Preparing Pre-Service Teachers for Inquiry-Based Practical Work in Multiple-Deprived Classrooms: A Decoloniality Approach

Maria Tsakeni
https://orcid.org/0000-0003-3208-1362
University of the Free State, South Africa
tsakenim@ufs.ac.za

Abstract

Amidst debates on decoloniality in higher education and instructional strategies earmarked for the 21st century in science classrooms, this paper argues for the preparation of teachers who have the epistemic capability to be functional in all school contexts. The study adopts a decoloniality approach and Sen's Capability Approach to explore the link between pre-service science teacher preparation and the practice of inquiry-based practical work (IBPW) in multiple-deprived classrooms. Inquiry-based learning is an impetus of current reforms and curriculum projects in science education. Practical work is also central to science teaching and learning. The integration of inquiry-based learning and practical work results in IBPW instructional strategies. The implementation of the strategies is filtered through school contextual settings such as material resources and teacher professional identities, which are some of the unmet needs in multiple-deprived classrooms. What is subject to debate in this paper is how teacher training programmes prepare pre-service science teachers to effectively implement IBPW under the adverse conditions of multiple-deprived classrooms. Using one university in the Free State province of South Africa as a case study, data were generated by means of two focus group interviews, each with five final-year pre-service teachers, and semi-structured interviews with two lecturers. Theorising on a decoloniality approach for pre-service teacher preparation in IBPW implementation, the study highlights some epistemic and pedagogical issues that create multiple-deprived classrooms and perpetuate non-inclusivity and injustices.

Keywords: decoloniality; inquiry-based learning; inquiry-based practical work; multiple deprivation; pre-service science teacher preparation

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Introduction

I used a decoloniality lens to problematise the role played by teacher training programmes in preparing science teachers to be functional in multiple-deprived classrooms when implementing inquiry-based practical work (IBPW) strategies. In doing so, I explored how a methods course prepared physical sciences pre-service teachers for classroom settings defined by multiple deprivation for the implementation of IBPW strategies. In addition, I also made an assumption that school science curriculums may not come tailor-made for all school science classroom contexts. Some of the conditions of multiple deprivation in science classrooms are a result of disadvantaged historical backgrounds and one wonders how the teachers are prepared for these particular environments. Curriculums, instructional strategies and multiple-deprived classrooms are part of modernity, described by Giddens (1996, 1) as the modes of social life and organisations that originated from Europe around the 17th century. Through processes such as slavery and colonisation, modernity spread to other parts of the world, resulting in Eurocentric hegemony. Accordingly, modernity (curriculums included) continue to be characterised by aspects of coloniality and hence the current decoloniality calls.

The decoloniality agenda in higher education is evolving amidst some other higher education transformation drives such as the internationalisation of the curriculum. The transformative aspects of curriculum internationalisation call for the development of global citizens with particular attributes earmarked for the 21st-century citizen (Clifford and Montgomery 2015, 50). These include respect for diversity, participation in and contribution to local and global communities, and repulsion for social injustices, among others. I view the radical change embodied in transformation drives as one of the options to replace coloniality by overcoming Eurocentric modernity without throwing away the positives of modernity (Grosfoguel 2011, 1).

In countries such as South Africa, transformation discourses in higher education have taken an interesting twist by including the need to explore active participation by all in knowledge production, through decoloniality impetuses (Kessi 2017, 1). To expound on the research problem articulated in the first paragraph, I propose in this study that knowledge production is a skill that enhances the capabilities of pre-service teachers to function in multiple-deprived classrooms when implementing IBPW strategies. Teacher training programmes play an important role in developing such capabilities in pre-service science teachers. Science syllabi, such as the Curriculum and Assessment Policy Statement for physical sciences, are undergirded by scientific-inquiry teaching and learning methods (DBE 2011, 8). However, the syllabi do not explain how the science teachers should implement the inquiry strategies, although emphasis is placed on practical work by listing some forms of practical-work strategies, which include experiments and investigations (DBE 2011, 11).

