COMPLEXITIES IN THE AVAILABILITY OF MATHEMATICS AND PHYSICAL SCIENCE TEACHERS IN RURAL HIGH SCHOOLS WITHIN THE KING CETSHWAYO DISTRICT

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DECLARATION

I, **Vincent Titos Smith (Student Number: 201551088**), the undersigned, hereby acknowledge that the contents of this thesis are my work, except where otherwise specified, and it has not been submitted, in part or full, to any other university to obtain a degree. I do hereby declare that:

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I am satisfied that I have given the candidate the necessary supervision concerning this thesis and that it meets the university's requirements in respect of postgraduate research.

I have read and approved the final version of this proposal and it is submitted with my consent.

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Dr. Date…….

DEDICATION

I would like to dedicate this study to my ever-loving and kind wife and children for their support, love and sacrifice and their unceasing prayers to God for me. Furthermore, to my entire family for believing in me. Thank you all!

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ACRONYMS

ASSAf	Academy of Science of South Africa
CCK	Common Content Knowledge
CGE	Centre for Global Education
CPD	Continuous Professional Development
DBE	Department of Basic Education
DoE	Department of Education
ECDoE	Eastern Cape Department of Education
EFA	Education For All
FET	Further Education and Training
GW	Group Work
HE	Higher Education
HEI	Higher Education Institutions
HSRC	Human Sciences Research Council
IMU	International Mathematics Union
JICA	Japan International Co-operation Agency
NDP	National Development Plan
NPC	National Planning Commission
NPC	National Planning Commission
NSC	National Senior Certificate
NSC	National Senior Certificate
NTEA	National Teacher Education Audit
OECD	Organization for Economic Co-operation and Development
PBL	Problem-based learning
SACE	South African Council for Education
SACMEQ	Southern and Eastern Africa Consortium for Monitoring Educational Quality
SCK	Specialized Content Knowledge
SCT	Social Constructivism Theory
SGB	School Governing Body
SMASSE	Strengthening of Mathematics and Science in Secondary Education
SMT	School Management Team
STEM	Science, technology, engineering, and mathematics

TIMSS	Trends in International Mathematics and Science Study
UCT	University of Cape Town
ZPD	Zone of Proximal Development

ABSTRACT

Research indicated that South Africa currently lacks the potential to develop economically without importing international technical and technical resources. If this country is to be a part of the technologically advanced global village, science must educate policy and accelerate the transition to a mathematical and critical ththinkersociety. This is critical since a lack of experience affects the country's overall economic outlook. The study examined the complexities in the availability of Mathematics and Physical Science teachers in rural high schools within King Cetshwayo District while focusing on exploring the factors responsible for the poor performance among Grade 12 learners. Results show that rural environment demotivates teachers. Most science and mathematics teachers only stay for two to three years, while only a few stay for five years or more. It is therefore difficult to keep science subject educators in rural schools. The study also established that fewer students are taking mathematics and science-related subjects at the universities for their degree qualifications, which adversely affects the supply of teachers in rural-based high schools. In some cases, this has led to schools discontinuing the teaching of mathematics and physical science. The study recommends that teachers in rural areas should be motivated by offering them enough support and giving them incentives or allowances. The department of education should provide resources to equip the school’s science laboratory for science teachers to deliver results.

Keywords: Rural schools, mathematics and science teachers, incentives, rural environment, complexities in availability of mathematics teachers.

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CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.1 Background to the study

Many South African secondary schools continue to record poor performance in mathematics and Science among learners in rural areas, particularly in the King Cetshwayo District, in the KwaZulu Natal province. During the apartheid era in South Africa, education and training was generally depicted by the underdevelopment of human potential, particularly with the black South Africans. Post-Apartheid, the Department of Education (DoE) (2006) noted that science, mathematics and technology teaching and learning were the most affected. Several studies, including those by Chubb and Holmes (2015), and Howie (2003), have described inadequacies experienced in the teaching and learning of mathematics and science subjects in South Africa. There are perceived school-based factors that may contribute to learners' performance, such as the accessibility to and usage of teaching and learning facilities, environmental or societal, and economic aspects. The education of the learners' parents or guardians and, by extension, their economic status, as well as learner's factors – motivation and attitudes, school type, and the characteristics of the teachers are all factors that contribute to the students' low performance in various science disciplines (Amukowa, 2013; Kibet, et al., 2012; Makgato & Mji, 2006; Mwaba, 2011).

1.2. Moving South African Education beyond the Legacy of Apartheid

Over 25 years since South Africa became a fully democratic society, there remains a colossal disproportion of inequality in the provision of quality and affordable education for all its citizens across every society (Scott, 2019). The majority of South Africans, particularly black South Africans, find it incredibly difficult to obtain inexpensive and high-quality education and training at all levels of the educational system (Scott, 2019). The first step in addressing the past is to eliminate blatant racism in educational systems, but there are other socioeconomic inequities that must be addressed to

prevent future racial inequalities in education. Ocampo (2004), focuses on the issues of inequalities that the Apartheid system created in the education system, through overt racist policies while introducing the Bantu education system. “The Bantu Education Act of 1952 ensured that Blacks get an education that would limit educational potential and remain in the working class (UCT)”. This legislation impacted the quality and functionality of learning to promote systematic racism by restricting access to further education.

Apart from the content, the apartheid policy influenced the cognitive ability of students (Scott, 2019). Schooling was compulsory for whites from 7 to 16 years of age, Asians, and Coloureds from 7 to 15 years of age, and blacks from 7 to 13 years of age (US Library of Congress, 2004). The less students are educated, the less choice they have in the world of work, and the less access to they have to further education. These regulations maintained that the content and standard of education reinforced racial inequality, reforming these policies in the post-apartheid period was a rational step toward social equality. The educational disparity has also been apparent in funding education and providing required resources to where they are needed. The Bantu Education Act established distinct departments of education for each race, with schools for black learners receiving less funding, and those for whites receiving more (UCT, 2004). Because funding determines the quantity and quality of learning resources, facilities, and instructors, discrepancies in learning environments resulted from the unequal allocations (Baker, 2019).

Apartheid funding, for example, resulted in a teacher-to-pupil ratio of 1:18 in white schools, 1:24 in Asian schools, 1:27 in Coloured schools, and 1:39 in Black schools (US Library of Congress, 2004). Aside from that, the apartheid system had an impact on teacher quality. Teachers with teaching credentials were found in 96 percent of white schools, but only 15 percent of black schoolteachers were certified (Garson, 2004). In addition to lowering educational standards, the Bantu Education Act forced the closure of some educational institutions by withholding money from religiously linked colleges. As some church schools provided instruction to black individuals, the loss of these funding disproportionately impacted black children (US Library of Congress, 2004). Although the government justified its actions by citing the separation

of church and state, the closing of black-serving institutions is the most egregious form of educational discrimination.

Policy and funding inequalities in schools have make sure that there is a difference between access to higher education. “Four Afrikaans-speaking universities and one English-speaking university accepted only Whites, while the other five had limited admissions and segregated classrooms” (US Library of Congress, 2004). Furthermore, there was little financial assistance, and banks refused to lend to blacks or coloureds (Knipe-Solomon. 2004). This implies that, even if students could break through working-class education with under-qualified teachers in overcrowded classrooms, they still faced financial obstacles to achieving their academic targets.

1.3. The Post-Apartheid Challenges in South African Education

Following the end of apartheid, various policy reforms in education were implemented to address the educational disparity. The educational process has been integrated, and all races are required to attend school for nine years (Garson, 2004). While the Bantu educational ideology has been formally abandoned, schools remain isolated in practice. Whites have moved to private schools, and suburban schools have large numbers of coloured students, whilst township schools are largely black, and rural schools appear to have both black and coloured children (Knipe-Solomon, 2004).

Elizabethfontein School in Western Cape, is a rural school where pupils travel long distances to attend classes every day of the week. The students are coloured. While there is diversity in the Cape Town area's schools, the student population of the different sites remains largely racially divided, and the schools' standards reflect this separation. Even in the Western Cape, a province renowned for its breath-taking views, the view from the community of *Imizamo Yethu* is remarkable, a panoramic view of rolling hills, dunes, and rocky cliffs unfurling the shore. On the one side, there is a fishing village that has developed into quaint cafes and craft shops; on the other hand, there are stately mansions, horse paddocks, and the sprawling campus of a prestigious private school (Baker, 2019).

Despite efforts to equalize educational opportunities for all races, many ostensibly racially neutral financial practices can have a disproportionately negative impact on blacks and coloureds. Education accounts for 20% of the government's budget. The nine provinces and elected school governing bodies have administrative responsibility for deciding how to allocate their education expenditures (Garson, 2004). The government intends to address inequity with a funding plan that separates schools into five strata based on the community's economic level, with the lower income group receiving more funds per child (Pearce, 2004). This finance structure is unquestionably a huge step forward in addressing historical shortcomings, but it is insufficient to manage schools.

Schools are given a base amount from the government, and parents are expected to pay school fees; rates vary greatly depending on criteria including class size, facilities, and quality, as well as the quality of teaching provided (Garson, 2004). In 2004, former white schools in the suburbs, for example, charge R10,000 ($1,500) per year, while other schools charge R150 ($25) per year (Pearce 2004). Because of the disparities in school fees, there are inequities in quality of the schools (Ocampo, 2004). Private schools have one instructor for every fifteen students, whereas public schools have a class size limit of thirty, and disadvantaged institutions have as many as forty to fifty students per teacher (Chubb & Holmes, 2015; Garson, 2004). Even though more students have been accepted to middle class schools since Apartheid ended, these ratios are far more typical than they were during the apartheid era.

The issue is that Bantu Schooling is no longer available, and black people are unofficially at the bottom of the social ladder (Baker, 2014). This de facto educational division is the result of a mix of race and socioeconomic status. Africans won only 20% of whites on average when apartheid ended in 1994 (O'Gorman, 2004). In a rural area, black people are likely to have fewer financial resources to pay for or access a higher-quality education. Parents in some schools in rural areas are 90 percent unemployed (Pearce, 2004). In this arrangement, schools must charge lower tuition in locations where more money is needed to give a better education. Furthermore, "While 65% of whites over 20 years old and 40% of Indians have a high school or higher qualification,

this figure is only 14 percent among Blacks and 17% among the Coloured population" (Pearce, 2004).

The apartheid educational system was designed to keep blacks and other minorities at the bottom of the socioeconomic ladder, so they would have fewer resources to pay high fees for high-quality education. Access to resources such as money and educational standards is not limited to primary and secondary schools. Even in higher education, there is still inequality. There is no financial assistance available to help students attend college (Chubb & Holmes, 2015; Knipe-Solomon, 2004). Because blacks and coloureds have typically been limited to working-class employment, funding education for future generations is a challenge that many families are unable to overcome. Furthermore, according to Knipe-Solomon (2004) after apartheid ended, scholarships from abroad were no longer available. Again, a lack of access to higher education contributes to ethnic disparities. It is difficult to address educational inequities without considering the economic imbalances that arose from apartheid education.

A huge number of working-class blacks stand out against the elite skilled workforce, which is largely made up of whites, in the aftermath of apartheid's separatist influence on the labour force. This ideal reform of universal free public education and financial aid for higher education requires funding. Because education already receives 20% of the finances, the Department of Education must pursue innovative changes to reallocate funds or find money through other means, such as township tourism. These activities will aid in the pursuit of the objective of moving beyond the past and working for social justice management. Equal Education (n.d.), an organization that strives to combat social injustice in education, states that inequality and historical legacies, as well as their influence in South Africa, require more attention.

> *The organization's 2016 annual report indicates that, "despite efforts to improve the system, class, and race-linked inequalities persist, unequal educational opportunities remain among the greatest obstacles to equality, dignity, and freedom in South Africa" (Equal Education, n.d: 8).*

An immensely contributing element to the poor or underperformance in mathematics and physical science is the inadequate quantity of qualified trained teachers in the rural. Mathematics is known to be the mother of all learning or erudition in other areas, stemming their perceptions from it, both in the arts and sciences. According to Belhu (2017: 7), mathematics is the 'queen of all sciences', including chemistry, physics, biology, and economics. Mathematics is a way of thinking and constructing a logical argument, according to the scholar, and it may be used to assess whether an idea is true, or at least, whether it is likely true as a way of thinking. Belhu (2017), goes on to say that mathematics reveals the capacity of the human mind and serves as a test of intellectual curiosity.

It is no surprise that somebody who is proficient in mathematical sciences may also study and perform well in other subjects (Belhu, 2017). South Africa and other countries around the world are engaged in discussions about sustainable development, and science, technology, engineering, and mathematics (STEMs) cannot be ignored or separated from strategies to achieve sustainable development. Development, according to Nwafor (2012), is a process in which society, individuals, or recipients actively participate in defining what they require and how to offer it. The performance results of black high school learners are remarkably weak in terms of mathematics and physical science. According to the 2016 national matriculation results, "of the 33,511 learners who scored above 60% for Maths, only 1 700 (5%) were black African learners" (Stats SA, 2016).

Given the fact that black Africans make up about 80.7% of the country's population (Statistics South Africa, 2016), this proportion of quality pass rate is extremely little. In terms of access to higher education, there is a disparity between different population groupings (Stats SA, 2018). In the rural and urban areas, the South African General Household Survey examined between 20 000 and 30 000 homes. According to the data, 12 percent of white people and 11.5 percent of indians have access to postsecondary education, whereas coloured and black people have much lower percentages (Stats SA, 2019). South Africa may be a democratic country today, however, the area in which the learner resides has an impact on the level of quality

education that is received. Physical Science is also regarded as a pivotal subject to master as a learner.

According to Business Tech (2017), Physical Science focuses on examining physical and chemical phenomena through scientific inquiry by applying scientific models, theories, and laws to explain and predict events, as indicated by the National Curriculum Statement (NCS). Science, technology, and mathematics have become the main economic drivers, in terms of creating employment, job opportunities, and economic growth. Physics, chemistry, the earth sciences, and mathematics, according to (Chubb & Holmes, 2015), assist to support our national prosperity. We must maintain our national commitment to the advancement of physical and mathematical sciences if we are to recognize opportunities and enjoy the benefits. The Australian Academy of Science Grayson (2009) states that science is of substantial economic benefit.

In South Africa, learners in those schools that are in rural areas are highly disadvantaged or underprivileged with regards to receiving highly trained and qualified science teachers. This has been a constant issue that requires immediate attention. Learners' low performance in physical science and mathematics is influenced by outmoded teaching methodologies and a lack of fundamental understanding, resulting in poor teaching standards (Mji & Makgato, 2006). Mji and Makgato (2006), continue to explain that poor standards are exacerbated by under-qualified and unskilled teachers who teach in overcrowded and under-equipped rural classrooms. The Grade 12 results are steadily improving in KwazuluNatal, according to van der Berg, et al., (2016). The 2018 physical science pass rate increased to 73.6%, from a pass rate of 57.76% in 2017 (Daily News24, 2019). However, the increase in the overall physical science pass rate in Grade 12 includes all the schools in the province.

Hence, the issues of schools in the rural areas being disadvantaged should not be overshadowed by the constantly increasing overall physical science Grade 12 marks. Teacher’s assessments conducted in 2016 by the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ), show poor knowledge amongst them. Van der Berg, et al. (2016), indicates that, “only 32% of Grade 6 mathematics teachers in South Africa had the required subject knowledge in

mathematics". When compared to much greater rates in other countries such as Kenya (90%), Zimbabwe (76%), and Swaziland (75%) (van der Berg, et al., 2016). "Another study conducted with a section of 253 matric mathematics teachers from the KwaZulu-Natal province unearthed that their average mark for a past matric mathematics examination paper was only 57%" (Bansilal, et al., 2014).

1.4. Addressing Educational Challenges and Reform in Post-Apartheid South Africa

This section of the study looks at the challenges faced and the efforts made to address the educational inequalities through reform in the Post-Apartheid South Africa. At the beginning of the Truth and Reconciliation Commission (TRC) in South Africa, According to Ramphele (2008), noted that Archbishop and TRC head Desmond Tutu articulated the necessity of exposing the truth. He explained:

> *"We are charged to unearth the truth about our dark past; to lay the ghosts of that past so that they will not return to haunt us. And that we will thereby contribute to the healing of a traumatized and wounded people—for all of us in South Africa are wounded people—and in this manner promote national unity and reconciliation." (Archbishop Desmond Tutu).*

Although the TRC process's entire impact and worth are still being contested, there is universal agreement that it at least allowed for an open, public discourse about the past and how to go ahead as a nation (Cole and Murphy, 2009). For South Africa to flourish and develop as a community, the past must not only be recognized, but also remembered, so that it "will not return to haunt us." 2008, Engelbrecht Thus, remembering the past, particularly via history education, is critical. The purpose of this section of the study is to investigate and understand the complexities in the availability of mathematics and physical science teachers in rural high schools in the king cetshwayo district. In South Africa, socioeconomic disparities were and continue to be profoundly rooted in and reflected in all aspects of life, because of colonialism and

apartheid's systemic exclusion and inferior incorporation of blacks and women The higher education system was, and continues to be, no exception.

Class, racism, gender, institutional, and regional discrimination, and inequality have profoundly impacted, and continue to shape, South African higher education. Given this, South Africa's new democratic government pledged in 1994 to alter higher education as well as the inherited apartheid social and economic framework, as well as to institutionalize a new social order. Indeed, nearly no sphere of higher education has avoided examination or been left undisturbed during the last fourteen years, and there has been a wide range of 'transformation' focused projects. These have included defining the purposes and objectives of higher education.

> *"extensive policy research, policy formulation, adoption, and implementation in the areas of governance, funding, academic structure and programmes and quality assurance; the enactment of new laws and regulations; and major restructuring and reconfiguration of the institutional landscape and of institutions" (Smith, 2010).*

Inevitably, the realization of social equality and reparation for historically disadvantaged socioeconomic groups in higher education, and therefore the admissions issue, has loomed big in policy discourse. Three remarks are required in the context of the pursuit of social fairness and restitution, admissions, and the affirmative action policy in South African higher education. First, apartheid ideology and planning fundamentally affected higher education institutions, which were reserved for separate 'racial' groupings and were assigned diverse ideological, economic, and social tasks in regard to the reproduction of the apartheid social order. The basic distinctions in assigned duties were the core axis of differentiation and the primary source of inequities between historically white and historically black institutions.

Inherited designs of benefits and disadvantages continue to shape institutions' abilities and capacities to pursue excellence, engage in knowledge production, provide high-quality teaching and learning experiences, ensure equity of opportunity and outcomes, and contribute to economic and social development. Second, apartheid's distinct

development programme's socioeconomic and political aims heavily influenced research and education. Higher education has been tasked with addressing and responding to the development demands of a democratic South Africa since 1994. These requirements have been expressed in a variety of ways. The Reconstruction and Development Programme of 1994 speaks of "fulfilling people's fundamental necessities," "developing our human resources," "growing the economy," and "democratizing the state and society."

