prepared to teach the SSI.

"I analysed Curriculum (CAPS) documents. The CAPS document highlights only two forms of treatment for cancer which focuses on medical biotechnology. They are Radiotherapy and Chemotherapy. Both these treatment forms have western origins.
    This means that Westerners are seen as the only people with enough powerful knowledge on cancer to propose treatment while the rest of the world buys into this. Western medical industries make vast sums of money from cancer treatment. Other types of medical

options are seen as useless fads. Learners will be colonised to believe that only Western forms of treatment are useful. Since only Western treatment is acknowledged in the curriculum, non-western South African learners may feel marginalised and inferior. People will not have access to expensive Western cancer treatments and they could die because of this." (RJ)

The following motivation for the selection of the topic was documented in the portfolio.

"I did a survey of learners' beliefs and views about cancer to understand learners' prior knowledge and beliefs about cancer in their communities. Then it was (my) reading articles and research from literature mostly. But other experienced teachers who were in tune with IK offered guidance as well. The lessons I prepared included African indigenous treatments in addition to Western treatments." (P)

Summary of lesson plan which informed teaching about alternative treatments for cancer

Grade: 10		
Knowledge Strand: Life at the molecular, cellular and tissue level		
Topic: Cancer treatments		
Aim:		
access information about cancer treatments from a variety of sources (reference books, textbooks, internet, community elders)		
critically evaluate scientific information and functionality of different cancer treatments		
appreciate different world views in treatment of cancer		
Resources: projector for powerpoint presentation,		
Teacher activities	Learner activities	Teaching strategy
Present powerpoint slides on alternative treatments for cancer	Listen to presentation, contribute to discussion	Teacher-learner discussion
Facilitate group work	Draw on previous homework task about common treatments for cancer from alternative knowledge systems. Use electronic devices (tablets, cell phones, laptops), articles from scholarly texts (research periodicals) to search for information. Discuss and debate your views about the usefulness of alternative treatments for cancer. Create a poster to report findings	Group work, discussion
Facilitate class discussion	Poster presentation by learners	Class discussion

Source: Portfolio of Teacher A

Slides were included in the powerpoint presentation, and contained pictures and summaries of treatment for cancer based on naturopathy, homeopathy and indigenous knowledge.

11.6.2   Results from Teacher B

11.6.2.1   Reasons for Selecting African Treatments for Cancer as an SSI

The following extract was sourced from the portfolio:

> "Information regarding traditional African treatments for cancer in the current curriculum is very brief and through decolonisation of the information it would lead to a deeper understanding of where this information came from." (P)

In her reflective journal, Teacher B wrote:

> "Cancer seems to be a disease with in the Pietermaritzburg area that everyone knows about because they have a friend or family member who has been affected by it or is currently suffering from it. On a more personal note I have seen how people who undergo cancer treatments which are westernised (chemo, surgery, radiotherapy) often suffer from extreme side effects and feel that personally there needs to be research into alternative treatments that have less server side effects. And yes a large part of this was to draw learners' attention to what was not in the textbooks and to give recognition to practices that occur around them and to show them that traditional African ways are valued." (RJ)

11.6.2.2   Preparing to Teach about African Treatments for Cancer as an SSI

In her reflective journal, Teacher B made the following entry:

> "All information that I used to plan a decolonised lesson was from the Internet … there are articles of indigenous and other knowledges to manage cancer." (RJ)

In the portfolio, Teacher B described how she prepared her lesson:
"I studied the CAPS curriculum and textbooks. In analysing the prescribed textbook I found that:

- Treatment options listed in textbooks are of Western origin: Chemotherapy, Radiotherapy, Surgery
- Availability of the best treatments depends on social class. Those who can afford it receive best treatment.
- Scientists shown are of European or North American descent. Textbook idolises European scientists and leaves no hope for the African child who…..might believe that scientific inquiry and discovery is not for the African child because African are not depicted in the everyday teaching of science." (P)