Inquiry-based practical work is therefore a pivotal teaching and learning strategy in science classrooms in all contexts. It can be deduced that the science syllabi suppose that teachers already possess the pedagogical content knowledge (PCK) to implement the innovative science strategies. As part of higher education, pre-service teachers' preparation comes under the spotlight in the raging debates on decoloniality and the higher education curriculum. Similarly, in this paper, I interrogate how the science teacher training programmes should take into account all school contexts, including multiple-deprived classrooms. A significant number of school contexts in South Africa are characterised by multiple-deprived conditions in the material sense. These include those in farms, rural areas and townships, among others. Particularly for physical sciences practical work, many schools do not have the required laboratory facilities, materials and equipment as demanded by the curriculum. Classroom practices which include inquiry through practical-work facilitation are adversely affected in conditions of multiple deprivation. These conditions may also include lack of specialist skills and classroom pedagogies, among others (Tsakeni 2018, 187). The implication is that conditions of multiple deprivation for IBPW may be experienced not only in poor schools (in the material sense), but also in schools that are backed by affluent backgrounds.

Using one South African university as a case study, I used the opportunities presented by the current discourses on decoloniality and higher education to argue for the empowerment of pre-service science teachers to be able to implement IBPW in multiple-deprived classrooms. I used Sen's Capability Approach as a way of empowering pre-service teachers to work in multiple-deprived physical sciences classrooms. I ask the question, How does the decoloniality approach proffer a link between pre-service teacher preparation and IBPW implementation in multiple-deprived classrooms? In terms of original contribution, this paper adds value to decoloniality discourses. In addition, the paper demonstrates the practical application of decoloniality concepts in science teacher preparation and science teaching.

Decoloniality and the Higher Education Curriculum

Some authors associate coloniality with modernity. Mignolo (2007, 155) propounds that modernity encompasses coloniality by projecting oppressive and imperially bent, modern European ideals over the non-European world. The effect of modernity spreading to the rest of the world was that some racial groups became ontologically silenced in terms of their cultural, lingual and general social expressions (Ndlovu-Gatsheni 2018, 16). Ontological silencing is one of the ways in which the disadvantaged are deprived, which results in limited participation in knowledge production. Therefore, in modernity establishments such as globalisation, being European or non-European has become a form of racial categorisation (Quijano 2000, 534).

Higher education is one of the spaces in which decoloniality discourses are increasingly playing out. Decoloniality discourses are characterised by a notable urgency in some

formerly colonised countries, possibly because of their position in a radical-reform space (De Oliveira Andreotti et al. 2015, 31). In this space there is awareness and recognition of Eurocentric epistemological dominance at the expense of local forms of knowledge. As a way of ensuring meaningful participation in the process of knowledge production, some African scholars have begun to ask crucial questions concerning the identity of the producers of what we know as knowledge in higher education and who exactly is intended to benefit from this knowledge (Ndlovu-Gatsheni 2013, 14). The decoloniality impetus pushes for African discourses to serve as lenses when addressing issues relating to content, languages and methodologies used in teaching and learning (Waghid and Hibbert 2018, 264). Similarly, the position in this paper is to embrace decolonial stances and challenge the methods used to prepare pre-service science teachers to be school-context sensitive and inclusive.

In this paper, decoloniality is understood based on some important definitions of coloniality. De Oliveira Andreotti et al. (2015, 23) explain that "coloniality can be understood as a system that defines the organisation and dissemination of epistemic, material, and aesthetic resources in ways that reproduce modernity's imperial project." The imperial project comes with injustices of non-inclusivity and marginalisation as violences that certain groups of people continue to suffer. Much of the injustices may be evident as conditions of multiple deprivation (poverty) in a material sense. However, a holistic and integrated approach to view multiple deprivation as including epistemic and aesthetic dimensions may be useful in understanding the actual impact of coloniality. The influence of coloniality is currently deep-rooted to the point that efforts aiming to address some of the injustices have a very insignificant impact. For example, transformative agendas through other approaches such as the internationalisation of the higher education curriculum operate under conditions of coloniality. The coloniality conditions are characterised by conservative macro and micro factors that hinder the goals of transformation (Clifford and Montgomery 2015, 60). These factors include the political environments of institutions and current pedagogies in the different disciplines. For the formerly colonised countries in Africa and Latin America, and including the indigenous people in settler nations such as Canada and New Zealand, coloniality is problematic, because it is viewed as a source of injustices (Nakata et al. 2012, 23). Against this background, the decoloniality project is one way of taking the challenges of coloniality head-on by attempting to address the key injustice challenges holistically.