Higher education is urged in the 1997 Higher Education White Paper to help South Africa achieve "political democratisation, economic reconstruction and development, and redistributive social policies focused at equity." Third, the attempt to transform higher education takes place against the backdrop of a formidable overall challenge of simultaneously pursuing economic development (including restructuring economic relations to address inequitable historical patterns of ownership, wealth, and income distribution), social equity, and the extension and deepening of democracy. One or more elements of this triangle cannot be abolished, postponed, or addressed sequentially for valid political and social reasons. They must all be pursued at the same time.

Finally, the speed of socioeconomic fairness and reparation in higher education is substantially hampered by South African educational settings. Despite virtually universal formal school enrollment, South Africa's schools face major challenges in terms of dropouts, retention, development, and effective completion. "The basic fact is that enrolment is not the same as attendance, and attendance does not imply learning," as it has been said (Sayed, 2007:8). South African school pupils do horribly on a variety of international assessment tests, with "65 percent of school leavers...functionally illiterate" (ibid.:6).

There is still a strong relationship between social exclusion of disadvantaged socioeconomic classes and groups and fairness of access, opportunity, and results, as well as academic success. At the moment, 60 percent of African youngsters come from

families that earn less than R800 a month; conversely 60% of white children are from families whose income is more than R6 000 per month.

The implications are seen in disparities in school performance and accomplishment. Without appropriate and extensive state interventions to significantly improve the economic and social circumstances of millions of South Africans from the working class and rural poor (primarily black), the experiences of school drop-outs, poor retention, limited educational opportunities, and poor outcomes will be borne primarily by these socioeconomic strata.

1.5. The Teaching of Mathematics and Science Education System in South Africa

Mathematics and Physical science education in South African secondary schools has been rated as among the poorest in the world. Unacknowledged bad mathematics teaching in the majority of public schools denies many students access to both higher education and modern, knowledge-intensive job skills. The South African mathematics curriculum has undergone significant reform, and the mathematics education research community has grown significantly as a result. The objective and emphasis of this chapter is to examine South Africa's post-apartheid mathematics education system. The author draws and constructs anticipated results bearing changes in the country's system from numerous researchers. Curriculum change in South Africa has mostly been motivated by political considerations. As a result, education in the country has been reduced for the past 28 years to, "economic ends, coupled with the conflation between mathematical prowess and problem-solving skills for the knowledge economy, which has resulted in mathematics being isolated as essential knowledge in South Africa" (Jojo, 2019, p. 5).

Thus, in the country's post-apartheid era, a redress was made to ensure that all pupils had been exposed to some type of mathematics by the time they pass matric. Many changes occurred in South Africa during the 1994 democratic elections and post-elections, with education being the most affected by necessity. The Department of Basic Education initially introduced Curriculum 2005 (C2005), which was inspired by Outcomes Based Education (OBE). It was characterized primarily by cooperative group instruction, making it difficult for teachers to detect weak pupils in mathematics

comprehension at all levels. Outcomes-based education was implemented in 1997 to eliminate curricular divides, and it was reassessed in 2000, "after the experience of its implementation by stakeholders returned bad results" (The Departments of Basic Education and Higher Education and Training, 2011).

In 2002, the Revised National Curriculum Statement (RCNS) for Grades R–9 and the National Curriculum Statement for Grades 10–12 were introduced. As a result, according to (Bjorklund, 2015), the RNCS system failed because instructors did not grasp it and frequently could not notice the distinction between C2005 and the RCNS. As a result, the implementation issues of RCNS were identical to those of C2005 (Bjorklund, 2015). It was also shown that RCNS was extremely loaded and fell short of its goals, employing ambiguous and convoluted language and providing insufficient training to teachers and district authorities. It was evaluated again in 2012 and replaced by the Curriculum and Assessment Policy Statement (CAPS), which was implemented throughout all phases. According to the writers (Carnoy, Chisholm and Chilisa, 2012), the basic principle is still OBE that underpins the philosophy of CAPS.

Consequently, CAPS is the curriculum used in the country to address injustices and imbalances from the past. In Grades R-12, a single comprehensive Curriculum and Assessment Policy Statement was produced for each topic in January 2012, replacing Subject Statements, Learning Programme Guidelines, and Subject Assessment Guidelines. CAPS in general seeks to develop learners who can:

> *use critical and creative thinking in making decisions of identification and solution of problems; work effectively as individuals and with others as members of a team; manage and organize themselves in handling their activities responsibly and effectively; collect, analyze, organize and critically evaluate relevant data; use visual, symbolic and/or language skills in various modes to communicate effectively; and recognize that problem-solving contexts do not exist in isolation and demonstrate an*

> *understanding and interpretation of the world as a set of related systems (Jojo, 2019, p. 6).*

As a result, the learner develops (a) correct use of Mathematics; (b) number vocabulary, number concept, calculations, and application skills; (c) learning to listen, communicate, think logically, and apply gained mathematical knowledge; learning to investigate, analyze, represent, and interpret information, pose and solve problems; and (e) developing awareness of the important role that Mathematics plays in real-life situations, including his/her personal development (The Departments of Basic Education and Higher Education and Training, 2012). The proposed CAPS stipulated particular themes and content categories to be taught in each grade, as well as the weighting of the content areas in each phase, outcomes, and pertinent assessment instances. Mathematics is taught at the following levels: foundation (grades 1–3), intermediate (grades 4–6), senior (grades 7–9), and further education and training (grades 10–12). According to Ramatlapana and Makonye (2015), "although the teachers were free to teach the previous curricular as they saw fit, CAPS was prescriptive and demanded uniformity in implementation across the country".

This prescription was imposed since the flexibility with the implementation of altered curriculum was counter-productive, as learners' performance in mathematics remained weak. This is evident from national school assessments as well as the Trends in Mathematics and Science Study (TIMMS) (Howie, 2001), which was conducted in collaboration with the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) (Moloi, 2012). Government officials and mathematics subject advisors can monitor the current curriculum. This is due to the fact that the mathematical subject to be taught is precisely defined, timed, and sequenced using specified mathematics textbooks that refer to specific instances. However, Ramatlapana and Makonye (2015) believe that the prescription limits the professional autonomy of mathematics instructors. This curriculum is popular in the nation because it aids in the teaching of "low achieving learners from disadvantaged socio-economic backgrounds using a more structured teacher directed instruction" (Feza, 2012, p.7).

Furthermore, Mathematics Continuous Professional Development programs make systematic attempts to improve the practice, attitudes, and beliefs of mathematics instructors in the classroom in order to affect student learning results and familiarize teachers with curriculum implementation. These projects were designed to increase the quality of mathematics education, mathematics teacher quality, numeracy, and mathematics instruction in lower grade levels. According to research (Govender , 2012), there may be changes in the way mathematics is viewed. Among the modifications are:

(i) In 1994, mathematics was a required school subject until grade 9, after which it was optional. Until 2007, those who registered for it at the matric level did so on either a higher or regular grade. (ii) In 2001 and 2002, the intervention of "Outcome-Based Education (OBE) and the Common Task for Assessment (CTA) was introduced to high school learners, but was shortly discontinued due to serious challenges in terms of its implementation. (iii) In 2005 another curriculum change in the form of an “outcomes-based” approach was introduced".

Because it was unclear what had to be taught in different years, this adjustment had a significant influence on learning and instruction in the GET (grades 7–9) (Govender , 2012). (iv) Curriculum changes throughout time have also had an impact on the content taught in various grades. The modifications included transferring content from one grade level to another, eliminating some information, and introducing new stuff. Technical Mathematics and Technical Science were just introduced in grade 10 technical schools beginning in 2016. This clearly shows that curriculum revision is a continuous process in South Africa (Jojo, 2019). Along with the curriculum reform came the introduction of Mathematical Literacy as an option for students who were not proficient to do mathematics in the FET phase. This was done to accommodate pupils who could not study pure mathematics while also keeping the required status. This assures that all students are exposed to some type of mathematics by the time they graduate from high school.

1.5. Mathematics teacher training and empowerment

The Mathematics teacher training and empowerment as an effort by the South African government to improve mathematics and Science subject, Stinson (2004) presents a historical viewpoint that illustrates the existence of mathematics as a gatekeeper in the United States' educational system structure. A solid score in mathematics at the grade 12 level also helps pupils to enroll in and pursue high-status occupations in South Africa. As a result, it is crucial to guarantee that mathematics teachers receive high-quality training so that they can provide pupils with strong critical thinking and problem-solving abilities (Adler, Alshwaikh, Essack and Gcsamba, 2016). Prior to the re-dressing of the education system during the apartheid era, mathematics teacher preparation in South Africa was handled by training colleges. Those colleges were separated into the many levels where the teacher would be teaching. Teachers who completed the basic teachers' course (PTC), for example, were enrolled in "complete their 2-year certificate qualification in primary teachers' colleges. "

Various colleges enrolled and trained secondary school teachers, who were issued a Junior Secondary Teachers' Course (JSTC) credential after two years. At addition, after completing their first degrees, a few were trained in universities through a one-year higher diploma in education (HDE). This last category consisted of a few students who would enter the teaching profession due to various flaws or requirements that they could not satisfy in order to progress to higher degrees. This was due to the fact that teaching was and still is an unpopular and undervalued profession in the country.

According to Act 98 of 1998, numerous institutions were closed or transformed into centers for Further Education and Training (FET) colleges or Technical and Vocational Education and Training (TVET) during the post-apartheid era. As a result, instructors were now educated at universities. The bachelor of education (BEd) program lasts four years. To be able to finish training to be a mathematics teacher, a candidate must have completed mathematics up to the second year level. Others might pursue a junior Bachelor of Science (BSc) degree before enrolling in a one-year postgraduate certificate (PGCE) study in mathematics didactics. Because of the country's high

unemployment rate, several currently hired mathematics instructors possess an engineering degree but opt for teaching to escape the poverty lines.

As a result, Kaino et al. (2015) contend that today's mathematics instructors are a mix of teachers with disparate school subject knowledge and competing patterns of classroom practice, as well as proactive, reactive, and over-reactive teachers (Lindeque B, Gawe N, Vandeyer, 2016). The authors, Kaino et al. (2015), go on to say that teachers with non-matching school subjects need ongoing professional development to address and adjust to the consequences of an environment marked by massive infrastructure backlogs, resource constraints, a scarcity of high-quality learning support materials, and the absence of common national learning and assessment standards. As a result, at each of South Africa's provincial ministries, members of the Professional Development and Research Division's Sub-Division are in charge of the "implementation of the Continuous Professional Teacher Development Management system in all provinces."

The South African Council of Education (SACE) facilitates such provision by liaising with other stakeholders such as teacher unions, School Governing Body organizations, and others to authorize service providers in various provinces around South Africa (Motshekga, 2013). In addition, mathematics instructors at all levels participate in programs developed by South African institutions in order to be empowered and enhance their mathematics teaching abilities. It is my contribution and recommendation in this chapter that mathematics instructors receive mandatory professional training in-service before being hired permanently. During the training, the mathematics content knowledge gap may be addressed, and they will be prepared with the skills to handle the topic even in resource-constrained situations. This is done in other nations such as South Korea and Singapore. Students in such nations are well-taught and do exceptionally well in maths.

1.6. PROBLEM STATEMENT

Resaerch indicated that South Africa currently lacks the potential to develop economically without importing international technical and technical resources (Ramsuran, 2005; Gardner & Hill, 1999; Frantz, et al., 1996; Department of Arts, Culture, Science, and Technology (DACST), 1996; Pratzner, 1994). If this country is to be a part of the technologically advanced global village, science must educate policy and accelerate the transition to a mathematically and critical thinkers' society. This is critical since a lack of experience affects the country's overall economic outlook.

For example, to offer jobs for everyone, whether, by job production or opportunities in the employment market, a degree of science and technological innovation that allows for economic development and expansion is required (Miji & Makgato, 2016). South Africa is currently far from this perfect scenario. Mathematics, on the other hand, is one of the essential skills required of a physical science learner must acquire. According to annual evaluation results, we are not doing so well in mathematics as a country.

Findings from research conducted by the Academy of Science of South Africa (ASSAf) in 2010 confirmed this reality to be true at both primary and secondary school levels. The finding shows that there is an averaged result mask of a very wide disproportion between learners in South African schools. Most learners fail to perform at suitable levels, while a minority of students continue to make substantial progress in certain subjects.

As a result, the pool of potential scientists, engineers, health practitioners, and future mathematics and physical science teachers is severely limited. This, therefore, reduces the ability of South Africa to be internationally competitive, which in turn impact its ability to provide the foundation or structure needed for the wellbeing of the South African majority.

The Department of Basic Education initially introduced Curriculum 2005 (C2005), which was inspired by Outcomes Based Education (OBE). It was characterized primarily by cooperative group instruction, making it difficult for teachers to detect weak

pupils in mathematics comprehension at all levels. Outcomes-based education was implemented in 1997 to eliminate curricular divides, and it was reassessed in 2000, "after the experience of its implementation by stakeholders returned bad results" (The Departments of Basic Education and Higher Education and Training, 2011).

In 2002, the Revised National Curriculum Statement (RCNS) for Grades R–9 and the National Curriculum Statement for Grades 10–12 were introduced. As a result, according to (Bjorklund, 2015), the RNCS system failed because instructors did not grasp it and frequently could not notice the distinction between C2005 and the RCNS. As a result, the implementation issues of RCNS were identical to those of C2005 (Bjorklund, 2015).

It was also shown that RCNS was extremely loaded and fell short of its goals, employing ambiguous and convoluted language and providing insufficient training to teachers and district authorities. It was evaluated again in 2012 and replaced by the Curriculum and Assessment Policy Statement (CAPS), which was implemented throughout all phases. According to the writers (Carnoy, Chisholm and Chilisa, 2012), the basic principle is still OBE that underpins the philosophy of CAPS.

Mathematics is known to be the mother of all learning, both in the arts and sciences (Scott, 2019). Learners have a high failure rate in essential science subjects (Scott, 2019), which continues to be a threat in the King Cetshwayo district. Few students are taking mathematics and physical science subjects at the universities as degree qualifications, which seems to affect the supply of teachers in rural-based high schools (Scott, 2019). In certain cases, this has led to schools discontinuing the teaching of mathematics and physical science (DoE, 2001). Over 25 years since South Africa became a fully democratic society, there remains a colossal disproportion of inequality in the provision of quality education for all its citizens across every society (Scott, 2019).

1.7. Purpose of the Study

The study aimed to examine the complexities in availability of mathematics and physical science teachers in rural high schools within King Cetshwayo District. This was motivated by the high level of low performance by the secondary school learner’s

report by the South African Department of basic education. It was highlighted earlier that only few students are taking mathematics and physical science subjects at the universities as degree qualifications, which seems to affect the supply of teachers in rural-based high schools (Scott, 2019). In certain cases, this has led to schools discontinuing the teaching of mathematics and physical science (DoE, 2001). Over 25 years since South Africa became a fully democratic society, there remains a colossal disproportion of inequality in the provision of quality education for all its citizens across every society (Scott, 2019).

1.8. The Aim and Objectives of the study

The study aimed to examine the complexities in the availability of mathematics and physical science teachers in rural high schools within King Cetshwayo District. The study was guided by the following objectives:

To explore factors that affect the supply of qualified science teachers in the rural high schools of King Cetshwayo District

To explore whether the availability of professional mathematics and physical science teachers in the rural high schools of King Cetshwayo District affect learner's performance

To evaluate the possibilities of attracting mathematics and science teachers to accept employment in the rural-based high schools of King Cetshwayo District.

1.8.1. Research Questions

The aim of the study answered the following critical research questions:

What are the factors that affect the supply of mathematics and science teachers in the rural high schools of King Cetshwayo District?

How is the availability of mathematics and science teachers in rural high schools linked to the teaching environment?

How can mathematics and science teachers be motivated to accept employment in the rural-based high schools of King Cetshwayo District?

To what extent does the availability of mathematics and science teachers in the rural high schools of King Cetshwayo District contribute to learner's performance?

1.9. Significance of the study

It is hoped that this study will add to the existing body of knowledge on the role of high school teachers and poor performance challenges faced by the King Cetshwayo District rural schools, especially in the subjects of mathematics and physical science. As this research looks at the complexity in supplying qualified teachers to the rural-based high school, it located possible ways to motivate teachers to take up employment to teach in this area. The research results are presented as policy recommendations to develop frameworks from its findings to the department of education for implantation in improving performance rate. The teachers' employment procedures are expected to be investigated in this research to see what problem is associated with it, which may have contributed to the non-availability of mathematics and science teachers in the rural areas of King Cetshwayo district. Recommendations from the study will be sent to various schools.

1.10. Questionnaire

This research used a questionnaire to conduct and collect data from individuals within the area of study, around explicit themes regarding their own and their association involvement in teaching mathematics and physical science subjects in the King Cetshwayo district, to get their perceptions about the low-rate performance of learners in the critical subjects.

1.11. Content examination

The information gathered was broken down by using the technique for the subjective material survey. The information was categorized and interpreted by paradigms found in the information.

1.12. Thesis Chapters

Below is the layout of the thesis.

Chapter one: provides the orientation of the study; it includes an introduction as well as the study's justification. This chapter also includes a statement of the problem, the study's motivation, goal, and objectives, as well as research questions, and the definition of concepts.

Chapter two: provides the theoretical and conceptual understanding of the study; it also explores the literature regarding learner's poor performance in science subjects in rural-based schools. This chapter explains the theories used, their application, relevance, and construct to shape the study

Chapter three: is the research methodology, it describes the research process, including the research approach, design, and methodology followed in the study.

Chapter four: presents the data collection and analysis of the research. The research findings are also discussed.

Chapter five: summarizes the results of the study and concludes the study. Delimitation and recommendations are also presented in this chapter.

1.13. Conclusion

The objective of the study is to examine the complexities in availability of mathematics and physical science teachers in rural high schools within King Cetshwayo district. This first chapter presented the background of the study. Studies on the South African mathematics and physical science subject in the secondary education system have frequently exposed the dire situation. Regardless of the deficiencies and conditions surrounding mathematics teaching and learning, repeating the inconsistencies in the system will not assist, but the present issues must be solved. Clearly, lowering the

quality of successful performance criteria in mathematics at the grade 12 matriculation level to 20% is not a solution. This tradeoff has a psychological cost for kids who want to pursue jobs that involve mathematics. In this chapter, I argue that teaching is an art, and that teaching mathematics involves ongoing professional development that provides instructors with mathematical material at various levels and how it may be taught in the classroom.

Mathematics teaching practice supervision must be preceded by proven micro-teaching sessions on diverse themes. All maths instructors should have access to publicly available online mathematics open education materials. A revolution in the thinking of mathematics instructors must also be encouraged. The Department of Education may propose reintroducing training institutions to train competent mathematics teachers. Performance in the topic must be independent of politics and guided by conceptual mastery of the subject. Students will not be taught in this manner for the purpose of passing mathematics at various levels, but rather for comprehension that can aid the student in connecting and applying learned and understood mathematical topics to the improvement of their everyday life.

