CHAPTER FIVE

Place-based Mathematics Education: An Education for Sustainable Development Pedagogy to Enhance Mathematics Teacher Training

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Abstract: Mathematics education in South Africa is experiencing a crisis that disproportionately affects the majority of learners, enhancing inequality and inequity and promoting unsustainable development. Part of the problem lies in the quality and training of Mathematics teachers, as well as the pedagogy they follow. South African education, particularly Mathematics education, should contribute to the transformation of society into an equitable and sustainable one. Hence, the orientation of South African education towards Education for Sustainable Development (ESD). It is believed that ESD will contribute to equity, equality, and sustainability. One way to implement ESD is through Place-Based Education (PBE). PBE capitalises on place, community, experiences, location, and geography to create unique, authentic, meaningful, and personalised learning opportunities. Consequently, PBE expands the mathematics classroom to include the surrounding community. This empowers Mathematics teachers to make the subject relevant to learners by incorporating their local context into their pedagogy. This approach to Mathematics teaching and teacher training promotes equity and the realisation of sustainable development, as it addresses the educational needs of the majority of South Africa's learners within Mathematics education. This desktop chapter scrutinises literature on the topic to highlight the value and relevance of ESD and PBE in Mathematics teacher training, and to situate PBE as a pedagogy within Mathematics education and teacher training. I provide an overview of Mathematics teacher training in South Africa; thereafter, I discuss ESD and its connection to Mathematics education; and finally, I reflect on PBE and its relevance and value to Mathematics teacher training.

Keywords: Place-based education, education for sustainable development, mathematics education.

1. Introduction

Place-based Education (PBE) is education that occurs when learners, teachers, and the broader community utilise the social, cultural, and natural environment they inhabit as an inquiry-based learning laboratory (Reed & Klassen, 2020). Thus, PBE expands teaching and learning into the surrounding environment, creating authentic learning opportunities beyond the walls of the school. In this way, the learner's place becomes an auxiliary text that they are taught to read, synthesise, explore, and elaborate upon in their understanding and mastery of Mathematics (Buck et al., 2016). Andersson and Wagner (2021) concur that learners benefit from PBE because it enriches their (Western) Mathematical knowledge. In research on geometry, Farid et al. (2024) found that PBE enables learners to connect their Mathematics learning to their local spaces and to draw on these spaces as sources for their geometry projects. Similarly, Leonard et al. (2013) maintain that PBE engages learners emotionally and increases their engagement,

which, in turn, positively impacts their retention and performance. PBE thus assumes that education, in general, and Mathematics education specifically, is not without a 'place'; rather, it is embedded in and informed by a unique social, environmental, and cultural context that guides teaching and learning and has the potential to improve the quality of Mathematics education.

Improving the quality of education is pivotal for realising the Sustainable Development Goals (SDGs) and for Education for Sustainable Development (ESD). ESD is "holistic and transformational education [that] addresses learning content and outcomes, pedagogy, and the learning environment" (UNESCO, 2014, p. 12). ESD is, therefore, an educational approach that promotes the integration of sustainability and the SDGs across all subjects in schools and institutions of learning. In this regard, Mathematics teacher education programmes and Mathematics education should be oriented towards sustainability and ESD. However, Li and Tsai (2022) find it difficult to understand how such an orientation could be achieved, while Renert (2011, p. 20) argues that sustainability and Mathematics education remain largely unconnected. Nevertheless, establishing links between sustainability, Mathematics, and Mathematics teacher training is important because of the potential of Mathematics education to address the needs of the 21st century (Mula & Tilbury, 2023).

Addressing 21st-century needs and achieving sustainable development (SD) requires high-quality education. Hence, Sustainable Development Goal 4 (SDG 4) focuses specifically on improving the quality of education by ensuring "inclusive and equitable quality education and promoting lifelong learning opportunities for all" (UNESCO, 2014, p. 12). In this regard, SDG 4 sets certain targets that governments and countries must reach to ensure a sustainable future. For example, Target 4.1 requires that governments ensure that by 2030, "… all girls and boys complete free, equitable and quality primary and secondary education" (UNESCO, 2014, p. 12). Similarly, Target 4.5 requires governments to "eliminate … ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples, and children in vulnerable situations" by 2030 (UNESCO, 2014, p. 12). The implication of this goal and its associated targets is that South African (SA) education will have to take definitive steps to improve the quality of education, paying particular attention to the eradication of inequalities and inequities and ensuring that Mathematics education is inclusive of the needs of all learners.