It is important to take note of the multidimensional nature of coloniality and that it permeates every area in society. One of the areas of contention under the decoloniality impetuses is the question of how to include other lenses in the manner in which knowledge is produced and validated. Morreira (2017, 287) observes, for example, that African knowledge is undervalued in South African higher education. In mitigation, decolonising the curriculum (withdrawing from curriculums inherited from the former colonial masters) is believed to be one way to include other players in knowledge production. There are a number of approaches used to decolonise the higher education curriculum. These may take different forms, ranging from the fixation on simplistic

decolonisation of Western knowledge to positions that take a neutral stance in viewing the world (Nakata et al. 2012, 123). Among the number of approaches used to implement decoloniality is the indigenisation of the higher education curriculum. Against the backdrop of a long history of racism and discrimination, Cupples and Glynn (2014, 56) present the option of interculturality as a pedagogic approach in one Nicaraguan university to empower and emancipate the local Creole people. Decolonisation is thus achieved by including the formerly disadvantaged indigenous groups' worldviews and knowledge systems in the higher education curriculum.

Another approach to decolonise the higher education curriculum uses existing theories to further theorise a higher education curriculum that is designed for the public good. Walker (2018, 555) uses a capability approach to theorise a decoloniality and epistemic-justice frame for higher education in the interest of the public good. Calling for a vision that nurtures the capabilities of students in higher education, Walker (2018, 559) theorises personhood self-formation, sufficiency of economic resources and epistemic contribution as the critical dimensions to be targeted for development. Subjects in school curriculums, including physical sciences, have always been viewed from Western epistemic standpoints. The views extend to the teaching and learning strategies and the methods and tools utilised for generating the science knowledge. Based on the literature that bemoans the shortages of resources in some schools and lack of teacher expertise (Ramnarain and Hlatswayo 2018, 1), it can be assumed that, ideally, practical work is associated with well-equipped science laboratories and certain teacher professional identities. The existence of science classrooms that are well resourced as opposed to some that lack resources is an example of injustices and discourses inherent to coloniality. These injustices and discourses are part of the knowledge systems which higher education has played a significant part in sustaining (De Oliveira Andreotti et al. 2015, 34). Since there is no promise of changing the conditions of multiple deprivation in some South African schools, in this paper, I explore how decoloniality can influence physical sciences pre-service teacher preparation for IBPW practice for multiple-deprived classrooms.

Capability and Pre-Service Teacher Empowerment

Sen (2003, 43), advancing what is now known as the Capability Approach, proposes that life can be taken as a set of "doings and beings" regarded as "functionings." The Capability Approach uses the functionings to assess the quality of life, contending that the assessment cannot be accomplished by focusing on the commodities and incomes that support the beings and doings alone. As Alkire (2005, 117) further expands, the Capability Approach is able to give insight into the actual freedoms that individuals have. The freedoms refer to the extent to which deprived people are able to enjoy valuable doings and beings. The Capability Approach is sympathetic towards efforts taken to reduce injustices and poverty. The approach outlines five instrumental freedoms which underpin conducive environments for the development of functionings

(Walker 2010, 156). These are political freedoms, social opportunities, economic facilities, transparency guarantees and protective (human) securities.