CHAPTER TWO

LITERATURE REVIEW

2.1. INTRODUCTION

The previous chapter presented the theoretical framework of the study. This current chapter look at the relevant literature in the field of study. This chapter aims to provide an in-depth, scholarly analysis of literature reviews the on complexities in availability of mathematics and physical science teachers in rural high schools within King Cetshwayo district. the chapter firstly provide a discussion on the global view of mathematics and physical science and secondly a section providing a discussion on the continental view and sub-regional and South African context. The theoretical framework underpinning this study was already presented in the previous chapter. The various arguments and relevance of the reviewed literature will be addressed further. The study reviews the available literature relevant to the complexities in availability of mathematics and physical science teachers in rural high schools, beginning with the global view, continental and national. The chapter further dives into understanding challenges in mathematics and physical science in Africa, while it examines learner's correlated factors to low performance. Finally, the study examines the mathematics and physical sciences and teacher learning culture in rural based high schools, and the environmental factors that contribute to low performance in these subjects in the rural based high schools.

A survey of scholarly distributions on the theme was directed to extend the comprehension of related ideas and speculations, and to assess past comparative cases (Boote & Beile, 2005; Randolph, 2009). Moreover, accessible documentation from government sources was consulted to represent real local practice. The state of physical science and mathematics in South African schools today has frequently been characterized as a national crisis". Learners have consistently performed poorly in comparative science and mathematics assessments conducted globally, regionally, and even locally. As a result, South Africans tried to figure out what was behind their alleged low success in mathematics and science (National Advisory Council on

Innovation, 2017). “This coincides with the Department of Basic Education's declaration of a 20% mathematics pass rate as a result of a significant number of students passing all subjects except mathematics and being required to fail the grade because mathematics is one of the compulsory subjects to pass” (NACI, 2017).

“The TIMSS is an evaluation of fourth and eighth-grade students' mathematics and science skills from chosen countries around the world”. South Africa competes in grades five through nine, and for the first time in grade five, it competes in only mathematics (TIMSS-Numeracy). According to NACI (2017), It is critical to highlight the problem of selected countries for correct analysis of the reports, as only 39 countries participated in grade eight in 2015 and 48 countries participated in grade four”. To scale the ratings, “TIMSS employs five ‘international benchmarks': Advanced (above 625 points), High (550 to 625 points), Intermediate (475 to 550 points), Low (400 to 475), and Not Achieved (less than 400)”.

The Human Sciences Research Council (HSRC) ‘adopted an additional benchmark, Potentials, for scores ranging from 325 to 400 points to designate a community of learners who can be targeted for upward shifting to a higher benchmark for the South African context. As a result, in a local sense, the ‘Not Achieved’ criterion is set at less than 325 points, rather than 400 points. The country's average national mathematics score is 372 points (38th out of 39 countries) while its average national chemistry score is 358 points (last place) (NACI, 2017). In 2015, South Africa ranked 47th out of 48 countries in grade five mathematics (TIMSS-Numeracy) with 376 points, while the difference between 46th and 45th is not statistically significant. In layman's words, mathematics achievement at the fifth grade ranks 45th out of 48 countries (a position shared with Morocco and Saudi Arabia). The international benchmark distribution of the country's TIMSS 2015 results is given below.

	Grade 5	**Grade 9**	**Grade 5**
International Benchmark	Mathematics	Mathematics	Science
Advanced (>625)	1%	1%	1%
High (550-625)	4%	3%	4%
Intermediate (475-550)	12%	10%	9%

Low(400-475)	22%	21%	18%
Potentials (325-400)	28%	35%	28%
Not Achieved (<325)	33%	31%	40%

Table : South Africa's TIMSS 2015 Performance Summary

Source: *National Advisory Council on Innovation (2017.77)*

According to the Academy of Science of South Africa (ASSAf, 2010), there is an averaged result masking a very broad discrepancy amongst learners at both primary and secondary school levels, as shown in the above table. That is, “a small minority continue to make significant progress in these subjects, while the majority fail to perform at appropriate levels” (ASSAf, 2010: 7). As a result, the pool of potential scientists, engineers, health practitioners, and future mathematics and science teachers is severely constrained. As a result, South Africa's ability to compete internationally is harmed, which has an influence on the country's ability to provide the foundation or structure required for the majority's well-being.

Crewe (2010: 7), states that 2009 was seen to be a seminal year for the South African education system as the first recipients of the new “National Senior Certificate (NSC) entered higher education, and in larger numbers than in the past”. The students were the first recipients of the program, having completed 12 years of post-apartheid schooling with an outcomes-based curriculum. According to Crewe (2010: 7), outcomes-based education was chosen as the educational principle that would underpin the new curricula, allowing every South African child to reach his or her full potential. Identifying the outcomes to be accomplished at the conclusion of the learning process is thought to aid in the promotion of a learner-centred, activity-based approach to education (Keiler, 2018). Keiler (2018), continues to say that, in contrast to the teacher-centred, passive learning exercise or method that had previously been prevalent in South African education.

2.2. Global-View in Understanding the mathematics

Understanding mathematics from a global perspective, it is significant to indicate that mathematics is a prerequisite to pursue a career in an economic sector. According to the 2010 South African Millennium Development Goals (MDG) survey, these goals are critical for economic development and growth (Mahlaba, 2020; Mogari, 2014). Mogari (2014), claims that low-quality education coverage is also cited in the 2010 MDG study as an impediment to the development of information and skills needed for participation in key economic sectors. To be good teachers, teachers must, among other things, consider the learning process and their role in learning such that they can organise and organise lessons in such a way that learning is more conceptually oriented. Furthermore, the lecture aims to dissect and profile the state of mathematics education in some of the countries that have outperformed South Africa in international mathematics assessments such as TIMSS, PISA, and SACMEQ. This is accomplished, in part, by contrasting mathematics instruction in South Africa with that in the Netherlands, Finland, Japan, the United States of America, and Zimbabwe.

The contrast is primarily intended to provide insight into how mathematics is learned in these nations, as well as the reasons that contribute to their progress in mathematics learning that can benefit South Africa. It is hoped that with this interpretation, South Africa would be able to review and improve on its mathematics teaching approach and strategies. Nevertheless, to best understand mathematics from a global perspective, it imperative to acknowledge the fact the world has become interconnected. Everyday mathematics as a subject has been able to show these possibilities and connections. Jackson (2014), argues that all curricular area has a comprehensive global dimension that could be imparted in the classroom, which includes mathematics.

This is repeated over and over in the region that many people find the most difficult to comprehend as being global, yet Jackson (2014), concurred that mathematics helps individuals understand the world, while we utilize the world to understand Mathematic. According to Atweh, et al. (2003), mathematics and physical science education are arguably, “the most internationalized subject in higher education”. The number of worldwide conversations, exchanges, and publications in the topic reflects this. While several publications have made significant efforts to address the internationalization of

mathematics education in both theory and research, the term ‘globalization’ is less well-known in the mathematics literature (Atweh, et al., 2003). The global concept (globalization and internationalization) towards the study and instruction of learner's mathematics (globalization and internationalization) in education is presented in this portion of the research. The section also discusses some of the significant challenges that each design raises, which may require further discussion and research in the future.

The globe is considered as a global village, and mathematics demonstrates these linkages and potential. The sooner young people can put these skills into practice, the more inventive society and economy will become (Centre for Global Education, 2019). Mathematics is a collection of knowledge and practice derived from the contributions of intellectuals throughout history and around the globe. The goal of this study is to see if the availability of professional mathematics and Science teachers in rural high schools in the King Cetshwayo District affects student performance. This will help us understand patterns, quantify relationships, and anticipate the future. According to the Centre for Global Education, "Algebra can explain how rapidly water becomes contaminated and how many people in a third-world country who drink that water become ill each year" (Centre for Global Education, 2019: 1).

A geometry study can provide an explanation of the science that is behind architecture throughout the world (Centre for Global Education, 2019). According to Jackson (2014), for students to be able to function in a global context in mathematics, the subject's material must assist them in achieving global competency, which includes understanding the subject from various viewpoints. This entails recognizing that issues are interconnected across the globe, as well as communicating and responding in ineffective ways. This means rethinking traditional subjects in new ways and showing students how the world is made up of circumstances, events, and occurrences that may be structured using the appropriate mathematics tools. Mathematics should find a way to contribute to a better understanding of the subject and the world in the global contexts.

To successfully do that, it is vital for teachers to stay motivated on teaching good, with “sound, rigorous, and appropriate mathematics or the subject content”, and use global examples that work (Jackson, 2014). In Europe, for example, employing kilometres instead of miles to solve a word problem has minimal meaning because the instruments can readily convert the figures. This does not add to a comprehensive understanding of the world (Centre for Global Education, 2019).

2.3. Mathematics and Physical science in Global Demand

Physical Science is generally applied to various areas, going well beyond physics and engineering. Mathematics is often studied as a pure science. Studying exponential growth and decay, or the pace at which things grow and die, in the context of population increase, disease spread, or water contamination, for example, is important (Roser & Ortiz-Ospina, 2017). Roser and Ortiz-Ospina (2017: 9), predicted that, “the exponential growth of the human population could lead to food shortages, global warming, and other issues of resource scarcity”. Giving such an example not only offers the learners a real-world context, by which in using mathematics, but go as far as helping them to understand global phenomena (CGE, 2019). The learners may hear about a disease epidemic just like the spread of COVID-19 in India, China, America, or South Africa, which is currently ravaging the entire world system, yet will not be able to make the connection.

To make the connection without understanding how fast disease such as cholera or coronavirus can be easily spread across different people in a densely populated area (Heather, 2014). What this means is that if learners in the science field such as mathematics and physical science are given the right content and context in terms of teaching, for a globally infused mathematics and physical science curriculum. The students will be able to use the topic (Mathematics) to make global connections, and they will develop a mathematics model that reflects the "complexity and interconnectedness" of global circumstances and events (Jackson, 2014). In this way, learners will be able to use mathematics knowledge as a strategy not only to solve

problems, but also to develop and explain the usage of a given mathematics topic in a broader sense.

Learners will be able to explain why a mathematics model they picked is relevant by using the appropriate mathematics knowledge as tools in the appropriate scenarios. More importantly, learners may use data to draw solid conclusions and apply their mathematical knowledge and skills in real-life situations. This means that a student should be able to apply mathematics skills and approaches to examine issues and possibilities in the world by the time they graduate from high school. That is, the learner will be able to apply mathematics representations and models not only to make but to defend suppositions and actions (Darling-Hammond, et al., 2020):

> *At the heart of any discussion on a global curriculum through mathematics, it's important to consider mathematics helps students make sense of the world, what students experienced, enables them to make contributions to the global community, and what mathematics content students need to solve complex problems in a complex world.*

Finding actual, relevant, and remarkable examples of global or cultural contexts that help to strengthen, deepen, and showcase a grasp of the mathematics subject is thus the issue. A scholar states that the global era will demand the skills above from the people, which the education system ought to provide learners with the wherewithal to be proficient in them (Alessandra, 2017). This means that recognizing the contributions of various cultures is also part of knowing the globe. In terms of the physical science subject, The National Academy of Sciences (2018), states that science teaching is a complex activity that lies at the core of the vision of NAS of science education that is being presented in the teaching standards. The teaching standards of physical sciences provide criteria for constructing conclusions about the progress toward the vision national academy of sciences.

While Mandla (2016), states that they define what teachers of physical science at all grade levels should understand as well as what they can do. To highlight the

significance of teachers in teaching physical science in education, these standards are presented first. Globally, it is important to understand that what learners in high schools learn is greatly influenced by how they are taught. The conclusions about the content and activities in which the teachers make are in line with their interactions with the learners, the selection of valuations, and the conduct of mind that teacher (Clarke, 2012). Physical science teachers should have both theoretical and practical knowledge, as well as skills in science learning and teaching. At the heart of any discussion of a global curriculum through mathematics is the question of how the subject might help students make sense of the world.

2.4. Continental View of Mathematics and Physical sciences

Learners from several African countries are assessed against a set of globally specified literacy and numeracy skills learning competencies on a continental level. South African learners scored fourth with an overall literacy score of 48.1 percent and last with a numeracy score of 30.0 percent, according to statistics from Tunisia, Mauritius, Malawi, Zambia, and Senegal (DoE, 2001a). The case studies presented here provide a gloomy picture of South Africa's mathematics and science teaching and learning. Scholars, doctors, scientists, and a variety of other science-based practitioners are needed in the country. Given the low overall level of mathematics and science literacy in the educational system, it is possible that such a system would be unable to produce enough students who merit to enrol in universities to pursue further SET courses (Howie, 2003; Centre for Development of Education (CDE), 2004).

2.4.1. South Africa Context

South Africa currently lacks the potential to develop economically without importing international technical and technical resources (Ramsuran, 2005; Gardner & Hill, 1999; Frantz, et al., 1996; Department of Arts, Culture, Science, and Technology (DACST), 1996; Pratzner, 1994). If this country is to be a part of the technologically advanced global village, science must educate policy and accelerate the transition to a mathematically and critical thinkers' society. This is critical since a lack of experience affects the country's overall economic outlook. For example, to offer jobs for everyone, whether, by job production or opportunities in the employment market, a degree of

science and technological innovation that allows for economic development and expansion is required (Miji & Makgato, 2016). South Africa is currently far from this perfect scenario. Mathematics, on the other hand, is one of the essential skills required of a physical science learner must acquire. According to annual evaluation results, we are not doing so well in mathematics as a country.

Many of the diagnostic findings examined to show that this is a challenge for many students. According to the diagnostic results from 2011 and 2013, "there is also a serious shortage of analytical skills such as graph analysis and drawing, mathematical calculations, and dealing with trigonometric ratios". It is also apparent that most students have few to no problem-solving skills. Most students are unable to deal with challenges. "Many students stopped halfway through their calculations based responses, likely due to a lack of calculators or a lack of the requisite skills to use the calculators" (DBE, 2011:117). Any candidates' low results were attributed to inadequate technical abilities and poor use of calculators. "Most candidates struggled with poor graph comprehension skills and sketch diagrams in Question 3 (projectile motion)" (DBE, 2013: 117). The pass rate for mathematics in the NSC at the national level reflects the issue of mathematical skills.

In the last five years, mathematics has become the lowest-performing discipline, and this has been a major issue for subjects that include mathematics. The general findings of the 2015 and 2018 diagnostic report reveal that, "in the case of subjects requiring the use of mathematical or calculation skills, it is clear that candidates lacking these skills are severely disadvantaged when it comes to earning marks for even the most basic application-type questions, and this adds to the complexity of them responding to more cognitively demanding questions" (DBE, 2015: 6). This indicates that physical sciences teachers do not believe their students have the mathematical skills required to study physical sciences. They are perplexed by the task of enhancing their abilities. Most physical sciences questions, for example, are presented in the form of a graph or table. Yet, most students struggle to extract data from the graph or table while addressing issues. As a result, these are the characteristics that should be taught in physical science class.

2.4.2. Mathematics and Physical Sciences in the African States

This section of the study look at teacher's perspective to Mathematics and Physical Sciences in the African States. For several years, efforts have been made to reform the South African education system by strengthening teachers' expertise, technical understanding, behaviour, self-efficiency, classroom practise, qualifications, and professional standing as teachers (Hofmeyr, 2015). The Integrated Strategic Planning Framework for Teacher Education and Development (ISPFTED), as well as several ongoing continuing professional development programs across the country, curriculum revision, teacher support through the Integrated Quality Management System (Mpungose, 2020). And the Quality Learning and Teaching Campaign, have all contributed to these efforts (Withers, 2011; DoE, 2007). However, learners' success in physical sciences remains poor, endorsing the demand for South African physical sciences teachers to continue their professional growth. In South Africa, it is necessary to investigate if research-based classroom activities will contribute to enhanced learner outcomes.

The great success of Japanese learners in TIMSS has been attributed to the skill of Lesson Study (Pang & Ling, 2012; Stols & Ono, 2016; Stigler & Hiebert, 2009). As a result, the technique has been broadly accepted as a way of improving learner success in other areas of Asia, Europe, and the United States. Lesson Study, based on its popularity in Japan, can be useful as a career development strategy for South African Science teachers. This section of the research gives an overview of research findings and sources linked to mathematics in African history. Africa can be regarded as a continent of contrasts According to IMU (2014), Africa's 50-plus nations vary greatly in terms of scale, economy, income, and community. Not unexpectedly, these differences can be seen in educational development, particularly mathematics development. Even though African countries differ in many ways, they are substantially comparable in crucial areas of concern - structural and national circumstances that encourage or inhibit mathematics progress (IMU, 2014). According to their findings, these circumstances seem to be nearly the same across the globe.

In the past few decades, the focus on educational change has been prevalent and insistent as education systems around the world have struggled to meet the real needs

of the times. The challenges and opportunities in the current era in mathematics education in Africa are still at a struggling level according to an extensive variety of both regional, national and international assessments (International Mathematics Union, 2014). Though there have been occasions where remarkable progress has been experienced since the 2009 International Mathematics Union report by the International Mathematics Union. The IMU (2014), states that the Africa mathematics project, which is supported by the Simons Foundation is one of those success stories, the mainstream challenges remain however with a low pass rate from learners.

2.4.3. Kenya Context

Sikolia and Sikolia (2016), articulate that in Kenya, physical science subjects such as biology, which is a science, has enormous practical applications in our daily lives. Conversely, in other science subjects just like mathematics, the performance in both science subjects at the national examinations has been recorded to be relatively low. As a result, in July 1998, the Kenyan government started the Strengthening of mathematics and physical science in Secondary Education (SMASSE) project in conjunction with the Japan International Cooperation Agency (JICA) (Sikolia & Sikolia, 2016). According to the researchers, the SMASSE has now begun to provide in-service training to all serving teachers in essential disciplines such as mathematics and physical science, with the sole purpose of making them better teachers. The International Mathematics Union (IMU) (2014), noted in an updated report that, “the 50-plus nations of Africa exhibit huge variability in size, population level, wealth and culture”.

Not surprisingly, these variations are also seen in educational development, including mathematics development. Nonetheless, even though African countries differ from one another, in terms of many features, they are broadly related in important matters that are of concerns to institutional and, “national conditions that help or hinder mathematics development” (IMU, 2014). According to the IMU's 2014 reports, these conditions are nearly the same across the continent. In summary, these challenges include the below:

- A shortage of secondary school instructors and mathematicians with master's and doctoral degrees. Countries are unable to meet the growing need for advanced, up-to-date mathematicians due to a scarcity of academics to train the next generation of leaders.
- Professional and geographical isolation, which limits career advancement chances; Low incomes, a bad public image, and a lack of mentors.
- Record numbers of students clamouring for a college degree.
- Poor infrastructure, apparatus, and teaching materials are all outdated.