The quality of SA education, particularly in Mathematics, is worrisome (cf. Schirmer & Visser, 2023). This concern stems from national Mathematics results and international test scores, such as those from the Trends in International Mathematics and Science Study (TIMSS) (2023) and the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ), which paint a grim picture of the state of Mathematics education in the country. This situation is attributed to various factors, such as the inadequate or weak knowledge of Mathematics teachers (Gobede & Mosvold, 2022) and the quality of Mathematics teacher training (Taylor, 2021).

Moreover, Mathematics and Mathematics education are also variously accused of advancing gender stereotypes (Holmes et al., 2022) and of perpetuating oppressive norms while maintaining oppressive structures and an exclusionary culture (Harper & Kudaisi, 2023). In addition, Helliwell and Ng (2022, p. 128) claim that the discourse on Science, Technology, Engineering, and Mathematics (STEM) education has largely focused on shaping "a future that works for all by putting people first,…[emphasising] that all…new technologies are first and foremost tools made by people for people." This not only suggests that Mathematics and Mathematics education perpetuate inequality, but it is also part of a discourse that promotes anthropocentric values and a human-centred orientation. This jeopardises sustainable development and makes Mathematics and Mathematics education part of the problem of unsustainable development and social inequalities.

Against this background, calls have emerged for a new and ecologically based Mathematics education that is oriented towards the needs of people, their cultures, and the planet. This approach fosters an awareness that our current global reality is characterised by "unsustainability" rather than "sustainability" (Biccard, 2019). It is in this context that teacher training programmes can contribute to sustainable Development (SD) and Education for Sustainable Development (ESD) by sensitising student teachers to place-based education (PBE).

This chapter advocates for Place-based Education as a pedagogy to equip student teachers with the necessary skills, knowledge, and values to enhance Mathematics education, thereby contributing to the alignment of Mathematics education with ESD and the realisation of SD. I will provide a brief overview of Mathematics teacher training in South Africa, followed by a discussion of ESD and its connection to Mathematics education. Subsequently, I will reflect on PBE and its relevance and value to Mathematics teacher training and education. I will conclude the chapter with some thoughts on the implications of PBE for Mathematics teacher training and education.

1.2 Why a refocus of mathematics teacher education

Mathematics is generally perceived to be difficult, abstract, static, and disconnected from our daily lives (Holmes et al., 2022). It is furthermore conceived as teacher- and content-oriented and it focuses on "teaching to the test" resulting in Mathematics teaching being strongly academically oriented (Li & Tsai, 2022). These perceptions are fuelled by a conviction that not all learners are supposed to take Mathematics at school because not all have the capabilities to master it. Subsequent to this, many learners see no value in the subject, they lose interest in it, and they opt out of it the moment they have the chance. However, opting out of Mathematics is deeply problematic for society (Li & Schoenfeld, 2019), especially when Mathematics and Mathematics education forms part of the development trajectory of a country such as the case is with South Africa.

The place of Mathematics and Mathematics education in the development of South Africa is evident in the status awarded to Mathematics and Mathematics Literacy within the national basic education curriculum promulgated in 2012. Here these two subjects are compulsory, and all learners are expected to take either the former or the latter during their basic education. The significance of these subjects in societal development is acknowledged by Jojo (2020) who opines that Mathematics and Mathematics education can empower people, and it can contribute significantly to the eradication of poverty, whilst it also advances gender equality. South Africa's National Development Plan (NDP) (2012) also emphasises that the basic education system should improve the outputs in Mathematics education, and universities are expected to deliver more trained graduates in Mathematics and to, deliver more and better qualified Mathematics teachers (NDP, 2012). Mathematics is therefore centred within the national development project.