The Capability Approach and the decoloniality discourses share a common agenda in terms of injustices and poverty reduction for deprived people. Both approaches recognise that the objective to empower deprived people should extend beyond focusing on the access to material goods. Whilst the Capability Approach focuses on the development of functionings in order to attain the instrumental freedoms, the decoloniality approach focuses not only on material empowerment but also on issues related to the deprived people's epistemic and aesthetic appreciation. For higher education, Walker (2008, 277) argues that widening participation should not only translate to the inclusion issues for the students from deprived groups; it should also translate to the widening of the capabilities of the students. One way of widening the capabilities of the students is to educate them to be critical and active participants of democratic processes in life. This study recognises the importance of developing the capabilities of physical sciences pre-service teachers to implement important reform-oriented instructional strategies that are in line with transformation-based science syllabi in adverse conditions, such as multiple-deprived classrooms. The development of the instructional-strategy capabilities would be a way of empowering both the pre-service teachers and the learners in multiple-deprived classrooms.

Methodology

This study is part of a larger design-based research project for which the researcher is the principal investigator, and which is funded by the National Research Foundation (NRF). Design-based projects inherently have different phases of research (Andriessen 2007, 5). This study used a qualitative interpretive case study in which the link between pre-service teacher preparation and their facilitation of IBPW in multiple-deprived classroom environments was interrogated. The assumption on the use of the interpretive paradigm is that all observation is theory and value laden (Ponelis 2015, 538). The decoloniality lens was used to open up space for accommodating other worldviews in addition to the traditional approaches used in teacher preparation. Convenience sampling was used to select participants at a university that the researcher had access to. The use of a single-case study facilitated the collection of in-depth data through participants' thick descriptions of their experiences in their capacity as lecturers and pre-service teachers in physical sciences education. Accordingly, the two and only lecturers for physical sciences education were interviewed using semi-structured interviews.

The university has two campuses that offer physical sciences education, one located in an urban area and the other located in a rural area. Forms of multiple-deprived physical sciences classrooms exist in both contexts. Semi-structured focus group interviews were conducted with five students at each of the campuses. The participating students were all in their final year completing either a Post-Graduate Certificate in Education (PGCE)

or Bachelor of Education (BEd) degree. For this study, the two campuses will be referred to as Campus C (campus in the city) and Campus R (campus in the rural area). Accordingly, the lecturers are assigned the pseudonyms Lecturer C and Lecturer R and the students are assigned the pseudonyms C1, C2 … C5 and R1, R2 ... R5. All interviews and discussions were conducted and facilitated by me as the researcher.

During the focus group interviews with the pre-service teacher participants, I elicited data on the following:

- How they have learnt to engage in IBPW (by probing their experiences at university);
- How they have learnt to facilitate IBPW for learners (by probing their experiences with classroom practice [at university or during teaching practice]);
- Their self-perceived capabilities in both engaging in and facilitating IBPW (by probing their reported challenges and strengths in different classroom environments).

The data collected reflect the pre-service teacher participants' content knowledge (CK) of IBPW practice, PCK for IBPW facilitation and the influence that the classroom contextual settings and teacher-preparation experiences had on their perceived capabilities with IBPW facilitation. The data collected from the focus group interviews were triangulated with the data collected from the semi-structured interviews with the lecturer participants. During the interviews with the lecturer participants, I gathered their views on how they:

- Facilitate IBPW for pre-service teachers;
- Ensure that the pre-service teachers would learn how to facilitate IBPW in different classroom environments;
- Perceive the pre-service teachers' capabilities in facilitating IBPW in real classroom environments, including multiple-deprived environments (by probing the perceived challenges and strengths).

Data Analysis

The interviews and group discussions were audio-recorded, and then transcribed verbatim by the researcher into textual data. Data analysis was conducted at three different levels. First, directed content analysis was conducted to determine the university practices in preparing pre-service teachers' CK and PCK for IBPW for different school environments in order to determine their capabilities for multiple-deprived environments (under the findings of the study section). These preliminary findings and the transcripts of the interviews were sent to the participants for member-checking. The second level of data analysis involved constant comparison techniques to

allow abstraction by setting the university practices in light of the Capability Approach (under the discussion section). Lastly, the data were used to theorise a decoloniality position for the preparation of physical sciences pre-service teachers for multiple-deprived classrooms.