The overall success story of mathematics and physical science development in Africa is one of the potentials that is yet to be fulfilled and the position of the educator. Indeed, one of the key goals of teaching and learning mathematics is to help high school students to gain confidence in utilizing mathematics to evaluate and solve real-world situations (Mazana, et al., 2020). The techniques that are used in real life circumstances, however, show that while some students excel at mastering mathematics courses, many others struggle and eventually flunk the subject (Mazana, et al, 2020). Fidele, et al., (2019: 93), argue that,

> *Effective teaching and learning of mathematics are vital not only for examination or assessment purposes but also for empowering learners to live in a modern age of science, mathematics, and engineering and enable them to role-play to the social and economic development of the developing countries and the whole world as well.*

Mathematics as a subject is, “the logical sequence of formulae” so that it is abridged to the build-up of rules and formulae (Dlamini, et al., 2021; IMU, 2014). Non-mathematics applications are not always necessary components of mathematics. According to Sikolia and Sikolia (2016), in terms of understanding of the teacher's perceptions, teachers have the core responsibility for learner’s learning and education works in a manner that allows the learners to get something tangible. Something fixed that has to be comprehended by the learners. The application of educated calculation approaches as noted by Fidele, et al. (2019), is very imperative, compared to reason oneself,

therefore against this background, the fundamentals just like that may need to be ‘memorized’.

The class teacher thus sees him/herself as, “a crammer who trains basics and who functions as a controller for systematic working” (Kaiser & Vollstedt, 2007). The tasks of teachers are extremely important in this view of teaching mathematics, as it is to primarily serve for the training of fundamental mathematics contents. The mere purpose of practice’ is vital. This means that, “they [the students] practice the same again and again with little variation’. In doing so, the relation to daily life is important, the tasks, however, do not have to be necessarily realistic” (Kaiser & Vollstedt, 2007: 2). The overall story of mathematics development in Africa is what is regarded as the unfulfilled potential. Based on some individuals' and institutions' exceptional achievements, the International Mathematics Union (IMU) (2014), states that it is clear that no “African country lacks talented potential Mathematicians”. In the absence of a more solid educational system at all levels, only about a few of the learners can reach their full potentials.

Understanding mathematics as a subject and the application can be developed, to contribute to the advance of a bigger understanding of some of these issues (IMU, 2014). As a result, at both primary and secondary level mathematics, education and training are regarded to be weak in most African countries, which form part of the issues identified by the IMU. The weakness in the education system thereby reduces the potential number of who choose to study mathematics majors at the university level (Mlotshwa, 2021). In some Sub-Saharan countries, “less than 10% of the secondary age population is enrolled in school; in the rest for which figures are available, only South Africa and Swaziland have gross enrolment ratios greater than 50%” (IMU, 2020). This condition according to research has been seen to attribute to the part of inadequate recruitment of teachers and the laws demanding universal basic education, which has amplified the overcrowding at the primary school level (Fidele, et al., 2019).

Furthermore, this has brought about a drop in quality, because of largeness in the size of the class, which prevents teachers from interacting with learners individually. In

further attending to those learners who might require special attention, or probably applying to practice learner-centred techniques. This is one of those results that leads to poor performance among learners, wherein in other cases only a few learners reach the secondary level (IMU, 2020).

2.4.4. Teaching Mathematics/ Physical Science in South African schools

With the reform and modification in education and the teacher-training programs, as well as school curriculum, there seem to be yet many challenges that are facing mathematics education in South Africa. According to Machaba (2017), there is, “a strangely low achievement of children in Mathematics”. Machaba (2017), states that the poor performance in both mathematics and physical science of children, in the foundation phase has been a concern of everyone. This is because in the foundation phase teachers have a vital role to play in, “the teaching and learning process of mathematics in schools” (IMU, 2020: 4). According to the findings, primary school teachers who engage with children in mathematics are expected to engage in a variety of activities to guarantee that the students are adequately equipped.

They ought to be fully ready to manage with prevailing and future knowledge of mathematics (Machaba, 2017). It is expected that the teachers must be able to help develop the children's foundation, with regards to mathematics and sciences subjects through a proper selection and utilization of content. At the foundation phase in schools, according to Bashir, et al. (2018), the teachers are seen as the “front line of mathematics because of their huge responsibility of preparing children for careers that require increasingly demanding levels of mathematics skill and thinking”. The level of education of secondary school teachers is a factor to be considered while discussing the competency level of mathematics (Mkhasibe, et al., 2021). According to the International Mathematics Union (2020), the educational level of mathematics teachers in secondary school is seen to vary from country to country, and particularly in South Africa.

This ranges from, “a bachelor’s or master’s degree at the high end to various certificates and diplomas that may not be in mathematics” specialization (IMU, 2020). As such, varieties in the level of qualification and field of speciality from degrees and

diplomas, as a result, it offers the sense of specificity and uniformity, even though formal standards are not often satisfied in practice. This is often attributed to the inherent ‘bottlenecks and the incapacity of governments’ to provide the essential training resources needed (Machaba, 2017). In some circumstances, the tight requirements exacerbate the problem. Teacher shortages are frequently alleviated by a strategy known as ‘inferior substitution’, in which a surplus of qualified teachers (in other subjects) and temporary teachers are sent to teach mathematics (Machaba, 2017). Even when they are not professionally qualified in terms of subject-specific to teach the subject mathematics and physical science.

Research Objective:

2.5. THE AVAILABILITY OF PROFESSIONAL MATHEMATICS AND SCIENCE TEACHERS IN THE RURAL HIGH SCHOOLS OF KING CETSHWAYO DISTRICT AFFECT LEARNER’S PERFORMANCE

The study indicated specifically that the availability of professional math and physical science teachers impact or effect learner performancc this aim is explored only in the literature review. Mathematics education is one of South Africa's national priorities, as stated in the executive summary of the National Development Plan (NDP), which states that "the demand for an increase in the number of students achieving above 50% in literacy and mathematics, respectively" (National Planning Commission, Department of the Presidency, Republic of South Africa, 2012: 2). The legacy of low-grade

mathematics instruction that was supplied to most learners during the previous apartheid government appears to be prominent in most public schools almost two decades since South Africa transitioned from the Apartheid regime to the democratic system (Ajani, 2021; Stols, et al., 2015). According to the results of the Trends in International mathematics and Science Study (TIMSS) 2011, South Africa was, "put among the poorest performing participating countries, as in the case of similar studies in the past" (Spaull, 2013: 17).

The existing critical challenges that are being faced in South Africa by teachers and in many other countries, with the developing and evolving economies, are associated with the individual lack of mathematics content knowledge (Spaull, 2013). This is in addition to the necessary skills to apply what they've learned in the classroom to the students (Stols, et al., 2015). Considering the foregoing, the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) III research from 2012 was undertaken. The research indicates that, “limited mathematics teachers in South Africa to teach mathematics and physical science subjects” (Rowland & Ruthven, 2011: 4). The discourse concerning the availability of mathematics and physical science teachers in South Africa frequently raises questions. It raises the question of what conceivable nature and method for additional support to be given to teachers that would have a constructive impact development (Stols, et al., 2015).

The weaknesses and strengths at the tertiary level of a mathematics teacher, some many causes factors that lead to weakness in African mathematics, however primary the factors are, the persistent scarcity of qualified and professional or skilled teachers at all levels (Stols, et al., 2015). Today many hundred students are assigned to the same room, which is crammed with students, harmonizing on projections, or even as far as standing along the classroom walls in the university.

Teaching that is mapped poorly to the learners’ needs, as well as the outdated curriculum, which is not in sync with career realities (IMU, 2014). This is a problem of the non-availability of qualified subject teachers. In summary, African nations including South Africa require more support for those who might wish to develop their careers as educators in subject specific, such as critical subject of mathematics and physical

science. Researchers in the field of mathematics and physical sciences, also need to do more collaboration among people and institutions that are seeking to make this happen. The necessary steps to achieve it would be to have a stronger teaching of mathematics and physical science foundation in both primary and secondary schools.

2.5.1. Teacher's Perceptions of the Challenges of mathematics and physical science among Learners

According to a variety of regional, national, and international assessments, South African mathematics education is failing (Reddy, al., 2015; DBE, 2014). Finding a way forward to address the numerous obstacles that have been identified as contributing to poor learning and performance in this learning area is therefore critical (Graven, 2016). There is extensive research that points to the critical need to address the real challenges of mathematics and physical science education, this is particularly in the early years of schooling, where more of the learners already "falls two grades behind expectation by the intermediate phase" (Graven, 2016; Taylor, 2015). This can be accomplished by addressing the need for mathematics knowledge in teaching (Adler, 2005); 'improving teaching pedagogies' that emphasize sense-making (Venkat & Naidoo, 2012; Hoadley, 2012); running after-school mathematics clubs aimed at extension and remediation (Graven & Stott, 2012; Stott & Graven, 2013; Carnoy, et al., 2011).

In response to the research objective, the availability of mathematics and physical science teachers in rural high schools, looks at the link between resources in the teaching environment and learner's failure. The remarkable shift in educational approach should occur in the context of the availability of mathematics and physical science professors. The background of a serious scarcity of professional skills in science and technology-related sectors has resurfaced as a source of concern for high school graduates (Crewe, 2010). According to the DBE (2017), the NSC, specifically the requirements for mathematics and physical science programs at higher education institutions (HEIs), is lower than in prior years, owing to the bigger intake. As a result, a greater number of students scored extremely low on their mid-year evaluations (Ajani, 2020).

According to the Academy of Science of South Africa (ASSAf), (2010), it has become clear that students who gained a National Senior Certificate (NSC) in 2008 joined HEIs with knowledge and abilities that differed from either those that HEIs expect students to have or those held by incoming students in the past (ASSAf, 2010). This situation has highlighted the necessity for a thorough examination of high school mathematics and physical science curricula, as well as how they are taught, assessed, and teachers are prepared to teach them (Spaull, 2015).

As an organized body of natural and human scientists, ASSAf has an important role to play in providing valuable information to members of society and government with evidence-based information that can be used to guide policy and pilot decisions for the benefit of society. Mathematics, unlike other science subjects like life science and geography science, if the focus is only at the further education training (FET) level, because mathematics literacy has become a concern that needs fuller attention.

The communication between the National Senior Certificate (NSC) mathematics and physical science in the National Curriculum (Vocational) needs to be addressed as part of the recommended differentiation (Department of Education, 2014). The bigger issue here is that there is a wide understanding that the problem with the mathematics and physical science examination is that it did not disaggregate at the bottom. It is noted by the Department of Education (2014), over 50% of learners failed the examination in 2008 that is they got less than 30% for the examination. The failure to differentiate at the top by the examination; there remained consequently a great number of A symbols that was achieved. It is believed that there may be a positive effect on the examinations from the assessment of growing cognitive demand, which include the various forms of problem-solving, modelling, and deductive reasoning (Acharya, 2017). It implies that, if HEIs become involved in developing curricular materials with teachers, as well as in teacher training and identification of appropriate curriculum content" (Woodland & Mazur, 2015: 4).

Fleisch (2008: 9), suggests that we need to have a "broader experience and knowledge base from which to draw as we deal with this in the curriculum". Grayson

(2009: 8), suggests that, “the HEIs should become involved in strengthening the pipeline from schools into university by encouraging students into the university earlier on in various kinds of programmes (for example, targeting talent activity and possibilities for learners to engage with universities from grade 10)”. In South Africa, according to Grayson (2009), most of the required continuous professional development (CPD) activities occur outside of the classroom setting, with most subject advisers and teacher education experts from various institutions of higher learning taking the lead. According to John (2019), school-based continuous professional development activities should be at the heart of teacher learning, and they should be strategically linked to other external continuous professional development activities.

The first reason is that schools are in the midst of teaching and learning in rural regions, and this is where the demand to deliver high-quality teaching and learning is felt most acutely (Darling-Hammond, 2017). "Understanding and utilizing a school's learning culture" can make a difference by improving teachers' learning, resulting in increased job satisfaction and wellness (Postholm & Wge, 2016). Lesson study represents a strong relationship between practice and teachers' requirements, according to teacher learning culture as continual professional growth as a social learning process (DNA Economics, 2020; Koellner & Jacobs, 2015). Hadfield and Jopling (2016: 205), suggest that, “the nature of the lesson study cycle makes it sensitive to how practice issues are constructed, and improvement is defined in a specific context.”

2.5.2. Infrastructural Need and Professional Development for Teachers

In addressing the Infrastructural Need" and Professional Development for Teachers", it is important to look at the challenges of learner’s poor performance in mathematics and physical science in Africa and South Africa, Crew states, “there has remarkably been a significant concern on the state of South African learners’ academic achievements in the high stakes NSC examinations. …[This is particularly in]… the performance of learners whose schools are located in low socioeconomic areas… One of the concerns faced by the South African government in the post-apartheid era is its failure to provide quality mathematics and physical science education for its diverse population of 55 million” (Crewe, 2010: 9).

Mathematics and Physical Science in Africa Challenges in South Africa

The term ‘quality’ in the context of education, according to Dewey (2019), refers to both changes in the environment in which education takes place and individual advances in students' knowledge, ‘skills, and values’. In general, Acharya (2017), indicates that,

> *“South African children are exposed to poorer quality of teaching than is found in its poorer neighbouring countries, particularly in mathematics in the Foundation, Senior, and Further Education and Training phases”.*

According to the National Planning Commission (NPC), The Presidency, Republic of South Africa (2012), "black children in South Africa receive a poor-quality education”, denying them access to quality higher education and decent employment, resulting in lower earnings and limited career mobility for those who do get jobs (Du Plessis & Mestry, 2019). Few factors could be responsible for this, which include the system inherited from the apartheid regime. The recent but history of the apartheid system in South Africa experienced inequality in the education sector. Rijsdijk (1997), claims that there is a general lack of science literacy and awareness as a result of unequal education, particularly in science. Schools with poor performance due to a lack of science teachers may have science laboratories, but they may lack the necessary chemicals and other forms of science equipment to conduct scientific tests and experiments in the classroom. Such issues at schools are sometimes exacerbated by other factors, such as a lack of adequate security, and as a result, they are vulnerable to vandalism (Nedlac, 1999). Ogunniyi (1999), emphasizes the importance of adequate physical science training.

2.5.3. Examining Learners Correlated Factors to Low Performance

In the discourse of learner's related factor to low-performance rate in mathematics among rural-based high schools, this is regarded as one of the essential aspects linking to the high rate of failure rate in the subject. This plays a dynamic role in teaching-learning development. Without learners having an interest in the process of teaching-learning, there is no likelihood to gain knowledge in the subject matter (Acharya, 2017). Lebata (2014), states that the achievement of learners hangs on their prerequisite,

attention, interest, exercises, and earnestness in the subject matter. This learner correlated factors to low performance which include mathematics anxiety and the previous knowledge of learners alongside the learner's effort in studying mathematics and physical science. Thus, these factors are elaborated further below.

2.5.4. Learner's Anxiety to Learning mathematics and physical science

Learners developing anxiety towards learning mathematics subject in high school is one of the vital aspects among learner's correlated factors in learning subject. 'Mathematics anxiety is a negative feeling to mathematics learning processes", according to Acharya (2017: 8), anxiety is defined as a sensation of "tension, apprehension, or fear that interferes with mathematics performance", whereas mathematics anxiety is defined as disregard and lack of trust in the subject. It has an impact on students' learning in mathematics and physical science. Similarly, it affects the subjects pass rate in mathematics and physical science in matric for 12th grade in South African high school. Acharya (2017), shows how student and mathematics teacher discussed while expressing anxiety about mathematics, which indicates that there are some formulas in mathematics that are difficult to comprehend and have no relation to other subjects.

Many learners believe that mathematics is a topic that is abstract. More evidence suggests that many learners are unprepared to learn this, "formula student's fear in learning mathematics" (Acharya, 2017: 10). The understandings from the learner's parents towards mathematics indicates that it is a difficult subject. Many people have the notion that mathematics is only for the cleaver ones in class. Learners feel that mathematics is a complex subject, and they find it very difficult to assimilate easily, because of the mathematics formulas. It is widely held that mathematics and physical science have no direct application in people's daily lives and have no connection to other subjects, which has caused learners to feel apprehensive about learning mathematics. According to Acharya (2017), students' worry about mathematics has a direct impact on their ability to study well, as reflected by students who believe that students' anxiety about mathematics is to account for their failure rate and poor performance in mathematics.

Similarly, Vygotsky (1978), argues that the unconstructive explanation about mathematics subject on the side of the teacher, parents, and other individuals, shaped fruition with anxiety and ready to understand meaningful way. Another feature that is a related factor is learner prior knowledge, which refers to the learners' prior knowledge of mathematics contents. According to the studies, the fundamental understanding of mathematics and physical science in some high school at the lower levels is the key factors that determine the good performance of the learners or not (Acharya, 2017; Best & Kahn, 1999). This also determines a learner's performance rate in the advanced study. The pre-knowledge of mathematics is the groundwork as well all corpulent development of learners in mathematics subject. The students who have insufficient prior knowledge previously would not want to learn further and may not be able to succeed in the upper level. This is one of the factors that is said to be responsible for learner's failure and low performance in mathematics in many high schools particularly in the rural based schools.

The above was backed up by Acharya (1999), who stated that many students lack sufficient previously learned mathematics knowledge and are unable to incorporate new mathematics ideas and principles into previously learned mathematics structures. However, according to Acharya (2017), the majority of learners are promoted in the subject of mathematics at a lesser level since they are unable to perform well in mathematics similarly. This is according to the conclusions of a mathematics teacher, who claims that an adequate basic idea of mathematics was not included in the lower secondary mathematics curriculum. Many students believe that mathematics is a new and difficult topic (Acharya, 2017). Learning mathematics as a subject is said not to be related to learner's behaviour in life and it has no relevance with their locality and social background since it often taught in the English language, many learners from rural area are disadvantaged homes who often face language problem especially.

As learners "background is a very critical stage for survivable" in modern society (Acharya, 2017). The fact that they spend several study hours, not to mention the foundation procedure, is not discussed further. According to Acharya (2017: 13), "during study time, the learners prefer to go harvest herbal valued plants and graze the animals in the forest to make a small bit of money". Fundamentally, learners from rural

areas are not concerned or serious about learning basic mathematical rules. This emphasizes the necessity of seeing and modelling others' behaviours, attitudes, and emotional reactions, according to Albert Bandura's social learning theory (John, 2019). "Learning would be extremely difficult, if not dangerous, if people had to rely exclusively on the repercussions of their activities to tell them what to do", (Bandura & Walters, 1963: 22).

> *Fortunately, most human behaviour is learned observationally through modelling: from observing others one forms an idea of how new behaviours are performed, and on later occasions, this coded information serves as a guide for action* (Bandura & Walters, 1963: 22).

Social learning theory illuminate's human behaviour in relations to continuous reciprocal communication between 'cognitive, behavioural' and environmental influences. In this regard, the constituent processes that are fundamental to observational learning include, "attention, which is the modelled events uniqueness, affective valence, complexity, prevalence of a functional value" (John, 2019). While sensory "capabilities, arousal level, perceptual set, past reinforcement" are among the observer qualities, the researcher also included retention, which includes symbolic coding, cognitive organization, symbolic rehearsal, and motor rehearsal (John, 2019). Mechanical reproduction, which includes physical capabilities, self-observation of replication, feedback accuracy, and motivation, which includes external, vicarious, and self-reinforcement, is another consideration (Acharya, 2017).