However, the realisation of this vision is hampered by the crisis Mathematics education finds itself in, with Mathematics teacher readiness and training frequently appearing as a potential factor contributing towards the crisis. Jojo, (2020) blames curriculum implementation and the readiness of Mathematics teachers, whilst (Pournara et al., 2015) blames the poor Mathematical knowledge of teachers for the crisis. A study conducted by SACMEQ found that only 41% of Grade 6 Mathematics teachers in South Africa had "good proficiency in mathematics" (Schirmer & Visser, 2023), whilst Spaull (in Mlachila & Moeketsi, 2019), found that four out of five teachers in public primary schools lack the content knowledge and pedagogical skills to teach Mathematics. Verster and Sayed (2020) also blame Mathematics learners' poor and underperformance on a shortage of confident and competent qualified Mathematics teachers. In terms of teacher training, Taylor, (2021) found the preparation of final year Bed Mathematics teachers so poor that they are described as "patently incompetent to teach maths to primary school learners". It is because of this that the United Nations Educational, Scientific and Cultural Organisation (UNESCO) (2015, p. 192) claims that "millions of South African children are not acquiring basic arithmetic skills and are therefore most likely to drop out of basic primary education".

These statistics points to rather stark educational inequalities in the quality of Mathematics education in a system where historically black schools make up most of the schools in South Africa. When it therefore comes to Mathematics education, black learners are still disproportionally disadvantaged and therefore set up for failure by an education system that is supposed to promote equity and take them out of poverty. There is therefore a pressing need to rethink and re-envision Mathematics education and to consider a) the use of a range of resources to support the development of Mathematical concepts (Naidoo, 2022), and b) the use of suitable pedagogies based on the learner's language, culture and living environments (Mapungubwe Institute for Strategic Reflection [MISTRA], 2020).

In this chapter I focus on the learners' place as one such a resource and a pedagogy. However, before I reflect on Place-Based Education (PBE), let me first locate it within the broader discourse around SD, the SDGs and ESD. Such a location is relevant because of the close connection of PBE with SD and ESD and because of the contribution it could make in realising quality education as is advanced by SDG 4.

2. Methodology

This chapter is based on an extensive literature review. In this desktop chapter primary and secondary literature were used to formulate and build out the argument that is presented. I used the identified keywords, and I searched for relevant and recent sources on platforms such as Google Scholar, EBSCO Academic Search Complete, ERIC, JSTOR. All sources were subjected to an intensive reading to identify relevant information. Policy documents used in the chapter were analysed to identify sections that speaks to the argument of the chapter. All sources were carefully read, and relevant information were coded. To ensure the trustworthiness of this chapter, all sources were appropriately cited and referenced, and care was taken to engage with all sources in an objective and unbiased manner.

3. Place-based Education

3.1 Place-based education: Its origin

PBE is not an entirely new concept to teaching and learning. Rather, it has a long history within education that can be traced back to Dewey's ideas on teaching and learning. In this regard, Dewey believed that learning occurred most naturally when focused on the intersection of people, their local environments, and an authentic purpose (Yemini et al., 2023). However, PBE owes its more recent popularity to the rise of neoliberalism in the 1990s and the impact of its associated ideologies on education policies. Neoliberalism is a political ideology that is focused on the economy, and is - 76 -aption- 76 -ing- 76 -o by an emphasis on market-driven policies, privatisation, individualisation, and the commodification of education (Villarin et al., 2024). This ideology impacts every sphere of our existence, and in education, it is most visible in standardised tests, performance-based funding, accountability regimes, efficiency, and competition, which variously disadvantage the poor and the marginalised and promote inequality. PBE thus serves as a counter-educational force against neoliberal educational reforms that propagated a disregard for culture in education and which promoted the decentring of cultural connections, community, and environmental stewardship (Yemini et al., 2023). This neoliberal turn resulted in schools increasingly becoming detached from the communities and people they serve and from the animals and plants that they share space with. As such, neoliberalism projected the learners' 'place' as bearing no significance on teaching and learning and thus as something of no pedagogical value and significance. With neoliberalism advancing a detachment from culture and from the 'place' of the learner, a form of education was established that "distracts our attention from and distorts our response to the actual contexts of

our own lives (places)" (Gruenewald, 2003, p. 621). Such distractions and distortions are of course detrimental to effective and quality teaching and learning. Hence the focus on a reconnection and a reattachment with the 'place' through PBE.