Findings of the Study

Pre-Service Teachers' Experiences of IBPW as Content Knowledge

From what the pre-service teacher participants narrated, it could be seen that they had engaged in some forms of IBPW which were either guided or open-ended. However, their IBPW experiences occurred in the faculty where they learnt the physical sciences content and not in the Faculty of Education. When asked if the pre-service teacher participants engaged in some form of IBPW activities that were not prescribed in the textbooks, R1 from the rural campus said,

> I think we are being taught to do that because all of us here, we did the assignment where everyone came up with a problem and then do the scientific methods; we all did and it was not in the CAPS document [referring to the school syllabus for physical sciences]; we came up with your [our] own thing … your [our] own thing, your thing.

The pre-service teacher participants gave examples of some of the problems they formulated for the IBPW activities. C1 said,

> I made some observations [on a rainbow]. I remember it was in rainy days so in my observations it [the rainbow] did not come out all week so I started doing my investigation. I came up with a conclusion that the rainbow is not caused by the rain; the conclusion was that the rainbow is caused by the water drops that are directed to sunrays, so when they are directed to sunrays, that's when the human eye will see the colours of the spectrum; if the raindrops are combined with the sunrays, then we experience the primary colours, we see the primary colours, and then I did the experiment with bubbles. I took the bubbles and I popped them and then they went up and then I saw the rainbow without rain.

Participant R2 also shared how she formulated a problem from scientific phenomena observed from real life and solved the puzzle, as presented in the following interview excerpt:

> **R2:** Mine was that one of a bird standing on an electric wire and not being shocked.
>
> **Researcher:** Okay, how did you investigate that?
>
> **R2:** Actually, my question was that, do birds get shocked if they are standing on one electric wire and also what happens? Let me say, if they have one foot on the wire and on something else that is relative to the ground, obvious they are going to get shocked, which is why they don't get shocked. If you are standing on the ground, then you touch

an electric wire, you were going to get shocked because you are standing on the ground; so if a bird is maybe standing on the tree and then on the electric wire [at the same time], it will get shocked. It is going to get shocked because there is something else which is relative to the ground, which is a tree, so that is what my project was about.

The above examples show how the pre-service teacher participants engaged in open inquiry (identifying a problem that they could solve through practical work). In the practical work, the pre-service teacher participants were able to handle or manipulate materials and/or use real-life situations. In addition, the pre-service teacher participants also engaged in guided-inquiry activities through practical work. In this case, they needed to engage in hands-on activities to solve problems under certain science topics that were being covered at that moment. C2 shared what she did for a topic on intermolecular forces:

C2: My problem was why liquids evaporate at different rates.

Researcher: Okay, and what did you come up with?

C2: The reason for different evaporation rates is that the liquids have different densities and different boiling points.

Researcher: So, which liquids did you use?

C2: The orange juice, nail-polish remover and water.

Researcher: So, which one was evaporated faster?

C2: The nail-polish remover.

Researcher: Alright. Did you go deep in trying to find the organic materials that are inside the nail-polish remover or the substances that are in orange juice; the water is an obvious one, it's the water?

C2: In the nail-polish remover, we are having acetate; it evaporates faster, therefore it gets dry faster because of its density.

All 10 pre-service teacher participants gave examples of how they engaged in IBPW. The above examples were just selected for illustration. In the methods courses given in the Faculty of Education, lecturers work on the premise that pre-service teachers would cover the required CK in another faculty. This was acknowledged by Lecturer R when he said the following:

We assume that the students have been trained academically, so we don't get deep into the content of the experiments, but we show them how to do the experiments in the school syllabus.