Social learning theory applies to both cognitive and behavioural domains since it embodies paying attention, recall, and excitement. The scope and applicability of social learning theory have been pragmatically applied to the study of aggression and psychological disorders, particularly in the context of behaviour modification (Bandura & Walters, 1963). It is also considered the theoretical foundation for the behaviour forming approach that is commonly used in coaching and education programs. Recently, Bandura's study has focused on the concept of self-efficacy in a range of circumstances (Acharya, 1999). Television commercials are one of the most common and comprehensive models of the idea of social learning settings. If a commercial claim that drinking a certain beverage or using a certain hair product, such as shampoo,

would make you popular and get the respect of beautiful people. Depending on the factor developments intricate (such as attention or motivation), you may end up modelling the behaviour presented in that commercial and make you buy the product that is advertised on television (John, 2019). Consequently, the role of prior understanding of the mathematics subject is an imperative characteristic for learners to pass the mathematics and physical science subject in an examination.

2.6. FACTORS THAT AFFECT THE SUPPLY OF QUALIFIED MATHEMATICSAND PHYSICAL SCIENCE TEACHERS IN THE RURAL HIGH SCHOOLS OF KING CETSHWAYO DISTRICT

Exploring the factors affecting the supply of qualified mathematics and physical science teachers in the rural high schools of King Cetshwayo District, call for the need to train teachers in South Africa as important. Ogunniyi (1999), argues that due to varying low levels of learner enrolment in physical science and mathematics in schools, especially in places that were previous homelands. In such circumstances, a scarcity of trained scientific teachers may cause problems for those who are already in the classroom, particularly due to additional demands, such as environmental variables (Legari, 2004). Based on the environmental factors, the rural-based schools may have their circumstances differently regarding the availability of mathematics and physical science teachers, but most of the above-aforementioned situations may apply because there is still much to be considered in South Africa's education system.

In South Africa, the status of mathematics and physical science teachers has been noted to be obsolete in terms of teaching strategies and a lack of basic material knowledge, resulting in poor teaching standards and low learner performance. Many under-qualified or untrained teachers who teach in overcrowded and inadequately equipped classrooms have exacerbated the poor or low standards. As a result of the confluence of all of these reasons, a new generation of teachers has emerged, perpetuating the cycle of mediocrity (DoE, 2018; 2001). The National Teacher Education Audit (NTEA) of 1996, as well as the mathematics and physical science

Audit of 1997, revealed facts and figures on teachers and teaching outcomes in these areas.

The DoE (2018), the report shows that more than 50% of mathematics and 68% of physical science teachers have had no formal subject training in mathematics and science audit (DoE, 2001). As the setback of incompetent training with teachers, this was mainly acknowledged in the general education phase of the schooling system in South Africa (DoE, 2001). The Education for All (EFA) assessment in 2005, reported that despite having approximately 85% of mathematics educationalists being proficiently fit, only 50% had a specialisation in mathematics subject training (DoE, 2018; EFA, 2005). Similarly, whereas over 84 percent of science teachers are highly qualified, just 42% are science experts. In-service training is expected to be necessary for 8 000 mathematics and 8 200 physical science educators to address their deficiencies in these disciplines (DoE, 2001). According to the Department of Education assessment, there is a concern with the number of students who select teaching as a career after graduating with a bachelor's degree in mathematics or physical science.

As a result of this, there is a vicious succession of extremely few students who are taking mathematics and science-related subjects at universities as degree qualifications, resulting in a teacher shortage in rural high schools. In certain cases, this has led to schools discontinuing the teaching of mathematics and physical science (DoE, 2018). Even those who teach these subjects lack the necessary facilities and equipment to ensure that they are taught and learned effectively (Nzama & Ajani, 2021; Legari, 2006). This environment has resulted in the teaching of physical science remaining at a theoretical level without any experimental development or knowledge solicitation (DoE, 2018). Legari (2006), adds that a variety of initiatives and programs have been launched at national and provincial levels, as well as by higher education institutions, to address concerns such as underqualified teachers and a lack of students choosing mathematics and science-related topics.

Several universities initiated the bridging courses which aimed to improve the gratified knowledge of mathematics and physical science students in getting into university, it has help in some ways (Emmeline, 2020; Gordon & Nicholas, 2012). The fact that quite several issues influence the teaching and learning of mathematics and physical science in the South African high school system is simply why several universities initiated the bridging courses. There is a link between the availability of the content knowledge of the scientific instructor and the academic performance of the students (SACE, 2010). Teachers, according to Mwenda et al. (2013) and the SACE (2010), play a critical role in the effective delivery of the curriculum. This necessitates their being well-trained to effectively disseminate the material, as Lebata (2014), Spaull (2013), Ihejieto, and Nwokedi (1993), emphasize when they remark that the quality of education cannot exceed the quality of a teacher.

Furthermore, research suggests that teachers or qualified teachers who are unfamiliar with the nature of the disciplines that must be taught (mathematics and physical science) create bad results (Lebata, 2014; Ogbonnaya, 2011; Dekkers & Mnisi, 2003). According to other research, there are still a considerable percentage of teachers that are underqualified or untrained to teach science courses (Modisaotsile, 2012; Cho, Scherman & Gaigher, 2012; Makgato, 2007; Makgato & Mji, 2006). Under-qualified teachers are unable to handle scientific equipment and, as a result, are unable to conduct science practical investigations with students due to a lack of practical inquiry abilities (Ogbonnaya, 2011; Muwanga-Zake, 2000). Muzah (2011), agrees that inexperienced teachers who merely studied science in high school and did not concentrate in science during their education lack scientific expertise. Because teachers only teach what they know at this level of schooling, they are unable to introduce students to effective scientific knowledge (Muzah 2011). This nature of teaching may as well lead to failure in the exams since some of the substance was not communicated to the learners (Ogbonnaya, 2011), maybe some of the teachers cannot teach the kind of mathematics and physical science.

In addition to a shortage of trained teachers, South Africa continues to struggle with qualified teachers who are unable to teach their subjects. There is also a requirement to specify the type of substance that science teachers demand. A few scholars,

(Sheperd, 2013; Dhurumraj, 2013; Ogbonnaya, 2011), have claimed that science teachers require specific forms of content expertise. However, most of them felt that content knowledge and pedagogical skills went hand in hand (Sheperd, 2013; Kennedy, 1997). Ihejieto and Nwokedi (1993), as well as Turnuklu and Yesildere (2007), support the concept that content knowledge must be combined with pedagogical abilities to be successful in teaching. Ihejieto and Nwokedi (1993), go on to say that educators should be trained in both content knowledge and pedagogical abilities.

Even though this has been indicated, Ball, et al. (2008), found that less attention is paid to the requirement for teachers to comprehend the subjects they teach. According to one study, having big classes forces teachers to use a teacher centred teaching technique. As a result of allowing students to lead the teaching and learning process, it has practically become impossible for teachers to focus on each learner individually at the same time (Akinsolu & Fadokun, 2009; Setati, 2011; Yelkpieri, et al., 2012; Mwenda, et al., 2013; Dhurumraj, 2013). This generally means that science courses cannot be taught effectively in big classes, as it is a subject that requires a constructivist approach, which also requires students to be completely engaged with the material they are learning with the help of a teacher.

According to another study, doing practical investigations in big groups is difficult (Akinsolu & Fadokun, 2009). It is also possible that it's due to a lack of appropriate science materials and room to accommodate the learners (Yelkpieri, et al., 2012). mathematics and science are critical subjects that require much practice. This implies that there ought to be much written work that is evaluated and curative procedures to the evaluated work to be offered, that is, if the learners encounter problems. However, noting the above, that type of assessment or evaluation becomes problematic in large classes as a result that these teachers have excessive workload and this limits them not to be able to regularly assess the learners (Yelkpieri, et al., 2012; Akinsolu & Fadokun, 2009). Perhaps, furnish them with constructive criticism on the learner’s work in time (Yara & Otieno, 2010).

Because of the apparent delay in providing feedback to the students, they will be unaware of their issues. This is likely to have an impact on existing knowledge about the work. This means that the students go on to the next section of their work without having a complete understanding of the preceding task. Teacher's low motivation could be a problem, because it is only when teachers are highly motivated, they cannot perform to their best capacity. Motivation of teachers, as defined by Woolfolk (2013:430), is, "an internal state that arouses, directs and maintains behaviour". Extrinsic motivation is triggered by external dynamics or elements other than the job at hand, such as punishment, rewards, and so on, whereas intrinsic motivation is initiated by interest in the activity at hand (Woolfolk, 2013).

2.7. MOTIVATION POSSIBILITIES OF ATTRACTING MATHEMATICS AND PHYSICAL SCIENCE TEACHERS TO ACCEPT EMPLOYMENT IN THE RURALBASED HIGH SCHOOLS

Discussion on the motivation possibilities of attracting mathematics and science teachers, to accept employment in the rural-based high schools of King Cetshwayo district, it is believed that motivating teachers is very imperative towards achieving academic success. Academic success for a learner is vital because it motivates learners, as a motivated instructor is enthusiastic about his or her job (Mart, 2013; Chux, et al., 2013; Makgato, 2007). Tsanwani, et al. (2014), agree that learners must be 'motivated and interested' in what they do in order to succeed in science, and that the environment in which teaching and learning takes place must be conducive to learning. However, teacher motivation remains a problem all around the world (Vassallo, 2014). As a result, numerous factors influence teacher motivation. Individual, internal, institutional, and other school elements can be categorized into these categories. The factors that affect the availability of teachers are discussed later in this study concerning mathematics and physical science subjects and vice-a-visa physical science teachers.

Having a passion for teaching is a motivating feature that leads to a teacher's commitment to his or her schoolwork and, as a result, good grades (Mart, 2013), Science disciplines necessitate a lot of passion on the part of the teachers, since they

must spend their time guiding the learners through the tough, uninteresting, and unimportant concepts of science. They must make them intriguing (Lebata, 2014). Mathematicians and physicists have frequently lost interest in the subject due to a variety of factors, including a lack of career options in the education sector and low pay (Mart, 2013). Poor working conditions, work overload, cultural obstacles, a lack of recognition, communication barriers with learners, and a lack of cooperation are all examples of poor working conditions (Chux, et al., 2013; Mbajiorgu, et al., 2014; Vassallo, 2014; Muzah, 2011).

The difficulties that cause teachers to be unsatisfied with their professions, which can lead to increased absenteeism, an increase in emotional problems, and even leaving the field (Vassallo, 2014). This can have an impact on the teaching and learning process since the lack of a teacher causes learners to fall behind in their coursework, and if teachers leave the industry, there will be a shortage of science teachers. This may result in loss of interest by the learners in the critical science subjects and hence lead to poor performance. Acharya (2017), notes that mathematics is one of the most significant subjects in human life, because, without the knowledge of mathematics, nothing is said to be possible in the world. Currently, mathematics and physical science as critical subjects are globally accepted but remain locally impractical.

Mathematics has been acknowledged as a key component of formal education from the ancient period to the present day, according to scholars like Acharya (2017). According to Acharya, (2017), "ancient scholars developed mathematics practically being forced to solve day-to-day problems, [and] …great shepherds developed mathematics in the ancient period".

According to the National Research Council (1989), learners tend to learn with understanding when they can construct their mathematics understanding and that this supportive knowledge requires them to “examine, represent, transform, solve, apply, prove, and communicate”. Debatably, mathematics is a meaningful subject in human life, as it has emphasized the corresponding language, many learners have failed in mathematics because they see it as a difficult subject and most learners particularly from rural-based schools fail in the subject (Acharya, 2017). This problem has become

a concern, capital strength and manpower of the state, the subject matter which is why this study is particularly aimed at examining the complexities in the availability of mathematics and physical science teachers in rural high schools within King Cetshwayo District, to also understand what factors are responsible for the low rate performance of learners in the district high schools.

2.8. THE EXTENT TO WHICH AVAILABILITY OF PROFESSIONAL MATHEMATICS AND SCIENCE TEACHERS IN THE RURAL HIGH SCHOOLS AT KING CETSHWAYO DISTRICT

In South African schools, learners have been seen to perform below par in comparative tests of physical science and mathematics internationally and at the regional level and even at local benchmark texts. This seems to be true for both primary and secondary school ranks, according to the Academy of Science of South Africa (ASSAf) (2010), there is an averaged result mask of a very wide disproportion between learners. That is, “a small minority continue to make significant progress in these subjects, while the majority fail to perform at appropriate levels” (ASSAf, 2010). As such, the collection of prospective engineers, scientists, future teachers of mathematics and physical science and health practitioners remain severely limited. This, therefore, reduces the ability of South Africa to be internationally competitive, which in turn impact its ability to provide the foundation or structure needed for the wellbeing of the South African majority.

Crewe (2010: 7), states that 2009 was seen to be a seminal year for the South African education system as the first recipients of the new “National Senior Certificate (NSC) entered higher education, and in larger numbers than in the past”. The learners were the first recipients of the program, having completed 12 years of post-apartheid schooling with an outcomes-based curriculum. According to Crewe (2010), outcomes-based education was chosen as the educational principle that would underpin the new curricula, allowing every South African child to reach his or her full potential. In contrast to the teacher-cantered, passive learning exercise or system that had become prevalent in South African education in the past, it is believed that identifying the outcomes to be achieved at the end of the learning process could help to encourage a learner-centred and activity-based approach to education.

According to Grayson (2009), most of the required continuous professional development (CPD) activities in South Africa take place outside of school, with most subject advisers and teacher education professionals from various institutes of higher learning taking the lead. Little (2012), argues that school-based continuous professional development activities ought to be at the core of teacher learning and it must also be linked purposefully to be in coherence with other external continuous professional development activities. So, why is it that teachers' learning cultures are being targeted as school-based continuous professional development (CPD) activities in mathematics? The first reason is that schools are in the midst of teaching and learning in rural regions, where the pressure to attain quality teaching and learning is felt directly (Darling-Hammond, 2017), and they are evaluated as having failed or succeeded (Woodland & Mazur, 2015).

The second reason is because the teacher's learning culture is school based as continuous professional development implies that a teacher who is teaching in a classroom is directly involved with the CPD that the teacher receives. And that "understanding and utilizing a school's learning culture" can make a difference by improving teachers' learning, resulting in increased job satisfaction and wellness (Postholm & Wge, 2016). Lesson study represents a strong relationship between practice and teachers' requirements, according to teacher learning culture as continual professional growth as a social learning process (Koellner & Jacobs, 2015). Hadfield and Jopling (2016: 205), posit that the nature of the lesson study “cycle makes it sensitive to how practice issues are constructed, and improvement is defined in a specific context”. As mentioned in the last chapter, there has been a great deal of concern over South African students' academic achievements in the high-stakes National Senior Certificate (NSC) examinations.

This is especially true in the case of students whose schools are perceived to be weak in the sciences. The failure to provide quality mathematics education for South Africa's varied population is one of the most prominent problems facing the government in the post-apartheid era (Crewe, 2010). According to Heneveld and Craig (1996:13), the word ‘quality’ concerning education, refers to, “both changes in the environment in which education takes place and the detachable gains in students’ knowledge, skills

and values". In general, according to Taylor (2008), South African children are exposed to lower-quality teaching than children in poorer neighbouring countries, particularly in mathematics in the Foundation, Senior, and Further Education and Training stages. South Africa school learners often perform poorly on the international comparisons of educational achievement in mathematics and physical science.

Spaull (2013), highlights the Trends in International Mathematics and Physical Science Study (TIMSS) that was conducted in 1995, 1999, 2002 and 2008, at Grade 8 level which showed that South African learners underperformed significantly. This is "in comparison to those of other participating countries, and that the improvements achieved in the years 1995 to 2002 were statistically insignificant" (Spaull, 2013). Nevertheless, the Trends in International Mathematics and Science Study shows that, "between 2002 and 2011 there was a huge improvement in mathematics scores for Grades 8 and 9, South African learners' performance continued to lag behind those of learners in other middle-income countries" (Crewe, 2010). While several dynamics have been described concerning the performance of learners in mathematics, the argument is that the learners' experiences in terms of background, as well as the quality of the teaching (teachers).

The following are the most important aspects that influence the quality of education received in the King Cetshwayo district's rural high school. According to the Organisation for Economic Co-operation and Development, there are, "factors that have to do with teachers and teaching which the most important influences on pupil learning are" (OECD, 2005: 2). A view shared by Barber and Mourshed (2007: 12), is that, "the main driver of the variation in pupil learning at school is the quality of the teachers", and, "the quality of the education system cannot exceed the quality of its teachers". Mourshed, (2007: 41) Further says, some lines of research which focused on high-school mathematics and physical science teachers in South Africa shown that many of these teachers possess inadequate common content knowledge (CCK) and specialised content knowledge" (SCK). Fleisch,(2008), notes that "frequent and quality professional development activities are lacking, to name a few problems".

As the perception is said to be “true that teachers can learn from social gatherings, such as workshops and seminars outside the school (traditional CPD of teachers)” (Meirink, et al., 2009). According to Taylor and Reddi (2013), in the context of South African mathematics and physical science education, the quality of mathematics teaching in disadvantaged communities remains inadequate. Given the importance of changing teacher learning cultures and continuing professional development activities for mathematics teachers, especially those from underserved schools, it is reasonable to conclude that school-based teacher learning can contribute to teachers' learning culture as a profession in these schools. According to Dudley (2015), research has shown that teachers frequently choose the wrong case learners, that is, whatever they expect about these students is frequently erroneous, as indicated by the findings of the research study.

In certain instances, Vrikki, et al. (2017: 6), note that, “all four stages of the research teachings are audio- and video-recorded, intending to share the clips in the future”. The goal of study experience observation, according to Schipper, et al. (2017), is to watch the learners' learning in the context of the topic being taught, rather than the teaching itself. Therefore, observing learners’ learning should be at the heart of experience-based teaching because it provides a rich narrative or “detailed depiction or representation of the effect of the study lesson on learners’ thinking and cognition” (Dudley, 2015:10).

Teachers should be encouraged to provide a learning atmosphere in which learners can communicate and share their ideas when answering questions or completing activities. This besides initiating a general class discussion of learners’ works, is expected to assist learners in building social networking between mathematics concepts and topics.

> *In the background of teaching mathematics in disadvantaged or rural based schools in South Africa, such as King Cetshwayo district, a study lesson as a form of continuous professional development can be initially co-implemented by both the mathematics teachers, teacher educators,*

*and subject advisors as well, however, this is not a prerequisite (*Dudley, 2015: 10).

Nevertheless, Leavy and Hourigan (2018), advise that, “at the commencement of the study lesson, the group of teachers ought to have a very clear focus on what they need to improve as far as learning is concerned”.

2.8.1. Physical Sciences and teacher learning culture in Rural Based-high School

Physical Sciences as a teaching subject in South African rural high schools is a complex topic that includes both physics and chemistry. In a perfect world, a physical sciences subject teacher in South Africa would be equally skilled, qualified, and at ease teaching both topics. However, the current situation in rural high schools does not appear to be in keeping with this goal. However, the apparent role of a scientifically motivated, “young generation is undeniable for the sustainable economic growth of any country” (John, 2019: 3). Among the various science subjects including mathematics and physical sciences in the South African school curriculum, it is noted that physical sciences have a conspicuous role in defining learners' acceptability into various in-demand university degrees with a specific field in science and technology.