3.2 What is 'place' in place-based education all about?

The concept of 'place' is the focal point of PBE. One cannot, therefore, come to deeper insights into PBE without a proper understanding of the concept of 'place'. On face value, one would be tempted to narrowly and superficially define the concept 'place'. However, within PBE 'place' is more than just an address, a plot, a piece of land, a home or a GPS location we inhabit, co-inhabit or can physically visit. Rather, 'place' is "a spiritual place, a place of being and understanding" where "interactions with places give rise to and define cultures and community" (Rubel & Nicol, 2020, p. 175). For Coughlin and Kirch (2010, p. 915) 'place' also represents "a lived entity that results from a dialogical transaction between a community and its material environment at a particular moment in cultural-historical time and which hence shapes and is shaped by the identity of the people". As such, 'place' is where living and non-living organisms exist and co-exist and where they form and are formed by the place they occupy at a given moment in time. Similar conceptions of 'place' are experienced by indigenous people and communities, who have an intimate connection with 'place' as a way of thinking about relations between and with humans, and with nature, and for whom "place is a way of knowing, experiencing, and relating with the world" (Rubel & Nicol, 2020, p. 175).

Its richness in terms of histories, emotions, stories, culture, aesthetics, and social problems (Buck, Cook & Carter, 2016), therefore makes place a valuable pedagogical asset that can enhance Mathematics teaching and learning, by presenting 'place' as a valuable educational resource and an alternative text to explore, read and synthesise. Gruenewald (2003, p. 620) attests to the pedagogical value of 'place' by stating that,

Place matters to educators, students, and citizens in tangible ways that include providing teachers and students with "firsthand experience" to link local contexts to learning environments in order to understand sociopolitical processes and shape what happens in the local community.

Similar sentiments are expressed by Rubel and Nicol (2020, p. 175) who view 'place' as conscious with memory that leads to its pedagogical potential as the first teacher with context specific "lessons to share". In this way place holds value and advantage for Mathematics teacher training, and it ought to be used in the service of Mathematics teaching and learning. Using it could assist in bridging divides between Mathematics teaching and learning as happens in the classroom setting and between the learner's real-life experiences, context and space. Thus, embedding Mathematics in the learners' place, and allowing the teaching and learning thereof to transcend the rather limiting boundaries of the classroom, could make the rather abstract and difficult Mathematics subject content more relevant and meaningful to the learner.

3.3 Place-based education: A definition

As a "transformative philosophy of education" (Carter-Guyette, 2019, p. 2), PBE is an umbrella term for pedagogical practices that prioritise experiential, community-based, and contextual or ecological learning to cultivate greater connectivity to local contexts, cultures, and environments (Yemini, Engel & Simon, 2023). PBE also supposes that education is grounded somewhere and to something for effective learning to take place (Leonard, et al., 2013). More specifically, PBE is also regarded as "an immersive learning experience that places students in local heritage, cultures, landscapes, opportunities, and experiences" (Ashari et al., 2018). These contexts, sites and spaces as well as the landscape and experiences are then used to leverage and to serve as foundation for the study of language arts, Mathematics, social studies, science and other subjects across the curriculum (Nadelson, 2014).

The use of the local context as a source of teaching and learning expands learning beyond the limiting space of the classroom, the school and places that are attached to the school — to also include spaces and sites that are effectively detached from the school, but who provide equally powerful sources and texts for effective and quality teaching and learning. In this way it situates teaching and learning within a different but local context and it provides local relevance and contextual motivation for learning.

With PBE embedded in the local context of the learner, local and family knowledges and place-based knowledge bridge the gap between the curriculum, new content and the learner's existing knowledge and community and family sources he/she has access to. This ensures that advantage is taken of geography, culture, and location to create authentic, meaningful and engaging - 78 -aption- 78 -ing- 78 - learning opportunities (Ashari et al., 2018). With teaching and learning taking place in spaces outside the classroom, the school now becomes an "open and inviting [place] in the community and the community welcomes student learning occurring in many dimensions" (Bandari & Khoshnevis, 2021). Thus, as education that takes place outdoors, PBE allows students to be a part of their outdoor surroundings. In this way it "provid[es] meaningful contextual experiences-in both natural and constructed environments-that complement and expand classroom instruction, which tends to be dominated by print and electronic media" (Kilinç & Evans, 2013, p. 263).