Pre-Service Teachers' Pedagogical Content Knowledge (PCK) Development Experiences

The two lecturer participants described some approaches that they use to prepare pre-service teachers in order to use the IBPW strategies. On the one hand, Lecturer C either demonstrated or made the pre-service teachers conduct the practical-work activities as a form of instructional strategy. On the other hand, Lecturer R requested the pre-service teachers to plan lessons and facilitate the IBPW activities in simulated conditions:

> **Lecturer C:** I developed a worksheet on practical skills which teachers must teach the learners; they are basically your scientific method [scientific inquiry]. So, for every demonstration or practical they do, I check the checklist on which it must be completed for the aim and the title of the experiment, the investigative question and the variables, the hypothesis, then the background research given the theory that informs the practicals [practical work].

Lecturer R used the lesson-study approach:

> We use the lesson-study approach whereby the students are divided into groups, and, for instance, this year I had 10 students who are divided into three groups. So, the three students in one group will sit together and plan a practical lesson together and then one of the students will present the lesson to the learners invited from the surrounding schools. The other students will be there; the two students are part of the planners so they will sit there and watch the one who is delivering the lesson and after that the three students will sit together and discuss how the other student performed and the rest of the other students who were not part of the group will also give feedback on the lesson. I am also there to give feedback as well and the teacher from the invited school is also part of [the] session.

However, R3 from Campus R felt that she learnt how to facilitate IBPW by completing the laboratory management courses. For her, learners were supposed to conduct practical work in a science laboratory. This could be inferred from the following interview excerpt:

> **Researcher:** So, do you think you have received enough preparation for you to be able to facilitate practical work for learners? Are you ready now?
>
> **R3:** For me, I think I am ready. I think I am ready because for laboratory management we did a course, a module about it, so we even wrote an exam that includes the laboratory management, so I think I just studied everything that I needed to know for me to do the laboratory work in schools.

Pre-Service Teachers' Experiences with Multiple-Deprived School Contexts

Below follows a description of some of the multiple-deprived conditions that characterised the physical sciences classrooms as experienced by the pre-service teacher participants. Lecturer C explained how some of the pre-service teachers' preparation is

affected by poor attendance of the methods courses. The poor attendance is due to some of the PGCE students being employed in full-time teaching jobs based on their Bachelor of Science qualification. These pre-service teachers obtain the responsibility for physical sciences classrooms before they are qualified and, in some cases, have not yet covered all that they have to learn during methods courses. Lecturer C explained,

> You see, the problem I see with us, maybe in South Africa, is that there is a critical shortage of science and natural science teachers, to the extent that they have come and asked for our student teachers to go to schools and teach. So, at a certain stage before or whilst they are in their fourth year or so, they take up that kind of a job; so, the problem becomes the timetable, which will be, say, 09:00 to 12:00 [hours], but tomorrow it will be 14:00 to 17:00. So, it is, like, maybe if we can put these two classes to be 14:00 to 17:00, then they will be able to attend. So, that is the unfortunate thing. There must be a way that they need to catch up with the work that we have already done.

Other forms of multiple deprivation in physical sciences classrooms were narrated by the pre-service teacher participants when the researcher asked them the following:

> I know you are not yet full-time class teachers, but try to compare the practical work you did during your undergraduate studies and the way you have seen … from your experiences … how things are done in secondary schools. Is there something that you think needs to be changed? You think they should continue doing things the way they do because definitely there are some differences?

Participant R4 pointed out that there was a shortage of materials and equipment in most of the schools and also that there was a lack of opportunities to facilitate practical work in real classrooms around Campus R. He observed the following:

> To start with, most of the schools that we are visiting currently, they usually do not have laboratories or apparatus, so, but what Doctor did was to invite students from outside, from around Campus R to come do the laboratory work here at the university and then that is where we got the experience and how to perform the experiment with the learners. So, my experience on performing the experiment with the learners is only here at the university.

Participant C3 also mentioned that materials were not sufficient for some of the schools around Campus C:

> I think there should be a change in the provision of apparatus [materials and equipment for practical work] because in secondary schools there is a tendency to let learners do the practical [work], like, in groups; yeah, so I think sometimes, they should allow them to work independently. So, some of the practicals, they should do them independently and others in groups so that they can even build things alone without depending on the others, because some of the learners are disadvantaged because of handling things with others.