Teacher B provided photographic evidence (in Fig. 11.1) to show that textbooks presented information which privileged Euro-Western knowledge.
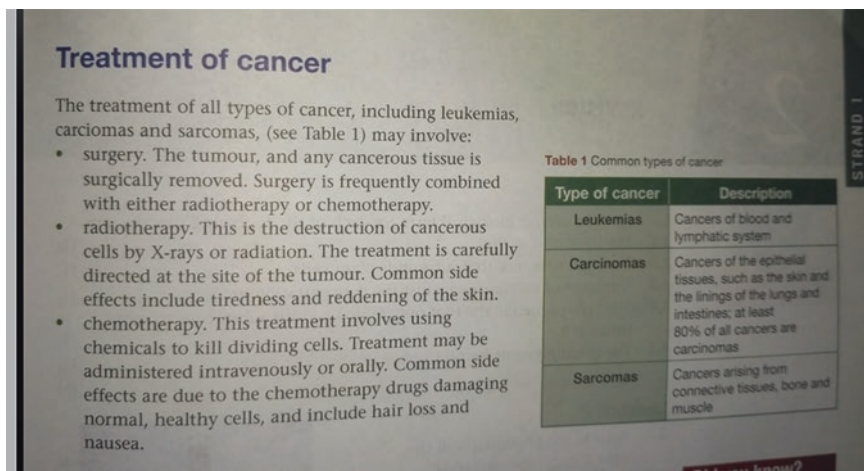
Fig. 11.1 Section of a prescribed science textbook to show privileging of Euro-Western knowledge

Summary of lesson plan which informed teaching about alternative treatments for cancer

Grade: 10
Knowledge Strand: Life at the molecular, cellular and tissue level
Topic: Cancer treatments
Aim:

access information about cancer treatments from a variety of sources (reference books, textbooks, internet, community elders)

critically evaluate scientific information about who researches cancer treatment and what treatment options are presented

relate AIK (African Indigenous Knowledge) to cancer and show its application in daily life

Resources: projector for powerpoint presentation, electronic devices

Teacher activities	Learner activities	Teaching strategy
Present powerpoint slides on treatments for cancer and scientists involved	Listen to presentation, contribute to discussion	Teacher-learner discussion
Facilitate group work	Refer to previous homework task about common treatments for cancer. Use laptops, tablets, cell phones, to search for information on treatments from African indigenous knowledge systems. Argue about the pros and cons of using indigenous knowledge treatments for cancer. Complile a report.	Group work, discussion
Facilitate class discussion	Report back by learners	Class discussion

Source: Portfolio of Teacher B

Fig. 11.2 Female African knowledge producer in cancer research

In the powerpoint presentation a slide on the Kraalbos plant, among others, was included to show how Africa Indigenous plants can be used to treat the disease. A South African scientist, Professor Burtram Fielding, who found chemical compounds from the African indigenous Kraalbos plant to be effective against breast cancer cells, was also included among the slides.

Another African researcher in the field of cancer research was presented in a slide. A picture of Professor Tebello Nyokong, who is a South African chemist at Rhodes University was included (Fig. 11.2). Her research on photo-dynamic therapy as an alternative treatment for cancer was presented (P):

11.6.3   Teacher C

11.6.3.1   Reason for Selecting Alien Invasive Plants as an SSI

Teacher C indicated in her reflective journal that the school environment was the reason for selecting the topic.

> "The school yard is overgrown with alien invasive plants. I thought 'Of what real use is this (writing a report on an alien invasive plant), when the whole area, not just the school, is full of them (alien plants)?'" (RJ)

11.6.3.2   Preparing to Teach About Alien Invasive Plants as an SSI

Teacher C presented the following insights into how she prepared SSI-based instruction in her portfolio.