3.4 Locating place-based education within education for sustainable development

Mathematics and Mathematics education are rather incompatible and ESD in Mathematics education is complex (Li & Tsai, 2022). The teaching of Mathematics also continues to pose challenges for many Mathematics teachers. Subsequent to this there has, in general, been a lack of engagement with issues of sustainability within Mathematics education (Boylan & Coles, 2017). This is despite the expectation that education would be orientated towards ESD, and the SDGs highlights the importance of incorporating sustainability into education at all levels. Goal 4.7 of SDG 4 which deals with quality education for all, by implication also promotes ESD in

Mathematics teacher training by establishes the importance of ensuring learners acquire the relevant knowledge, skills and values that promote sustainable development (UNESCO, 2017).

As an orientation towards education, ESD provides a different lens to view and transform learning objectives, content, methods, contexts, and assessment (Mula & Tilbury, 2023). It also uses emancipatory learning approaches, such as systems thinking, critically reflective thinking, participatory learning, and interdisciplinary learning, but also more disruptive pedagogical strategies, like place-based learning (Mula & Tilbury, 2023). Such approaches 'disrupts' conventional education and Mathematics education by incorporating and sensitising learners about social justice in and through Mathematics education, and to develop in learners the competences required to address complex sustainability issues such as climate change. Harper (2017) concurs that criticality in Mathematics education leverage learners' cultural, linguistic, and community knowledge, resources, and experiences. This supports Mathematics learning and critical consciousness development and it guides learners to interrogate and address social injustices in and through Mathematics.

To integrate ESD into Mathematics education, a need exists to reimagine Mathematics as a general human concern, and to see it as an opportunity to learn critical thinking, problem-solving, and contextual understanding (Nicol et al., 2020). For example, learners should be - 79 -aption- 79 -in about the social and ecological implications of Mathematics education, particularly in relation to the creation of social inequalities and the climate crisis (Helliwell & Ng, 2022). Framed within such a new paradigm, Mathematics teacher education can thus push back the boundaries of the traditional philosophy of Mathematics and accommodate the power of Mathematical applications in guiding human lives and the social world (Li & Tsai, 2022) as well as sustainable development.

PBE thus provides a new approach to Mathematics teacher training and education that will foster new relationships between humans, Mathematics and the planet and reinforces the interconnectedness between these aspects. More so, PBE in Mathematics teacher education can address the quality of Mathematics education and address societal inequalities. Mathematics teachers can only teach what they know, and they will base their teaching primarily on the methods and pedagogies they were exposed to during teacher training. To expect that teachers must apply PBE requires that student teachers be trained in the use of PBE.

3.5 Principles of place-based education

Principles are generally accepted rules that govern a phenomenon or behaviour. In a similar fashion, PBE is also governed by generally accepted rules that not only distinguish PBE from other approaches to education, but that also gives PBE its unique character and governs its approach to education. What we know about PBE is that it pivots on 'place' and that it is "primarily concerned with connecting place with self and community" (Mcinerley et al., 2011, p. 5). As such, it promotes active learner-centred inquiry using the surrounding community – or

place — as a classroom. In this regard, place represents more than the physical, but it includes experiences, the natural and the spiritual.

What makes PBE further unique is that it is "inherently multidisciplinary and experiential" (Mcinerley et al., 2011, p. 5), and it focuses on active learning modalities that is applied to the local context, in which learners become proactive researchers (Yemini, et al., 2023). Within this context, learning takes place from experiences in and from experiencing the local context, in which learners are taught to apply a problem-solving approach towards local issues and challenges. The multidisciplinary nature of PBE makes it possible for learners to supplement their exiting Mathematical knowledge with knowledge from diverse disciplines when trying to respond to community- or place-related challenges. The benefit of this is that learners come to understand that Mathematics does not exist in a silo, but that it is in a relationship with other subjects and disciplines. For the multidisciplinarity of PBE to come to full effectiveness, require schools, their environments and communities must become more 'permeable' (Mannion & Adey, 2011, p. 38). This permeability allows the learners' place to become an integral text and for the community to become an indispensable teaching and learning resource.