Despite its importance to the country's economic progress, John (2019), claims that South Africa has always been hampered by its students' weak performance in physical sciences. This is true at both the national (as evidenced by matric exam scores) and international levels (achievement tests such as Trends in International Mathematics and Science Study [TIMSS]). Furthermore, in South Africa, confusing student performance is frequently isolated to Black and Coloured schools, while performance in historically White and Indian schools remains considerably above the national average. This situation was confirmed by Van der Berg, (2008), to constrains both Black upward mobility in, “the labour market and the skills required for the economic growth of a middle-income country like South Africa” (Van der Berg, 2008).

It further confirmed that the education system in the rural-based high schools in South Africa faces a unique set of challenges, according to Nkambule, et al. (2011), this is attributable to a variety of factors, including the schools' geographic location, learners' backgrounds, and learning styles. The South African Department of Basic Education (DBE) established a Rural Education Policy to address the issues. The policy aims to improve access to education as well as the quality of education for all students in rural schools (DBE, 2017). The strategy designates rural areas, such as farms and traditional lands, as those with low population densities, low economic activity, and inadequate infrastructure. According to the DBE (2017), the policy outlined that “despite several pro-poor initiatives, which have been implemented since 1994 to promote equity and quality of education in previously disadvantaged schools including rural schools”,

> *Many rural schools are still characterised by inadequate resources, teacher shortages, absenteeism, learners' dropout from school, and poor educational outcomes* (DBE, 2017:8).

The most challenges that are often experienced among rural schools generally are not restricted to South Africa and other developing countries, in advanced countries like the United States of America, teachers in rural schools are burdened with various tasks, including teaching multiple topics and ability levels. This according to Howley, Rhodes and Beall (2009), “is often pooled with unsatisfactory mentoring, lack of administrative inaccuracy, and insufficient pay”. Many rural-based schools' teaching strategies may limit learners' options for personalized acceleration and remediation. “Education literature on rural-based high schools repeatedly depicts or mirror a picture of rural schools as being distantly located that service the communities with high poverty, declining populations, and limited economic opportunity” (Redding & Walberg, 2012: 4). The well-known challenges that usually inhibit effective teaching and learning in rural-based high schools across the world, may lead to rural communities that have limited access to economic development.

> *"In South Africa, quite a number of attempts have been made to explore learners' low performance in both physical sciences and mathematics, one such study was conducted in the Gauteng province which described learners' and teachers' views about the factors which often lead to poor performance in physical sciences and mathematics"* (Makgato and Mji, 2006).

Many direct and indirect effects were found to be impeding South African learners' performance in the critical disciplines of mathematics and physical sciences in the study. According to the Eastern Cape Department of Education (ECDoE), the province's matric pass percentage has climbed marginally from 56.8% in 2015 to 65.1 percent in 2017 (ECDoE, 2018). However, considering the fact that the Eastern Cape Province has traditionally been associated with high levels of unemployment and illiteracy in the country (ECDoE, 2015). This necessitates extensive investigation at the provincial level, particularly in a rural setting.

As a result of the numerous factors that have been identified as contributing to poor performance in South African schools, outdated teaching methods such as the lecture technique, which is prevalent and chosen by many teachers, especially in subjects like physical sciences, have become a source of serious concern. This is claimed to emphasize the importance of subject-specific teacher education and training provided by South African institutes of higher learning. According to Islam (2012: 7), during the apartheid era "little provision was made for the Black majority to have the required number of quality teachers; the teacher training was done in racially-defined institutions to serve the needs of specific geographic areas, race, and ethnicity". Even as far as after the dawn of democracy, the status quo seems to remain in the education system, which was mostly in rural schools in South Africa.

Samuel and Stephens (2000: 12), articulate that, "the pre-service teachers themselves bring to the course their heritage of experiences of primary and secondary schooling". Nespor (1987), notes that, "teachers' classroom practices are affected by their own experiences of schooling, particularly for their previous interactions with their teachers".

As a result, the above shows that allowing pre-service teachers to disapprovingly reflect on their backgrounds and circumstances is oppressive. The preservice teachers' reactions and perspectives on their newly acquired abilities can then be used as a starting point for familiarizing the teacher training curriculum with the stated needs of the community in which they plan to serve in their professional capacity. Samuel and Stephens (2000), focus on the lives of two pre-service teachers who had wanted to become English teachers in the Kwa-Zulu Natal province, which is of a similar nature.

Though this is a promising start, the analysis of only two schools' settings cannot be claimed to be conclusive enough to provide a bigger picture of existing backdrops in South African rural-based schools. Furthermore, because several of the issues are primarily encountered by education systems in rural areas, it is appropriate to conduct additional research into the contexts in which rural-based schools specifically function. Also, if the rural communities across the world are to be reinforced, White and Reid, (2008: 6), articulate that teacher education programmes will, “need to prepare graduates specifically for teaching in rural schools”. Supporting healthy rural based community schools should be seen as a separate call, with teacher education programs being restructured not only for rural-based teacher education institutions but also for ‘metropolitan-based institutions’. As a result, Gruenewald's (2003) educational method of cultivating place-consciousness among ‘pre-service teachers’ might be considered an important aspect in fostering healthy and prolific rural communities around the world.

Furthermore, because learning cannot be separated from the environment in which it occurs, it is critical to investigate the contextual dynamics that influence mathematics and physical science learning, as well as the teaching process in rural schools (both positively and negatively). Keeping in mind the above background factors, this study aimed to offer suggestions to pre-service teachers an unintended critical reflection on their rural-based school backgrounds and perhaps listen or hear about their perception on the fundamental teaching and learning of physical sciences in the rural-based high schools in the King Cetshwayo district in the KwaZulu Natal province. Concerning the selection of basic information for subjects such as physical science, the question; is the selection of core content appropriate and adequate?

There appear to be common concerns that necessitate finding a way to evaluate the characteristics of performance in physical sciences syllabuses in grades 10 and 11. To begin, the question of overloaded content necessitates some form of pruning. The fundamental content for the course, which includes ‘big ideas in physics and chemistry’, must be carefully identified. Second, the investigation's cognitive level must be judged appropriate and should be at the appropriate level. There was considerable agreement that the abilities presented in the curriculum paper should be judged sufficient and adequate. The main question was whether the investigations did a good job of evaluating them. The learning outcomes will be argued further, while general observations will be emphasized on a scientific investigation, although this idea will be weakened by what is known as a ‘problem-solving strategy’. And this isn't in a practical setting, therefore it's referred to as a multi-step goal, a slippery word that may apply to all three learning domains.

It is, therefore, safe to agree to the notion that the instructional practices in the rural based high schools in South Africa, may restrain learners’ opportunities for the acceleration and remediation individually. As Redding and Walberg (2012), point out, education literature on rural schools frequently presents rural schools as isolated locations serving communities with significant poverty, dwindling demographics, and little economic opportunity. Again, there are pervasive concerns or challenges that are believed to obstruct good teaching and learning in rural schools all over the world, which may result in rural populations having limited access to economic development. Nonetheless, the perspective on the topic of preservice teachers' learning experiences could be used as a springboard for adapting a teacher training curriculum to meet the specific needs of the diverse communities in which they plan to serve the people in their professional capacity.

In this study, the moralities of a critical pedagogy of place are guided by the ideas of social constructivism as the framework, which claims that knowledge is constructed via social interaction, understanding, and interpretation (Vygotsky, 1962). As a result, the social environment in which knowledge is generated cannot be separated from the

base of knowledge (Adams, 2006; Woolfolk, 1993). Though the school and home environments are going to form part of the child's learning process, this study intends to remain on course by mainly concentrating on the complexities in the non-availability of mathematics and physical science teachers in rural-based high schools, within the King Cetshwayo District.

2.8.4. Environmental Factor to Learner's Low Performance in the Rural Based Schools

In determining how the immediate environment might contribute to good teaching and learning methods of both mathematics and physical sciences subjects in rural-based high schools. The above factors are thought to have an impact on both mathematics and physical science learning, performance, and teaching methods in rural schools. physical science is taught and learned in rural high schools through a variety of approaches. Legari (2004), observes that the primary distinction is influenced in part by the school environment in which the teachers work. Considering this, the scholar goes on to say that most researchers who study school resource shortages focus their efforts on issues such as a lack of adequate equipment, large classes, teacher qualifications, and extremely under-resourced school environments, such as a lack of water, electricity, and sanitation (Legari, 2004).

Most of the time, the emphasis is placed on the above to the point that the situations outside the schools, and possibly even in the surrounding communities, are overlooked, even though they may have a direct or indirect impact on what is going on in the schools. Diverse studies in the subject of education in South Africa have shown that most schools are under-resourced, particularly when it comes to teaching and studying mathematics and physical science. The HSRC's Third International mathematics and Science Study is an excellent example of this type of research. According to the HSRC (2002) study, approximately half of the schools surveyed thought that a lack of materials and equipment impacted mathematics and physical science instruction. According to the Department of Education (DoE), most schools that offer mathematics and science classes have a big problem with facilities such as laboratories and equipment that facilitate successful teaching.

Science's impact on the future of civilization is expected to be substantially more far reaching than its influence on human affairs in the past. “Some of the pressing problems of society today are related to the rapid decline in the quality of the global environment, depletion of natural resources, increasing poverty, hunger and illiteracy in many countries and regions of the world” (Kaptan & Timurlenk, 2012: 764). Science and technology-based solutions are likely to address some of these issues, yet science and technology as we know them today are not available to a huge section of the human population. Science and technology have primarily led to human satisfaction, community well-being, and national wellbeing in the industrialised world (Kaptan & Timurlenk, 2012). A large proportion of the world's population does not appreciate technology, its applications, or the potential for economic and social growth.

There is a tendency to be enthralled by technology items that can bring about a brief period of affluence. However, true growth in all countries, particularly industrialized ones, requires a thorough understanding of technological innovation and how science and technology are linked to society (Boakye & Ampiah, 2017). Today, such awareness is hampered by the obstacles that stand in the way of the exchange and application of science and other expertise used to make decisions and choices. Sewell & Burger (1998: 3), assert that in South Africa, “we have acknowledged that resources are a problem for Science Education”. Rapid developments in science and technology recently developed social and cultural expectations and beliefs, improvements in the climate and atmosphere, as well as natural resource degradation, all have a significant effect on the lives of children and adolescents, and therefore their ways of studying, seeing the world, observing phenomena surrounding them, and engaging with others.

Kim & Kim (2012), articulate that, these changes challenge science educators to rethink the epistemology and pedagogy in science classrooms today as the practice of science education needs to be proactive and relevant to students and prepare them for life in the present and in the future. According to Information Communication Technology Focus; *“*The foundation for this kind of condition has arisen from grave inequalities of access in the provision of services and opportunities between black and

white schools during the apartheid era in South Africa" (ICT Focus, 2002). It was also stated that prior to 1994, 'white education' received more than 90% of the state's education budget. The remaining ten percent was divided among the other groups (Coloured', 'Asian', and 'Black') (ICT Focus, 2002). Black students are believed to make up most of the student body in all of these schools. The scarcity of mathematics and science educators is also a serious issue, as it impedes capacity growth and human resource development.

According to the Department of Education's National Strategy for Mathematics, Science, and Technology (DoE, 2001), only a small percentage of Grade 12 students choose to teach mathematics and Science as a career. As a result of a lack of qualified subject-specific teachers, schools may be under-resourced, or they may have a shortage of qualified teachers for mathematics and physical science subjects. The basic argument is to critically look at the complexities in the non-availability of mathematics and physical science teachers in rural-based high schools, within the King Cetshwayo District. While it further considers the various conditions that are responsible for learner's low performance in rural-based high schools, considering the surroundings where the schools are located as a factor in the rural areas. In terms of available literature in this area of study, there is limited literature available which are not as much as another study that mainly focuses on the conditions of the school alone.

There appears to be common study on the impact of disadvantaged communities on education as well as the schools in the areas, but the two do not appear to be effectively integrated. Few earlier studies in South Africa have been able to successfully combine the challenges of disadvantaged communities with school instruction, such as those performed through the Nedlac Summit (1999). Along with Malcolm, et al. (2000). The Nedlac Summit (1999), commissioned a statement on the Challenges Facing Public Education, which focused on schools, particularly those in rural areas, that are plagued by a lack of resources and disadvantaged communities (further aggravated by generally low morale amongst the teachers). The study conducted by Malcolm, et al., (2000), dealt with the problems of 'working together towards enhancing successful schooling' in poor communities, which they identified as one of the factors responsible for learner's poor performance in rural schools. It may matter less if schools have

sufficient resources or not, mathematics and physical science are not one of the easiest learning areas to teach.

Over the past few years for instance, “the pass rate of mathematics and physical Science matriculants has been very low” (DoE, 2001: 3). Other stakeholders typically see teachers as the ones who can permit an appropriate learning atmosphere and program, despite issues of resources and conditions in rural-based schools in accordance with their diverse communities. Furthermore, for the teaching and learning process to be effective, teachers in rural schools frequently find themselves with many tasks to play in the education and academic growth of students. They are apart from that responsibility that is directly associated with teaching in the classroom. The roles include trying to meet the requirements of teaching and learning science subjects (mathematics and physical sciences), while thereby weighting other tasks that are enforced on them by the school as well as learners from various family backgrounds.

2.9. Conclusion

This chapter began by introducing the chapter as a literature review, then went on to discuss the state of physical science and mathematics in South African schools today, which has been frequently characterized as a national emergency. The reviewed literature showed that in comparative tests of physical science and mathematics, learners have performed very poorly both internationally and at the regional level and even at local benchmark texts. Findings from research conducted by the Academy of Science of South Africa (ASSAf) in 2010 confirmed this reality to be true at both primary and secondary school levels. The finding shows that there is an averaged result mask of a very wide disproportion between learners in South African schools. Most learners fail to perform at suitable levels, while a minority of students continue to make substantial progress in certain subjects.

As a result, the pool of potential scientists, engineers, health practitioners, and future mathematics and physical science teachers is severely limited. This, therefore, reduces the ability of South Africa to be internationally competitive, which in turn impact its ability

to provide the foundation or structure needed for the wellbeing of the South African majority. The chapter continued by explaining the importance of theory-driven thinking, as its emphasis on the theoretical application of the study with the theory of social constructivism. Individuals' interfaces or interactions with their social-cultural milieu and the greater society, according to the notion, form social worlds. As a result, knowledge emerges through a process of communal compromise and evaluation of individual understanding's practicality.

Fundamentally, every conversation or interaction between two or more individuals often provides an opportunity to develop and acquire new knowledge, as well as an opportunity to broaden one's understanding. Teaching and learning as explained above are not without many problems as it was illustrated in the application of social constructivist theory, the benefits and as well as the shortcomings. The social constructivist paradigm emphasizes dialogue and negotiation, which invariably aid students in developing a greater self-awareness of real-world interactions and issue resolution outside of the classroom. "Students love this technique because they learn better and faster when they are involved in learning projects rather than rote memorization", says Gleeson(2019).

This strategy prepares pupils to work together in everyday situations. One of the most noticeable benefits of social constructivism is that it decreases, if not eliminates, learners' emotions of uneasiness and insecurity. This is clarified by the fact that social constructivism provides learners with a self-contained learning environment, which encourages knowledge sharing through cooperation and the development of cognitive skills through learner-centred practices. Many academics have lauded the theory of social constructivism in their numerous works, particularly in the sphere of higher education. However, there are unavoidable flaws in this theory, just as there are in any other learning theory. Thus, despite the indicated educational benefits of social constructivist theory, some scholars have articulated their opposition to what constructivism offers as benefits.

Some experts argue that constructivism isn't practical enough because some pupils with less prior knowledge can learn faster than others. However, in terms of learning, the constructivist method or theory tries to eschew direct instruction in favour of encouraging students' active participation in the learning process while under the supervision of the teacher. One of the benefits of this style of learning, according to some experts, is learner centredness – that is, an emphasis on student-centred learning, which may possibly be constructivism's most important contribution. This is seen to be highly helpful since, in a classroom-learning setting, learners might become more interested and joyfully active because cooperation and exchange of ideas with a team is a prominent component.

In the global view in understanding the world through mathematics, it is noted that mathematics in the global perspectives, acknowledges the fact the world has become interconnected, as everyday mathematics has been able to show these possibilities and connections. Scholars believe that all curricular areas, including mathematics, have a comprehensive global component that may be conveyed in the classroom. This is repeated over and over in the area that many people find the most difficult to comprehend as being global: mathematics as a topic, aids in the understanding of the world, while people utilize the world to understand mathematics. This chapter also looks at how mathematics and physical science are taught in South African schools. It finds in the literature that the reform and modification in education and the teacher-training programmes, as well as school curriculum, there seem to be yet many challenges that are facing mathematics education in South Africa. There is a strangely low achievement of children in mathematics.

Everyone has been concerned about children's low performance in mathematics and physical science throughout the foundation period. This is because foundation phase teachers play a critical role in the teaching and learning of mathematics in schools. There has been a remarkable amount of concern in Africa when it comes to addressing the issues of teaching mathematics and physical science. Regarding South African learners' academic performances in the high-stakes National Senior Certificate (NSC) examinations, with a focus on the performance of learners from low-income schools, one of the concerns that the South African government has encountered in the post-

apartheid era is the country's failure to deliver quality mathematics and physical science education to its 55 million varied population.

The chapter further examined how the immediate environment can be a factor in the rural-based high schools, which could contribute to the non-effective teaching and learning method of both mathematics and physical sciences subject. In rural schools, the elements are thought to effect both mathematics and physical science learning, performance, and teaching methods. physical science is taught and learned in rural high schools through a variety of approaches. The key distinction is influenced in part by the educational environment in which the teachers work. Considering this, most academics that study school resource shortages focus their efforts on concerns such as a lack of adequate equipment, huge classes, teacher qualifications, and very under resourced school environments, such as a lack of water, electricity, and sanitation.

CHAPTER THREE

THEORETICAL FRAMEWORK

3.1. INTRODUCTION

The previous chapter introduced the background of the study with its aim and objectives, the research questions and significant of the study. The current chapter look at the theoretical framework of the study. The study adopted the social constructive theory to examine the cause and impacts of learners' low performance in critical science subjects such as Mathematics and Physical Sciences in the rural-based secondary schools. Furthermore, the aim of this chapter is to further explore the application of social constructive theory with availability of information and strategies related to the complexities in availability of mathematics and physical science teachers in rural high schools within the King Cetshwayo district in the KwaZulu Natal province. This chapter presents the theoretical framework underpinning the study and the application of the social constructivism theory. It also outlines the benefits and limitations of social constructivism.

3.2. THE THEORETICAL FRAMEWORK

The theoretical framework can be referred to as part of a study that sets out the term of the research question and the line of inquiry and method used to answer it (Ocholla & Le Roux, 2011). The theoretical application of constructivist theory to this study, explains the importance of theory-driven thinking emphasis on the chosen theory, concerning the selection of the theory. The development of research questions, the conceptualization of a literature review, the design approach, and the study's analytic plan is a list that was given by Grant & Osanloo, (2014). Therefore, theory serves as a lens that a study applies to survey a certain aspect of the study (Ocholla & Le Roux, 2011).