> "I saw the CAPS (read curriculum documents) and this topic is done under Human Impact on the Environment, for the purpose of environment management. For practicals learners must observe the impact of alien species on biodiversity, according to CAPS. CAPS wants

learners to write a report on an example of an alien invasive plant. This is not a good way to manage the invasion of alien plants by science learners. I wanted them (learners) to see these plants in their environment, know how these plants affect the environment negatively, and to remove them. I felt that by increasing learners' knowledge about these plants and letting them do a hands-on activity to remove these plants would be more relevant. Also I have a degree in Nature Conservation and my major subjects are Plant studies, Animal studies, Ecology and Resource management. I felt I could handle the topic nicely." (P)

"I took photographs of alien plants in the school yard. I identified the plants and read about how they can be eradicated. I used information from textbooks and charts and also worked with Environmental Officer from Natural Resources. I studied the textbook and other texts about alien vegetation management." (P)

Summary of lesson plan which informed teaching about alien invasive plants

Grade: 11
Knowledge Strand: Environmental studies
Topic: Human impact on environment and environmental management of alien plants
Aim:
Describe how alien vegetation can be managed using biological, manual, chemical and mechanical methods.
Describe the effects of alien plants on
Water resources
Agricultural production
Biodiversity
Identify alien plants in the school yard and remove these by mechanical means
Resources: Textbook, video, alien invasive species regulations policy document,

Teacher activities	Learner activities	Teaching strategy
Video presentation to show effects of alien invasive plants	Watch video and discuss	Teacher-learner discussion
Distribute handouts with pictures and names of common alien invasive plants, and mechanical removal. Facilitate group discussion	Study handouts in groups	Group work, discussion
Facilitate field work	Work in groups of 5 or 6. Go into the school yard and identify alien invasive plants. Uproot smaller plants. Use a slasher to remove larger plants under teacher supervision. Use a hoe to remove root balls or tap roots.	Field work

Source: Portfolio of Teacher C

11.7   Analysis and Discussion

Borrowing from Owens et al. (2017), the phases of the SSI-instruction framework, which were adapted in this study to apply to the teacher (instead of student) knowledge and practices, informed the analysis and findings. Common themes were generated from the results sourced from Teachers A, B and C. These themes are *identifying the social challenge, preparing a science lesson which infuses the issue,* and *addressing the issue through teaching*.

11.7.1   Identifying the SSI

Teacher A had knowledge of cancer treatment used in by the community members. He was aware that many members of the community relied on IK to manage the disease. The affordability of treatments by middle class people was also mentioned by Teacher A. In order to access learners' views and understanding of cancer, Teacher A used a survey. Teacher A did not assume to know learners' knowledge and experiences, and this was the reason for conducting a survey. Le Grange (2016, p.9) highlighted the importance of creating spaces for "voices and knowledges" of marginalised people.

Teacher B had knowledge of the incidence of cancer in the community, when she stated "cancer seems to be a disease with in the Pietermaritzburg area that everyone knows about because they have a friend or family member who has been affected by it or is currently suffering from it." In addition, she was aware of the dangerous side effects of Western methods of treatment, and this is evident by her statement: "I have seen how people who undergo cancer treatments which are westernised (chemo, surgery, radiotherapy) often suffer from extreme side effects and feel that personally there needs to be research into alternative treatments that have less severe side effects."

Teacher C was acutely aware of the invasion of alien vegetation in the school grounds. She was also aware of the invasion of alien plants in the wider community, when she said: "the whole area, not just the school, is full of them (alien plants)." Her awareness was possibly heightened due to her expert knowledge on the phenomenon, having qualified with a BSc in Environmental Science. She used this as an opportunity to teach about alien invasive plants as an SSI.

All three teachers identified the SSI based on their knowledge of the context, specifically that of the community. Teacher A had knowledge of community members' response to disease based on their worldviews which were dissimilar to that of Western science. Teacher B had knowledge of incidence of cancer in the community. In addition, she had concerns about the side effects of conventional Western treatments for cancer. This resonates with the assertion by Santos (2009) that society

be made aware of both the benefits and risks associated with products of modern science. Teacher C was motivated to incorporate alien invasive plants into the teaching based on her knowledge of the flora of the community. Unlike teachers A and B whose motivation was based on community members' practices, Teacher C's motivation was based on environmental issues in the community.