Furthermore, PBE is also context specific, and it makes use of authentic content, authentic assessment, teacher facilitation, cooperative learning, reflection, and incorporation of adult skills (Bandari & Khoshnevis, 2021). This context specificity focuses PBE on, and makes it applicable to, one particular location. PBE approaches of one context can therefore not effectively be applied to another context. Context specificity largely stems from the focus of PBE on the community, the natural environment, culture, etc. All these aspects are unique, and they experience unique challenges which require unique responses.

Buck et al. (2016) also identify the following principles that give PBE its unique character. These principles are: (a) taking advantage of local possibilities for teaching and learning; curriculum development; (b) students as knowledge producers; (c) learning from community members as well as teachers; and (d) fostering a regard and appreciation for home community.

Smith & Sobel, 2010 (in Carter-Guyette, 2019, p. 12) present a list of principles which according to them informs and drives PBE. According to them, PBE:

- is learning that takes place on-site (the school yard, in local community);
- is inherently experimental, including participatory action or service learning;
- comprises a curriculum that is multigenerational and multicultural
- interacting with community resources;
- is focused on local themes, systems, and content;
- is learning that is personally relevant to the learner;
- is learning experiences that contribute to the community's vitality and environmental quality and support the community role in fostering global environmental quality;
- is learning that is supported by strong and varied partnerships with local organisations/agencies/businesses/government;

d) collect, analyse, organise and critically evaluate information;
e) communicate effectively using visual, symbolic and/or language skills in various modes;
f) use science and technology effectively and critically showing responsibility towards the environment and the health of others; and
g) demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation.

Within the context of South Africa, the development of such skills in learners are important to strengthen the democratic project of the country. However, the development of these skills can more effectively take place when they are integrated in Mathematics teacher training programmes.

4. Integrating Place-based Education in Mathematics Teacher Training

The aim of this chapter is to advocate for Place-based Education as a pedagogy to equip student teachers with the necessary skills, knowledge, and values to enhance and improve Mathematics education and so contribute towards the orientation of Mathematics education towards ESD and the realisation of SD. To become the favoured teaching and learning approach for Mathematics teachers, it is advisable that PBE be integrated in all mathematics teacher training programs. It is only when the skills, dispositions and attributes of PBE are developed and to a large extent - 82 -aption- 82 -ing- 82 - in Mathematics student teachers that PBE will spontaneously be used in the teaching of Mathematics at school level. In response to the NDP and education policies, higher education in SA is oriented towards SD. It is therefore expected that SA higher education institutions will contribute towards the - 82 -aption- 82 -ing of the SDGs and SD. Leal-Filho et al. (2019) report that SA higher education institutions have, over the last 30 years, been incorporating sustainable development within their systems, processes, curricula, teaching, research, and local communities. As a pedagogy of ESD, the expectation is, therefore, that teacher training programmes will also implement PBE in their preparation of future teachers. So how should Mathematics teacher training programmes be oriented towards PBE in order to make possible the development of an affinity for PBE?

In terms of the curriculum for teacher training, it is important that principles of ESD be reflected. Curricula, teaching practices, and content should be selected and designed in response to the SD requirements of the NDP and education policies such as CAPS (2011), which is informed by the principles of social transformation, active and critical learning, human rights, inclusivity, environmental and social justice, and valuing indigenous knowledge systems. It is therefore important that Mathematics teacher training be focused on the transformation of society, on sustainable living and on equity and equality. For Chabbott and Sinclair (2020) this implies that education students have access to appropriate textbooks, flexible teaching pedagogy, technology, the Internet and data, and guidance to support home-based learning. More so, ESD is premised on the assumption that the realisation of SD and the SDGs will best be achieved through interdisciplinary teaching and learning approaches. As such, the preparation of

Mathematics teachers should explicitly reflect interdisciplinarity, and teacher students should be demonstrated how, and be encouraged to find ways of working with others and across disciples.