3.3. Social Constructivism theory

A few psychologists, including Jean Piaget (1960), Lev Vygotsky (1978), and Jerome Bruner (1980), have contributed to the development of constructivism theory (1996).

According to social constructivism, peoples' social worlds emerge from their interactions with their social-cultural milieu and the greater society (Teater, 2015). This suggests that knowledge develops because of social concessions and assessments of individual understanding's utility. Every interaction between two or more individuals often provides an opportunity to develop and acquire new knowledge, as well as an opportunity to broaden one's understanding. Social constructivism is concerned with the give-and-take or interchange of concepts and ideas that occurs because of human encounters. Social constructivist theories are concerned with the construction of reality and how individuals perceive the world (Teater, 2015).

Phenomenology and philosophical conceptions of what is real and what is socially produced affect social constructivism theories. Berger and Luckman (1966), who investigated reality creation and the effect of individual meaning constructed on life involvements, societal and cultural anticipations, or beliefs, rules, and norms, coined the term ‘social constructionism’, and laid the groundwork for today's social constructivist theories. Since then, theorists, such as Teater (2014), have developed social constructionism into a more precise theory that stresses either individual or social processes in the construction of reality. According to Teater (2015), constructivism maintains that reality is shaped more by one's biological factors, such as developmental processes, cognitive structures, and the human mind, than by external forces.

By stressing reality building on both societal and biological variables, social constructivism combines social constructionism with constructivism (Atatah, et al., 2016). The formation of reality is being influenced by both nature and nurture. Social constructivist theories have bolstered several commonly used theories in the social sciences (Atatah, et al., 2016). As a result, teachers and school administrators must not only adapt but also reshape their outlooks and general viewpoints when adopting social constructivism ideas in the field of education. In this setting, high school instructors and leaders must transition from being ‘teachers’, to ‘facilitators of learning in the educational system’ (Kim, 2001: 3).

In this scenario, a good constructivist teacher will question students' answers, regardless of whether they are correct or incorrect, to ensure that the student understands the concept. According to Atatah, et al. (2016), teachers should require students to explain their answers rather of simply allowing them to utilize words or equations without reasoning or elaboration for proper understanding. In addition to the foregoing, social constructivism believes that all knowledge emerges from social interaction and language usage, and hence is a shared rather than an individual experience. Knowledge in this regard, is also a result of numerous social processes and interactions, not only observation of the world (Can, 2009).

As a result, this research implies that constructivist learning characteristics give meaning to the learning process just as much as they do to the acquisition of new concepts or knowledge. Both the route and the destination are equally significant. In topics like mathematics and physical sciences, the teaching and learning process necessitates learners' active participation in creative activities and self-organization. Constructivism emerged as a critical theory in Europe and America in the 1980s, and it has since been applied to a variety of subjects. Social constructivism, according to Kim (2001), is founded on specific assumptions about reality, knowledge, and learning. Thus, in this study, knowledge transfer may be summarized as the identification, interaction, application, and integration of four aspects, with an emphasis on the objective of the knowledge being transmitted.

The transfer circumstance and “the interaction between transfer subjects, the critical aspects of knowledge being transferred, and the practicality of knowledge being received” (Kim, 2001: 3). The significance of the above argument therefore highlights a crucial element of knowledge transfer. The social learning constructivism theory is applied in this research. The two perspectives of this theory identified above will be applied to the study to trace the implication of science teachers to learner’s performance outcomes in rural-based schools.

3.4. The Application of Social Constructivism Theory

In the drive to understand the complexities in the availability of mathematics and physical science teachers in rural high schools within the King Cetshwayo district in the KwaZulu Natal province, this study adopted the social constructivist theory with the drive to improve standards of teaching and learning practice in the field of sciences. Few publications and conversations appear to seek to shift the focus away from performance and toward learning. Constructivism philosophy is frequently mentioned as a supporter of this endeavour. Constructivism, on the other hand, is not a single comprehensive philosophy of knowledge or teaching. In this phase of the study, the application of theory identifies one type of constructivist thinking, social constructivism, which is both correlated and epistemological (theory of knowledge) in nature.

The study examines current educational theories to show that many practical solutions and theoretical concepts can be marketed as 'excellent learning and teaching', and that they may have a lot in common with social constructivist thinking. Social constructivism theory (SCT) is a theory that recognises the use of social interactions and the environment in the learning process due to Vygotsky's concepts and theories. According to Brown (2000), social constructivist theories concentrate on interpersonal language communication. Brown (2000) explains that this style of learning is closely linked to how students engage with their peers, professors, and other members of society (Brown, 2000).

According to Vygotsky (1978: 98), "learning is a social negotiation of concepts and meanings using language to help others and solve problems". Individual notions of development and learning, according to Vygotsky's hypothesis, cannot be understood without reference to the social and cultural framework in which they are entrenched, (Can, 2009). The application of a cooperative learning technique, project-based learning, and discovery processes is at the heart of the social constructivism theory. To put it another way, these activities highlight the social character of learning, which allows most learners to contribute and share ideas from a constructivist perspective (Slavin, 2003).

3.5 Cooperative Groups Learning

When learners work in cooperative groups, for example, they can hear the inner voice of their more skilled peers while they strive to solve issues together; this improves their understanding more than when they work alone (Slavin, 2003). This notion, which is inspired from Vygotsky's theories, is referred to as 'cognitive apprenticeship'. "The process by which a student gradually learns competence by engagement with an expert, either an adult or an older or more advanced peer" (Slavin, 2003: 259). Vygotsky (1978), claims that learning takes place through dialogues between students or between teacher and students.

Another fundamental component of Vygotsky's theories of learning is facilitated learning, or scaffolding, in which the scholar stresses the significance of providing learners complex real-life tasks to accomplish with some help. Teachers, peers, or parents are the most common sources of assistance. According to Yang and Wilson (2006: 265), "the fact that these tasks need to be challenging to capture students' attention; besides, enough support is needed, otherwise students may give up easily". They go on to say that learners can learn as active members of society, and that the teacher is accountable for creating a conducive learning environment (Yang & Wilson, 2006). In addition, the notion of scaffolding is linked to the Zone of Proximal Development (ZPD) of students, which is concerned with the types of tasks that children may do if they are not supported through scaffolding practice (Vygotsky, 1978).

Social constructivism is based on "three main assumptions: reality (constructed through human activities), knowledge (a human activity that is socially and culturally constructed), and learning (a social process that takes place when individuals are engaged in social activities)" (Vygotsky, 1978: 3-4). Kim states "the general perspectives of social constructivism on learning" (2001: 5). In summary, the social constructivism perspective of Vygotsky emphasizes the cultural and social context for cognitive growth and development through learning. Vygotsky is convinced that social interaction plays an important role in cognition growth at the level of awareness and knowledge formation (Vygotsky, 1978).

3.6. Social Constructivist Approach and Teaching Skill

When discussing what social constructivism is, it is important to remember that communication is crucial to learning oral skills. However, for most learners, particularly among learners in the rural-based high schools, in terms of improving their performance rate in mathematics and physical sciences subjects, speaking, and involving in practical group work remains one of the most difficult skills to master (Beghoul & Chelghoum (2016). Most students participate in classroom activities very little or not at all. Even though teachers have utilized a variety of teaching strategies over the last few decades, research shows that speaking is still one of the four difficult abilities to master (Beghoul & Chelghoum (2016).

Teaching mathematics and physical science in a medium other than the learner's first language can be challenging, as it is a major component of the oral skill that requires more advanced techniques and methodologies (Beghoul & Chelghoum) (2016). Constructivism, according to Beghoul and Chelghoum (2016), is a learning theory that has influenced the area of education over time. Constructivism emphasizes the environment in which the learner constructs his knowledge, with the teacher serving as a guide or facilitator (Blyth, 1997).

Constructivism, according to Jin (2011), is an active learning process that tends to shift the focus away from the teacher and toward the students. This shift in mindset may place the student at the centre of the learning process, allowing them to understand various concepts based on their existing knowledge and experiences (Jin, 2011). Slavin (2003: 257), believes that, “the core concept of the constructivist theory is that learners must independently construct knowledge”. Can (2009) uses a constructivist perspective to emphasize the importance of content in learning. According to Can (2009), learners should be given a choice of content to examine issues and themes of their choosing, with teachers serving solely as guides.

3.7. The Application of Social Constructivism

With current technological advancements and a greater range of technological tools available for learners, using the theory of social constructivism as an approach. Teaching oral skills at a rural high school in the King Cetshwayo district using a social constructivist method. The context, where learners can interact with their teachers and as well as their peers during a class lesson, thereby helping to enhance their confidence and communicative competency. This is mainly that, in the certainty of many learners, the classroom becomes a place where interact with confidence, while speaking in English as a foreign language. Moreover, Beghoul & Chelghoum (2016: 8), suggest that “the use of some constructivist materials and resources such as the Internet can be considerably valuable used materials”.

In a similar vein, Can articulates that: "Constructivist approach is promising at promoting learners, language and communicative skills as well as at fostering their autonomy, social and interactive skills contributing to their development into more confident … Individuals who are proactive and accountable by supporting incentives in language learning and teaching using a variety of media" (2009: 60). As mentioned, in the past, the use of oral skill as a mode of learning was mostly teacher-centred, with the teacher bearing primary responsibility for class management and content or material selection. From a social constructivist perspective, the goal of implementing new pedagogy, sometimes referred to as ‘student-centred education’, is to create a flexible and supportive classroom environment.

According to Beghoul and Chelghoum (2016: 10), instead of being contained in, “a deep silence operating as only audiences to teachers and advanced peer involvement", every student might take an active role in real-life dialogues and express themselves more easily. To develop such an understanding, a set of constructivist methods are suggested to be adopted by the Department of Basic Education, as an attempt to primarily tackle students’ psychological issues of understanding and learning sciences subjects confidently. This is to emphasize that applying this suggested method which is ‘Group Work’ (GW), will hopefully diminish learners’ anxiety and lack of confidence in learning those critical subjects, on the one hand, while it will help to boost their

problem-solving skills in the classroom. This may help to address public critical situations elsewhere, in real-life.

3.8. Social Constructivist theory in Group Work

In the previous section, it was highlighted that in the social constructivist classroom, the focus is usually shifted from the teacher to the learners. In this case, the classroom has undergone modification. Those learners wait upon the teacher like an empty vessel ready to be filled up. In the applicable constructivist model in this study, the learner is encouraged or motivated to become actively involved in their learning process, both teachers and learners think about knowledge as a dynamic, everchanging perception of the world that we live in today. Having the ability to successfully explore and further stretch out that perception, not as inert factoids to be memorized. Adopting group work (GW), has proven to be an effective method for shifting learners' attention away from negative feedback and toward actual knowledge application. According to Shi (2013: 65), group work allows students to share information while also lowering anxiety levels. According to Beghoul and Chelghoum (2016), the teacher will be more likely to provide appropriate aid and guidance when needed.

Törnqvist compliments group work for being, “an activity that fosters students’ communicative skills through asking and answering each other naturally” (2008: 9). Scholars such as Törnqvist (2008), and Beghoul and Chelghoum (2016), have pointed out that learners create not only a bigger amount but also a greater diversity of language functions (for example, disagreeing, hypothesizing, requesting, clarifying, and defining) when working in groups. As a result, students learn English language use in pairs or small groups without even realizing it, without even realizing they are learning what should be taught and used in future interactions and social connections (Beghoul & Chelghoum, 2016). In other words, compared to the traditional approach to teaching and developing oral competence, learners are given more opportunity to practice the task in social circumstances.

In constructivism, cooperative and discovery learning is a basic practice that accelerates the learning process and increases students' excitement and

consciousness (Beghoul & Chelghoum, 2016). Discovery learning, according to Slavin (2003), arouses students' curiosity and drives them to strive harder until they uncover the needed explanations. In general, learners figure out what they are expected to do when they engage in discourse and ask their peers questions in a natural and appropriate manner rather than the old or traditional unnatural approach of questioning and answering. This will improve learners' cognitive abilities, allowing them to become more critical thinkers. Furthermore, the utilization of enjoyable activities, roleplay, debates, and discussions is an important element of a constructivist classroom. Encourage students to employ these activities in natural social contexts to help them learn to communicate more effectively (Jamila, 2014).

Teachers, according to Jamila (2014), must create a negotiation environment that encourages students to work together as a team, which boosts their self-esteem and reduces their anxiety. Mason and Syahrani (2013), state that in a group discussion, the learning environment is no longer stressful or dull because students are working and learning together. As a result of insufficient exposure to the target task and language culture, learning social and practical activities might be difficult. Finally, the use of group work for discussion, in this case, can become very instrumental as a better means to discern more about a particular task in solving an issue like mathematical problems.

3.9. Social Constructivist and Problem-Based Learning

In contrast to direct presentation of facts and concepts, problem-based learning (PBL) is a teaching style in which complicated real-world issues are utilized as the vehicle to promote student understanding of concepts and principles. Problem-based learning can help students acquire critical thinking skills, problem-solving talents, and communication skills in addition to course knowledge. It can also provide opportunities for collaborative work, which can lead to the discovery and evaluation of research materials, as well as lifelong learning (Duch, et al., 2001).

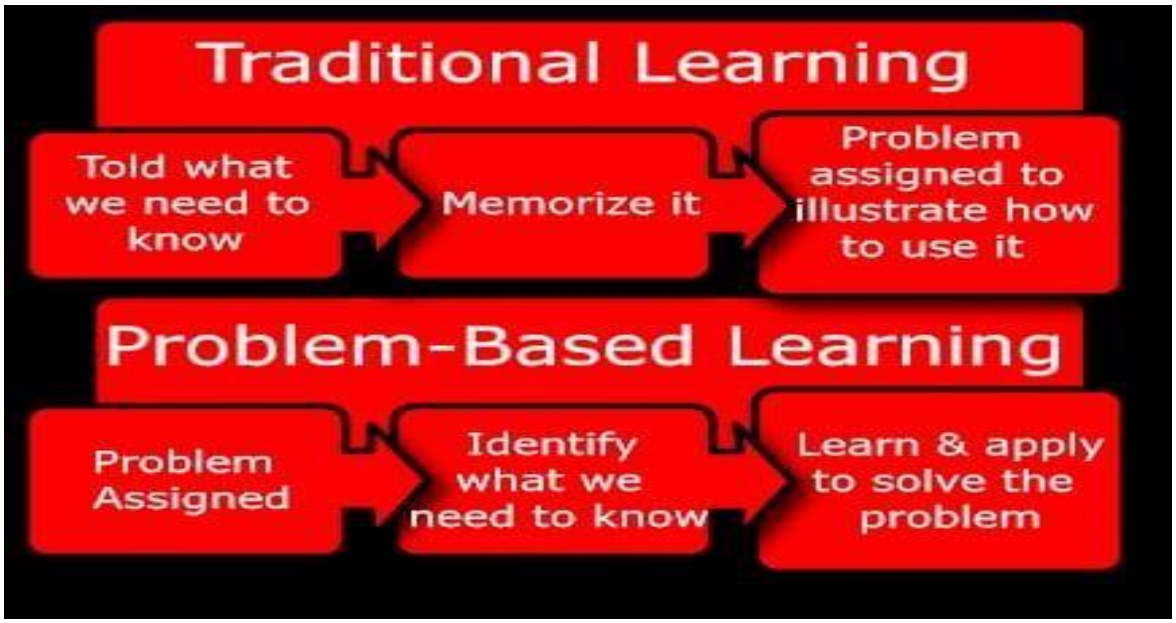

Figure 2: Traditional learning versus Problem-based learning

Source: *Nannini, (2017) pg9*

Figure 2 shows the differences between traditional learning and problem-based learning, the learning system, and its application. Any learning circumstance can benefit from the problem-based learning system. Problem-based learning is one of constructivism's strategies (PBL). Students learn through participating in a variety of problem-solving tasks, with the teacher simply providing essential assistance (Masrom & Syahrani, 2013). Problem-based learning has the potential to be very beneficial in several aspects, particularly because it is centred on the students, who are the only ones who can be responsible for their own learning and problem-solving methods through free communication. Instead of relying solely on the teacher's teaching, learners are given additional opportunity to deepen their learning independently with this technique.

It also aids in the development of critical thinking and cooperative learning skills through teamwork (Masrom & Syahrani, 2013). "English teaching aims to train the students how to use the language, yet this kind of ability will more quickly be developed on condition that the students are greatly engaged in the English language learning and immersed in an atmosphere of using the language" (Yang & Wilson, 2006: 270). In this situation, learners should be the primary speakers in the class, under the

supervision of the teacher, rather than passive listeners, allowing everyone to participate in a variety of tasks and activities.

3.10. The Benefits and Limitations of the Social Constructivism

The Social Constructivism approach has some benefits or advantages and as well as Limitations. In terms of learning, the constructivist method or theory aims to eliminate direct instruction in favour of active student participation in the learning process under the supervision of the teacher. One of the benefits of this method of learning is students' centeredness; they say, "a focus on student-centred learning may well be the most important contribution of constructivism" (Mvududu & Thiel-Burgess, 2012). This is seen to be highly helpful since, in a classroom-learning setting, learners might become more interested and joyfully active because cooperation and exchange of ideas with a team is a prominent component.

Social constructivism emphasizes dialogue and negotiation, which invariably assist students in increasing their self-awareness of real-world interactions and problem-solving outside of the classroom. Gleeson states that, "Students enjoy this approach because they learn better and faster when they are involved in learning projects than when solely through rote memorization" (2009: 5). Gleeson (2009) adds that this method prepares students to be collaborative in their daily life. One of the most noticeable benefits of social constructivism is that it decreases, if not eliminates, learners' emotions of uneasiness and insecurity. This is clarified by the fact that social constructivism provides learners with a self-contained learning environment, which encourages knowledge sharing through cooperation and the development of cognitive skills through learner-centred practices.

Many researchers have lauded the theory of social constructivism in their numerous works, particularly in the sphere of higher education (Masrom & Syahrani, 2013; Rhinehart, 2012). However, there are inescapable flaws in this theory, just as there are in every other learning theory. Despite the previously mentioned educational benefits or advantages, some scholars have expressed their opposition to what constructivism offers as benefits. For example, Masrom and Syahrani (2013) claim that constructivism

is not practical enough because some students with lower prior knowledge could learn faster than others. Students who are teacher reliant, according to the researchers, are individuals who have been overexposed to the traditional style of learning and are unable to switch to a new one that emphasizes independent learning and less reliance on teachers and specialized materials (Masrom and Syahrani, 2013).

If teachers want to challenge students and gain their attention, they can employ unsuitable items that can turn a boring classroom into a fun setting. Students learning in this kind of backdrop or circumstance will not be able to face highly demanding lecture-based teaching approaches, according to Gleeson (2009). Rhinehart (2012), who disagrees with constructivism, claims that the methodology's main flaw is its lack of structure. Some learners, in this scenario, require a highly structured atmosphere to assist them in acquiring knowledge and excelling. Another flaw in social constructivism is its self-evaluation and assessment, which may lead to learners disvaluing themselves because there are no precise ranking criteria, as there are in traditional techniques. This study adopted the social constructivist theory to understand and put things in the right perspectives.