11.7.2 *Preparing to Teach SSI: Deconstructing the Curriculum*

Teacher A enhanced his knowledge of the curriculum by analysing it using a critical lens. He examined both the explicit and the hidden curriculum. His analysis of the curriculum revealed that it ignored the treatment used by many community members. In this way, the curriculum could have marginalised learners, by not addressing what they were familiar with in daily life, according to Teacher A, who stated "Since only Western treatment is acknowledged in the curriculum, non-western South African learners may feel marginalised and inferior." He concluded that the curriculum valued Euro-Western epistemic frameworks because knowledge producers (scientists of Euro-Western descent), the context in which knowledge was produced (North America and Europe) and the type of knowledge (radiotherapy and chemotherapy as treatments for cancer) in the curriculum privileged Euro-Western knowledge traditions. The complicity of the curriculum in neglecting non-Western worldviews and knowledge systems is well documented (Heleta 2016; le Grange 2016).

Teacher A enhanced his subject matter knowledge by reading texts about alternative treatments for cancer. He networked with more experienced teachers to improve his capacity to teach. The advantage of appropriating epistemic knowledge by interacting with more experienced colleagues was advocated by Maistry (2015) and Mudaly (2015).

Teacher B analysed the curriculum critically. In addition, she analysed prescribed textbooks and found that the content and underlying ideology privileged Euro-Western paradigms, when she stated: "Treatment options listed in textbooks are of Western origin…, Scientists shown are of European or North American descent. Textbook idolises European scientists and leaves no hope for the African child." For Teacher B, the lack of role models with which the African learner could identify, impacted negatively on the learner. The insidious denigration and subjugation of people, by using the institution of education, was emphasised by le Grange (2018) and Connell (2016).

Teacher C conducted an analysis of the curriculum documents. She found that the response to alien invasive plants, as outlined in the curriculum, lacked meaning for learners. She asserted: "CAPS (curriculum) wants learners to write a report on an example of an alien invasive plants. This is not a good way to manage the invasion of alien plants by science learners. I wanted them (learners) to see these plants

in their environment, know how these plants affect the environment negatively, and to remove them…" The importance of science education which is relevant to learners has been underscored in several studies (Holbrook and Rannikmae 2007; Mudaly 2011). Teacher C prepared to teach using visual methods, by taking photographs of alien plants in the school yard and identifying them, using reference books. She also leveraged support from an external expert, by working with the "Environmental Officer from Natural Resources." Obtaining outside support for developing new teacher knowledge was recommended by Rogan (2007).

11.7.3 Addressing the Social Challenge through SSI-Based Instruction: Reconstruction

Teacher A re-imagined the curriculum by adding other remedies for the treatment of cancer in his presentation of powerpoint slides. Learners were encouraged to take responsibility for their learning by doing a homework exercise on cancer treatments from alternative knowledge sources. Learners were encouraged to engage in "recovering and re-discovering" (le Grange 2016, p.3) knowledge about treatment of cancer. This disrupted the dominance of treatments from Euro-Western sources, and learners were enabled to access information in groups about the use of alternative (to chemotherapy and radiotherapy) treatments, using electronic devices and scholarly texts. Learner centred pedagogy informed the lesson, where learners were encouraged to debate usefulness of alternative treatments, based on the information they sourced. Alternative knowledge which had been excluded during centuries of oppression (Kruger and Fataar 2017), was (re)appropriated by learners. Critical thinking was enhanced by asking learners to "discuss and debate your views about the usefulness of alternative treatments." The importance of debates in reconstructing the curriculum was emphasised by Santos (2009).

Teacher B expanded her teaching to transcend what was stipulated in prescribed textbooks and the curriculum, by including African indigenous plants and a female, African scientist who researched alternative therapy for cancer, to learners. This marked a departure from the monocultural perspectives (Kincheloe 2008) of who is a legitimate knowledge holder, and what is valuable knowledge. It resonated with Hountonji's call for African knowledge to be reappropriated and for "épistémologies du Sud" to be revived (Hountonji 2009, p.1). The importance of female role models in science education was underscored by Juan et al. (2018).