Participant C4, however, added another dimension to the multiple deprivation of the physical sciences classrooms around Campus C when she mentioned that learners were not given an opportunity to conduct the practical-work activities. She recalled,

> My mentor used to do the practical for learners: he just [stood] in front, then perform[ed] the experiment, he don't [didn't] give the learners a chance to perform. It's him who was performing for learners.

Yet another dimension to the conditions of practical-work activities was added by participant C5 when he revealed his experiences in which the mentor neither demonstrated nor let the learners conduct the practical-work activities. The mentor only described to the learners how the practical work could be conducted and what the expected results were. This finding is revealed in the interview excerpt below:

> **C5:** Based on what was said here, some teachers don't even do the practical for the learners but sometimes they just give the problems to the class to go find out the answers based on the experiment that should be done by the learners and the teacher then just give them the answers to the questions.
>
> **Researcher:** And the experiment is never done?
>
> **C5:** Yeah, and the experiment is never done.

Participant R1 felt that practical examinations should be introduced in order for the practical-work instructional strategies to be taken seriously in physical sciences classrooms:

> I think the practical should be introduced as kind of an exam because learners, they take something seriously if it is an exam, for example; everyone takes exams seriously. So, I think if practicals can be introduced, let me say, in a form of an exam, let's say, where they are going to write practical exam, I think that is when learners are going to be serious and that's when they are going to be interested in doing practical.

The findings above reveal how the pre-service teacher participants developed CK on IBPW through engaging in some guided- and open-inquiry activities. During the IBPW activities, the practical work was defined by hands-on activities and real-life problems which the participants solved through hands-on activities and/or theoretical physics or chemistry. The participants developed PCK for IBPW classroom practice through conducting some of the practical-work activities in the school syllabus, demonstrating to peers how they would engage learners in IBPW and also participating in lesson-study activities involving learners and teachers from the surrounding schools. However, the pre-service teacher participants experienced forms of multiple deprivation in their preparation both at university and during teaching practice. These multiple-deprived conditions include poor attendance of methods courses after securing full-time teaching jobs, and poor IBPW mentoring by schoolteachers during teaching practice. According

to the pre-service teacher participants, learners in schools always conduct the practical activities in groups, which compromises activities that are meant to be completed individually. Some teachers in schools either conducted demonstrations for learners or did not conduct any practical activities at all. Inquiry-based practical work was undervalued as an instructional strategy. The pre-service teacher participants also revealed that some of the schools lacked the materials and equipment that would enable them to facilitate school IBPW as they understood it (inquiry-based laboratory work). The notion of understanding practical work as laboratory work seems to be strengthened by some of the pre-service teacher-preparation activities. Campus R invited learners and teachers from surrounding schools (that lack materials and equipment) to conduct some of the practical-work activities in the campus laboratories.

Discussion

This study adopted a decoloniality lens and set out to proffer a link between pre-service teachers' preparation and the implementation of IBPW in multiple-deprived classrooms. According to Waghid and Hibbert (2018, 263), pre-service teacher preparation is one of the areas that has experienced little transformation in terms of epistemic processes and pedagogical practices. Similarly, for this study, the pre-service teacher preparation for IBPW was set in traditional coloniality practices. As discussed in the section above on decoloniality and the higher education curriculum, the injustices of coloniality are enduring because they are deeply entrenched in the manner in which knowledge is generated and in some pedagogical practices. The injustices revealed in this study include practices that compromise pre-service teachers' capabilities or functionings for IBPW classroom practice. Walker (2008, 277) calls for widening participation in higher education to mean enhancing students' capabilities to participate meaningfully in democratic societies for the public good. For physical sciences pre-service teachers, this would mean expanding their capabilities to implement instructional strategies such as IBPW which are currently negatively affected by conditions of multiple deprivation. Pre-service teachers' capabilities should be expanded in light of some of the multiple-deprived conditions inherent to the practices of their preparation.