Starrett et al. (2020) opine that PBE frequently uses constructivist or contextual approaches and often involves social or environmental justice issues. These approaches make use of teaching and learning methods such as project-based or inquiry-based learning OR service learning, environmental education, experiential learning and workplace education respectively. As such, Mathematics teachers should be exposed to ways of incorporating and using these approaches in the teaching of the various components and concepts of Mathematics.

Secondly, Reed and Klassen (2020) hold that in PBE everyone is a learner. PBE embraces the concept of the life-long learner, which supposes that learning is a continuous process and that teachers should continue to learn. The notion that everyone is a learner calls for a paradigm shift in the way Mathematics teachers perceive themselves. Amongst other, this requires that Mathematics teachers acknowledge they do not have all the answers and that they are not the holders of ultimate Mathematical and educational truths. Rather they need to develop the ability to acknowledge that they can also learn from others – that is from learners, from community members, from nature and broadly from the place they and the learners occupy. In that way they no longer have to teach only the little they know, and in traditional ways, but they become learners alongside the young ones they are supposed to teach, and they also become experimental and explorative.

Thirdly, during their training, Mathematics teachers should also be exposed to and encouraged to use multiple non-traditional texts for and approaches to teaching (Lowenstein et al., 2018). Using non-traditional Mathematical approaches during teaching will require from student teachers to 'teach against the grain'. Teaching against the grain can be unsettling and disruptive. However, the complex issues that 'place' presents, requires that Mathematics teachers use unconventional teaching approaches, and that they 'unlearn' some of the things that keep them in their 'comfort zones'. More so, it also requires that they draw from and integrate different perspectives and knowledges from diverse sources and disciplines.

Fourthly, the use of PBE in teacher training programmes requires that student teachers be skilled and trained in ways to locate and to situate mathematical problems within the learners' local area and so establish a strong educational grounding (Buck et al., 2016). PBE uses the learners' local community as an auxiliary text and source of teaching. Mathematics teachers should therefore be trained in ways that will make it easy for them to teach their learners how to read, how to synthesise, and how to explore their place, with the aim to enhance Mathematics teaching and learning.

This requires that Mathematics teachers understand the value and significance of the unique local history, geography, culture, and community, and appreciate it as valuable resources for enhancing, and being enhanced by, learners' learning of Mathematics (Showalter, 2012).

Mathematics student teachers must, therefore, have a thorough understanding and deep-rooted knowledge of the place learners occupy and hail from. More so, they need to validate and affirm it as part of the learners' identities and as such as a source of teaching and learning

5. Conclusions and Recommendations

The aim of this chapter was to make out a case for the use of Place-based Education (PBE) as an Education for Sustainable Development approach to promote equity and equality and to address the Mathematics crisis in South African education. I argued that the teaching of Mathematics, by merely transferring content from a textbook to a passive learner, is not effective. I belief that to be effective, Mathematics teaching should be connected to the real-life experiences and the real-life problems of the learner. In this regard, I proposed PBE, which is embedded in and informed by the learners' place and which fosters an appreciation of place as a carrier of relevant and valuable knowledge and teaching and learning opportunities.

The implication of which is that Mathematics teacher training programmes be designed in ways to develops in Mathematics student teachers the skills and knowledge to a) validate the educational value of the learners' place; b) know how to unlock and use the funds of knowledge and the multiple teaching and learning opportunities created by place; c) create different and out-of-the-classroom learning experiences for learners; .d) develop a constructivist orientation towards learning and learning; e) appreciate various teaching and learning approaches and ways of knowing. More so, Mathematics student teachers should also be taught to be open and flexible and to tap into the diverse learning opportunities a learners' place offers whilst celebrating the learners' place as a new and exciting source of teaching as well as a new source of knowledge. This does not imply that the classroom becomes redundant. Rather the classroom provides information about the place, and the place provides relevant, real-life examples and opportunities for Mathematics teaching and learning.

Within the South African context, using the learners' place will not only enhance teaching and learning, but will also change the story of Mathematics in the country. Rather, it will also address inequalities, advance inclusion, speak to the - 84 -aption- 84 -ing- 84 -on of education, and so promote sustainable development.

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