In Teacher B's classroom, a learner centred pedagogy was adopted and learners worked collaboratively in groups to actively construct knowledge about the use of African indigenous plants in treating cancer. Learners were encouraged to use argumentation to think critically as they constructed knowledge. Insight into the value of argumentation as a strategy to provoke thoughts about controversial SSIs was provided in another study by Karahan and Roehrig (2019).

Teacher C used a video as an aid to teach about the effects of alien plants on the environment. She worked with an external expert, an Environmental Officer to develop worksheets to enable learners to identify alien plants. Under her supervision, learners identified and eradicated alien plants in the school yard mechanically. This addresses the plea from Hountonji (2009) for the production of knowledge which meets the needs of African societies. Teacher C's engagement of learners in field work transcended the normal boundaries of activities prescribed in the curriculum. She developed in the learners the skill of identifying and removing alien invasive plants from the school, instead of following the curriculum guideline for learners to write a report on an alien plant.

The three teachers in this study adopted different strategies to implement lessons which were embedded with SSIs. They developed learner-centred lessons and encouraged group work and peer collaboration. Teachers A and B shifted the responsibility of accessing information to the learners. They were encouraged to think critically about the information which they collated and presented as posters or reports. Argumentation and debating were encouraged as learners constructed knowledge collaboratively. Teacher C prepared the worksheets to guide learners to identify alien plants, and this was dissimilar to the strategy used by Teachers A and B. However, Teacher C adopted a practical approach by involving learners in fieldwork. Teacher C was the only participant to engage learners in hands-on activities. Teachers A and B privileged minds-on activities.

11.8   Concluding Remarks

Teachers' professional knowledge and experiences informed ways in which they integrated SSIs in the curriculum within the context of decolonising the curriculum. Their reasons for selecting specific topics was based on their knowledge of the context, particularly that of the community. Teachers A and B understood the incidence of cancer in the community. Teacher A also demonstrated knowledge of treatments which community members preferred. Teacher C, a graduate in environmental science, was possibly more aware of alien invasive plants, based on her professional knowledge. This, combined with the invasion of alien plants in the school and community, spurred her to respond within the context of science lessons.

In preparing to teach lessons which integrated socioscientific issues, the teachers, as critical pedagogues, analysed curriculum documents. This involved deconstructing the unit of work which was outlined in the curriculum and in textbooks. Analyses by Teachers A and B rendered elements of the hidden curriculum more visible. The promotion of Euro-Western knowledge and knowledge producers in the curriculum and textbooks was perceived as a form of epistemic injustice. The critique of the curriculum by Teacher C revealed that the information on alien plants and the learner activities stipulated in the curriculum were inadequate and irrelevant.

Teacher A enhanced his subject matter knowledge and pedagogical content knowledge by collaborating with more experienced teachers. Teacher C leveraged

support from an Environmental Officer, an external expert, to deepen her subject matter knowledge. Each participant used the internet, textbooks and other reference materials to deepen their knowledge of science which was related to the topic.

In order to address the social challenge through SSI-based teaching, teachers reconstructed the units of work. Teachers A and B disrupted the process of re-inscribing dominant positions of Western figures by including non-Western scientists in their teaching. Teachers A and B included opportunities for learners to demystify IKS by engaging them in activities where they were required to actively access information. Pedagogic activities were designed to stimulate critical thinking and argumentation among learners. Teacher C engaged learners in a field study, where they eradicated alien plants, and contributed positively to the school environment. Each teacher was intellectually imaginative and cast learners as autonomous, self-reliant individuals.

This study revealed ways in which teachers adopted a human-centric approach to teaching, in order to address challenges in their communities. As critical social agents, they developed units of work which were relevant to the school communities. They asserted their self-determination by adopting an alternative pedagogic vision when designing lessons which valued lived experiences of learners and their communities.

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