The pre-service teacher participants understood IBPW (an epistemic position) to mean activities that should be conducted in well-equipped and resourced science laboratories. Lecturers equip pre-service teachers with the capabilities to function in well-equipped and resourced science laboratories, although these are not always available in schools. In addition, the participating pre-service teachers were not able to convert their CK of IBPW (obtained from the university's science faculty) into PCK for IBPW when doing practical work at the Faculty of Education. Failure to convert the CK to PCK is a teacher-preparation pedagogical issue. It was observed that the pre-service teacher participants engaged in guided and open IBPW using hands-on activities and real-life scenarios at the science faculty. The real-life scenarios presented opportunities to engage in hands-on activities and problem solving through the use theories/concepts in chemistry and physics. However, they did not have opportunities to facilitate similar

activities for learners. These opportunities would include the facilitation of IBPW using context-based approaches, and other activities and materials beyond the traditional classroom walls. The use of theoretical physics and chemistry to solve/understand real-life problems/situations could expand pre-service teachers' understanding of practical work. However, the expansion of pre-service teachers' capabilities for IBPW would require the reformulation of lecturers' beliefs on teacher preparation. Clifford and Montgomery (2015, 60) mention that institutional and disciplinary factors stand in the way of incorporating other lenses for knowledge production, validation and practice in higher education.

The pre-service teacher participants in this study were able to identify some classroom practices by their mentors during teaching practice that did not support IBPW. This situation presents lecturers with opportunities to empower pre-service teachers by integrating PCK development for the different conditions of multiple deprivation. The transformation of pedagogical practices for physical sciences pre-service teacher preparation to implement IBPW in multiple-deprived classrooms is a decoloniality impetus in higher education. Decoloniality questions the current content and pedagogies in higher education (Waghid and Hibbert 2018, 264). Coloniality presents educational promises that could be derived from reform-based practices such as IBPW. However, coloniality does not proffer deprived people ways or capabilities to benefit from such educational goals.

Conclusion

The study concludes that the physical sciences teacher-preparation programme may create multiple-deprived classrooms when pre-service teachers are not equipped with an epistemic capability to be creative when facilitating IBPW. I make the argument that the apparent mismatch between the preparation of the pre-service teachers and the realities of the classrooms is what is creating multiple-deprived teaching and learning environments. Pre-service teachers need the capabilities to develop the agency to function in all school environments. Without disregarding the good that comes with the current teacher training programmes, some epistemic positions on methodologies and content should be redefined to suit all classroom settings. An example of the good that should not be disregarded is the science education outcome to develop important skills in learners, such as the ability to conduct inquiry through practical work.

The study highlighted some epistemic positions inherent to coloniality in the preparation of physical sciences pre-service teachers. The positions have resulted in limited access to IBPW by learners. One epistemic position is to prepare pre-service teachers ideally for inquiry-based laboratory work instead of IBPW. However, laboratory work is non-inclusive because not all schools have science laboratories. Practical work is more inclusive because it integrates diverse strategies and materials beyond the classroom walls. Another epistemic position is the belief that classrooms that are perceived as multiple-deprived are not conducive environments for IBPW. The result is a physical

sciences teacher-preparation programme (both lecturers' and pre-service teachers' beliefs) that is able to identify conditions of multiple deprivation for IBPW but is not able to provide solutions. These epistemic positions have influenced the pedagogies used for teacher preparation.

Whilst this single-case study cannot be generalised, some theoretical insights can, however, be highlighted to demonstrate how coloniality practices create multiple-deprived physical sciences classrooms for IBPW. The study recommends for university programmes to prepare and equip physical sciences pre-service teachers with the capabilities to implement IBPW in all classrooms, irrespective of conditions of multiple deprivation. The study also recommends that further studies be conducted with a decoloniality lens in varied environments to develop pre-service teacher-preparation programmes for IBPW and to explore how pre-service teachers prepared under decoloniality curriculums implement the strategy to transform multiple-deprived classrooms.

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