3.11. CONCLUSION

Conclusively, this chapter began by describing the importance of theory-driven thinking and its emphasis on the theoretical application of the research with the theory of social constructivism, which states that individuals' social worlds emerge from their interactions with their social-cultural environment and the larger society. As a result, knowledge emerges through a process of communal compromise and evaluation of individual understanding's practicality. Every conversation or meeting between two or more individuals often provides an opportunity to develop and acquire new knowledge, as well as an opportunity to broaden one's understanding.

Teaching and learning as explained above are not without many problems as it was illustrated in the application of social constructivist theory, the benefits, and as well as the shortcomings. This, therefore, involves taking many challenges for both teachers

and learners. The implementation of the social constructivist approach based on Vygotsky‘s theories in teaching mathematics and physical science as a skill to learners in the rural-based high schools, cannot be but reliable because teachers act as guides to the learners. While the learners take active participation while learning through an interactional method, which is within a suitable learning classroom with a relaxed and collaborative environment, it is important to make such an atmosphere friendly. This will improve learners’ communicative skills immensely with problem-based learning practice and reduces their feelings of anxiety and lack of confidence, as they engage in group works and discussions.

The above concept is said to mainly encourage cohesion and teamwork, and therefore support students learning process rather than selfishness and egocentricity. Although it cannot be utilized as a complete learning system due to its weaknesses, however, it supports a learners-centred learning approach using a social constructivist method, which activates learners’ attention and inspires cooperative learning.

CHAPTER THREE

RESEARCH METHODOLOGY AND DESIGN

4.1. INTRODUCTION

The previous chapter presented the relevant literature that are related to the topic understudy. This chapter explains the research design and approaches adopted in the study in a quest to establish the challenges faced with the non-availability of teachers in the critical subjects (mathematics and physical sciences) in rural high schools in the King Cetshwayo District in KwaZulu Natal. The previous chapter presented the literature review and the theoretical framework of the study. This current chapter look at the research methodology and the procedures undertaken to conduct the research. Research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic. In research, the methodology section allows the reader to critically evaluate a study's overall validity and reliability. The methodology section answers two main questions: How was the data collected or generated? How was it analyzed? Denzin and Lincoln (2011) define research design as plans that will guide the collection of data and its analysis.

The study combines both exploratory and descriptive methods with a qualitative research paradigm. This method gave room to collect enough data on the challenges faced by secondary school learners with the absence of teachers in the critical subjects (mathematics and physical sciences) in rural secondary schools in the King Cetshwayo District in KwaZulu Natal.

4.2. RESEARCH PARADIGM

A research paradigm is an approach to piloting research that has been verified by the researchers for a long and that has been in practice for several years (Gerstenmaier & Mandl, 2001). There was a need to use the influential method of qualitative study, text analysis, to provide a literature review on the topic to enlighten researchers and teachers about the great imports, rich and valuable knowledge that they can glean from this vibrant model of philosophy. People shape or construct much of what they learn

by experience based on analogy or basis. Thus, for the constructivist, constructing sense is the only form of learning; there is no other. This eliminates the conventional idea of learning in a ‘chew, pour, and forget’ manner, resulting in examination-based learning with little to no opportunity to apply the gained knowledge in real-world environments (Adom, et al., 2016).

The constructivist theory depicts the notion that learning does not occur solely by the conventional approach of teachers standing in front of a class and lecturing. The constructivist believes that learning happens only as the learner seeks understanding in the spirit of discovery and doing. All research in qualitative “research is founded on some underlying philosophical assumptions about what constitutes legitimate" study and which research method(s) is/are acceptable for the advancement of knowledge” in each study (Martens, 2015; Chilisa, 2011: 4). It is therefore necessary to understand these assumptions to perform and assess any study. The philosophical assumptions and design methodologies that drive this research study are discussed in this chapter. The most “common philosophical assumptions were examined and presented”, the interpretative paradigm was chosen as the study's framework (Prochaska, 2017: 6).

Furthermore, the chapter describes the research methodology and design employed in the study, including strategies, instruments, and data collecting and analysis methods, as well as the study's stages and procedures. This study's research design is descriptive and interpretative case study that is analyzed through qualitative methods. Questionnaires were utilized to assess participants' WebCT abilities before to the commencement of the course and to gauge their degrees of satisfaction with the course (at the end of the case study). The student satisfaction survey was analyzed using a descriptive statistical approach. Data was gathered by participant observation, face-to-face interviews, focus-group interviews, questionnaires, and member checks. In addition, the rationale for each of the data gathering methods employed in the study was highlighted.

Finally, to assure the research's credibility, relevant qualitative research criteria were examined, and many approaches such as member checks, peer reviews, crystallization, and triangulation were recommended and afterwards implemented.

4.2.1. Paradigm

The research process is divided into three primary components: ontology, epistemology, and methodology. According to Searle (2015: 3); Chilisa (2005). A research paradigm is a comprehensive system of interconnected practice and thought that defines the character of investigation along these three dimensions. The term paradigm derives from the Greek word paradeigma, which meaning pattern, and was used by Thomas Kuhn in 1962 to refer to a conceptual framework held by a group of scientists (Chilisa and Preece, 2005: 4). This gave them a useful framework for analyzing issues and devising solutions. A paradigm as: “an integrated cluster of substantive concepts, variables and problems attached with corresponding methodological approaches and tools…” (Kivunja and Kuyini, 2017: 26).

According to him, a paradigm is a research culture comprised of a set of ideas, values, and assumptions shared by a community of researchers on the nature and conduct of research (Carpenter, 2013). As a result, a paradigm is a pattern, structure, framework, or system of scientific and academic ideas, attitudes, and assumptions (Jansen and Warren, 2020: 1; Mills, 2003). Ontological and epistemological elements are concerned with a person's worldview, which has a substantial impact on the perceived relative value of various parts of reality. There are two alternative worldviews: objectivistic and constructivist. These many perspectives on the world have ramifications in almost every academic field; nonetheless, none of these perspectives is regarded better to the other.

Both may be enough for certain uses while being insufficient or unduly complicated for others. A person's viewpoint might also shift based on the circumstances. For example, in this study, aspects from both perspectives are used and considered complimentary. (Mertler, 2005). Research paradigms are essentially reflective of our assumptions about the world in which we live and aspire to live (Sileyew, 2019: 1). Guba and Lincoln (1994) separate positivist, post-positivist, and postmodernist inquiry based on this premise, placing postmodernism and post-structuralism inside 'critical theory.' The nature of reality postulated by positivist is realism, in which a reality is supposed to exist; post-positivism, on the other hand, maintains that this 'reality' is merely 'imperfectly and probabilistically apprehendable' (Sileyew, 2019: 1; Merriam and

Simpson, 2000). Post-positivism is seen as a subset of the former positivism, but they are both objectivist.

> *"Critical theory adopts a more transactional and subjectivist epistemology where 'the investigator and the investigated object are assumed to be interactively linked, with the values of the investigator . . . inevitably influencing the inquiry" (Martens, 2015: 110).*

Whereas positivist and post-positivist "inquiry seeks to explain, predict, and regulate, critical theory seeks to criticize and emancipate" (Martens, 2015). Shah and Abdullah (2013: 4) distinguished three "conceptually diverse research paradigms: positivism, interpretivism, and critical postmodernism".

4.2.2. THE UNDERLYING EPISTEMOLOGY

This study considers the three-fold classification of positivism, interpretivism, and critical postmodernism to be excellent since these three categories may be utilized to simply position the more particular psychological and sociological theories employed in the area.

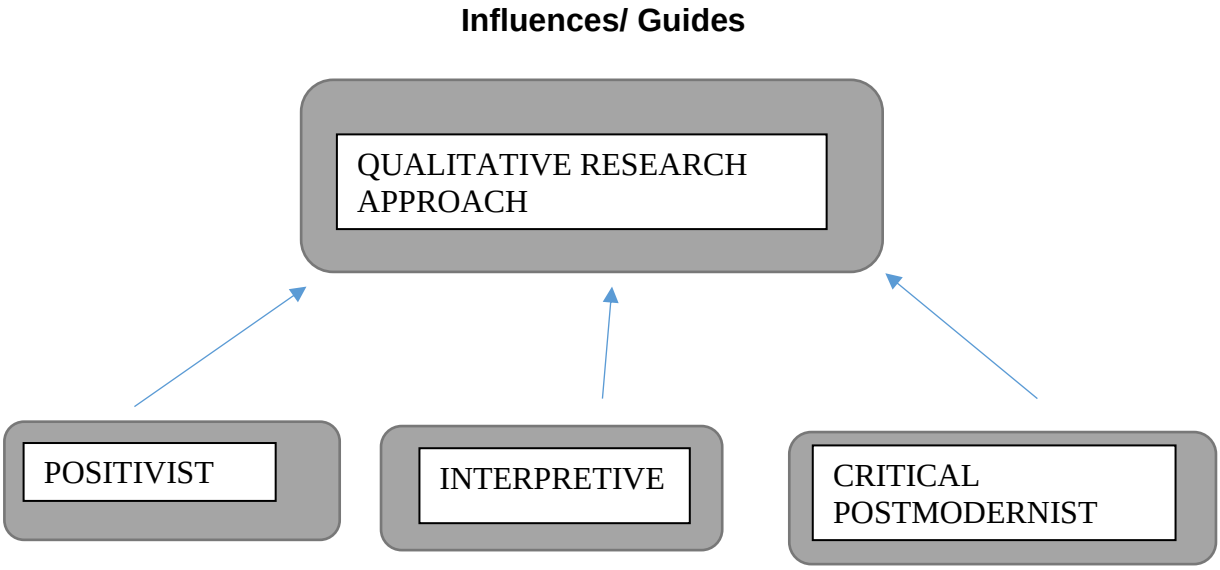

Figure 4.1: Underlying philosophical assumptions

Source: The researcher: Smith Vincent

Furthermore, these three philosophical approaches are prevalent paradigms in current social, organizational, and management research. The essential characteristics of these three views, which include the worldview, the kind of information sought, and the various methods by which knowledge is created and appraised within each paradigm or worldview, are as follows. Nevertheless, Makombe (2017), indicated that there is little agreement on whether these research paradigms are inherently antagonistic or whether they might play diverse roles in the same study.

> *A paradigm is a way of describing a world view that is informed by philosophical assumptions about the nature of social reality (known as ontology – that is, what do we believe about the nature of reality?), ways of knowing (known as epistemology – that is, how do we know what we know?), and ethics and value systems (known as axiology – that is, what do we believe is true?) (Patton, 2002: 3).*

Thus, a paradigm drives us to ask particular questions and employ proper methods of systematic investigation (known as methodology — that is, how should we investigate the world?) (Gunawan, 2015: 1). Ontology is concerned with whether we believe in a single verifiable reality or whether there are several, socially created realities (Mertens, 2009). The study of knowledge and truth is known as epistemology. It poses the following queries: What are the sources of information? How trustworthy are these sources? (Kawulich, 2011). What can one possibly know? How can one tell whether something is true? Consider how some individuals believe that the existence of witches is only a belief.

Further questions are raised by epistemology: Is a conviction genuine knowledge? Is knowledge limited to what can be verified using real data? As an example, For example, if you claim that witches exist, what evidence do you have? What strategies may you employ to discover their existence? These paradigmatic features work together to define the assumptions and beliefs that shape a researcher's understanding of a research topic, how he or she approaches examining it, and the techniques he or she employs to answer research questions (Norman and James, 2020: 9). The study's

fundamental question is, "What are the Essential Elements of a Research Paradigm?" Relevant Literature A paradigm, according to Robson and McCartan, (2016);

> *“consists of four components: epistemology, ontology, methodology, and axiology. It is critical to understand these parts since they contain the fundamental assumptions, beliefs, standards, and values that each paradigm possesses”.*

As a result, upon locating the study proposal in a particular research paradigm, the understanding is that this current research will uphold, and be guided by the assumptions, “beliefs, norms and values of the chosen paradigm" (Mihesuah, 2005: 34). It is therefore important that this research demonstrate that the researcher know what each of these elements mean.

4.2.3. Epistemology of a Paradigm

The word epistemology derives from the Greek term episteme, which meaning "knowledge." Simply defined, epistemology is employed in study to describe how we learn something; how we know the truth or reality; or, as Connelly (2016: 9) put it, what qualifies as knowledge in the world.

> *“It is concerned with the basic foundations of knowledge - its nature, forms, and acquisition, as well as how it might be conveyed to other humans. It focuses on the nature of human knowledge and comprehension that you, as the researcher or knower, may be able to gain in order to extend, widen, and deepen understanding in your field of study”.*

According to Shukla (2016); Lather (1992: 6), it is the study of the nature of knowledge and justification. Furthermore, when considering the epistemology of your research, you ask questions such as; If knowledge something that can be acquired on the one hand, or is it something that must be personally experienced on the other (Schwandt, 2001: 8).

> *"What is the nature of knowledge, and how do the knower and the would-be known interact? What is the connection between myself, the inquirer, and what is known? These questions are crucial because they assist the researcher in situating oneself" in the study setting in order to uncover what else is new given what is known (Ponterotto, 2005: 31).*

As a result, in order to comprehend the epistemological component of your paradigm, you must first ask the critical question of how we know what we know? This question is the basis for investigating 'truth'. While it is arguable if there is such a thing as 'truth' (Stringer and Dwyer, 2005: 2), if we regard factual evidence as truth, then epistemology may assist you pose factual questions like, "How do we know the truth?" What is knowledge? These are particularly crucial considerations since one of the criteria used to evaluate higher-level research is its addition to knowledge (Momoh, 2021). Researchers can draw on four sources of information when attempting to formulate responses to the aforementioned issues. These sources are intuition, authoritative knowledge, logic, and empirical knowledge (Makombe, 2017; Trochim, 2006: 7).

> *"If you rely on kinds of knowledge such as beliefs, faith, and intuition, your research's epistemological foundation is intuitive knowledge". If you rely on evidence acquired from experts, books, or organizational leaders, your epistemology is based on authoritative knowledge. When reason is emphasized as the surest method to understanding the truth, this approach is known as rationalist epistemology or logical knowledge.*

On the other hand, Prochaska (2017: 4), noted "if you put emphasis on the understanding that knowledge is best derived from sense experiences, and demonstrable, objective facts, then your approach leans towards empirical epistemology". Epistemology is significant because, "it helps you to establish the faith you put in your data, as it affects how you will go about uncovering knowledge in the social context that you will investigate (Prochaska, 2017: 5).

4.2.4. Ontology of a Paradigm

Ontology is a philosophical discipline that is ultimately concerned with the assumptions we make in order to believe that something makes perfect sense or is real, as well as

the fundamental character or essence of the social phenomenon under investigation (Putnam, 2012: 32). It is the philosophical study of the nature of being or becoming, as well as the fundamental categories of existing objects and their relationships (Makombe, 2017). It looks into your fundamental beliefs about the nature of being and existence as the researcher (Bergman, de Feijter, Frambach et al., 2012: 4). It is interested in the assumptions we make in order to believe that something makes sense or is genuine, as well as the nature or substance of the social phenomenon that is under study. It helps you conceptualize the shape and character of reality, as well as what you believe can be known about it.

Philosophical beliefs about the nature of reality are essential for comprehending how you interpret evidence (Cox, 2015: 34). These assumptions, conceptions, or assertions guide your thinking about the research topic, its relevance, and how you could approach it to contribute to its resolution. Ontology is so important to a paradigm because it serves to offer an understanding of the things that make up the world (Patton, 2002: 8). It attempts to ascertain the true nature, or the basic notions that comprise themes that we analyze in order to make sense of the meaning embedded in research data. It makes you ask questions such as:

> *"Ontology enables you to examine your underlying belief system and philosophical assumptions as the researcher, about the nature of being, existence and reality" (Bergman et al. (2012: 5).*

Philosophical beliefs about the nature of reality are essential for comprehending how you interpret evidence. These assumptions, conceptions, or premises direct your thinking about the research topic, its relevance, and how you might approach it to answer your research question, comprehend the problem under consideration, and contribute to its resolution.

4.3. The Methodology of a Paradigm

Methodology is a comprehensive phrase that refers to the study design, techniques, approaches, and processes utilized in a well-planned inquiry to discover anything (Denzin and Lincoln, 2011: 3). Data collection, participants, instruments employed, and data analysis, for example, are all components of the broader area of methodology. In

summary, the technique articulates the systematic logic and flow to undertake a research. The methodology articulates the logic and flow of the systematic methods used to undertake a research effort in order to learn about a research topic (Bhandari, 2022). It describes the assumptions made, the constraints found, and how they were handled or minimized. It is concerned with how we come to know the world or learn about a portion of it (Howell, 2013: 6). When planning the approach for your research project, ask yourself, "How should I go about getting the required facts, information, and understandings that will enable me to answer my research question and therefore contribute to knowledge?"

It entails establishing, assessing, and comprehending conceptions of good and wrong behavior in relation to the research. It evaluates how much weight we will give to various parts of our study, such as participants, data, and the audience to whom we will present our findings (Bogdan and Biklen, 2006: 7). Simply put, it asks, "What is the nature of ethics or ethical behavior?" In answering this question, it is critical to examine everyone who will be engaged with or participate in your research project's concern for human values. The following questions help to facilitate the thought process. What ideals would you live by or follow as you undertake your research? What should be done to ensure that everyone is respected? What should be done to ensure that the rights of all participants are respected? What are the moral concerns and features that must be taken into account? What cultural, intercultural, and moral challenges may arise, and how will I deal with them?

The critical question in this study is how will I ensure the participants' goodwill? How will I do the study in a way that is socially just, courteous, and peaceful? How can I prevent or reduce danger or injury, whether physical, psychological, legal, social, economic, or other? ARC (2015: 28); Corbin and Strauss (2008), provide answers to these concerns are best led by four ethical criteria: teleology, deontology, morality, and fairness (Mill, 1969: 5). Fundamentally, "teleology is a moral theory that holds that doing what is essentially good or desirable is a moral responsibility that should be pursued in every human endeavour" (ARC, 2015: 3).

4.3.1. Axiology

Axiology refers to the ethical considerations that must be addressed while developing a study project (Shah and Abdullah, 2013: 6). It considers the philosophical perspective to making decisions of value or the right decisions (Wilson, 2008: 34). Furthermore, teleology refers to efforts undertaken in study to ensure that the research leads in a meaningful end that will please the greatest number of people. Questions such, "Are the methodologies utilized in this research pragmatic and make common sense?" make it easier to apply this criteria.

4.3.2. Deontology

Deontology is the knowledge that every action performed during the research will have an effect on the participants, the researcher, the academic community, or the general public (Searle, 2015). It also gives you the freedom to deal with specific participants or observations. The morality criteria refers to the inherent moral principles that will be maintained throughout the investigation. For instance, the researcher will be honest in interpreting their data. Finally, the criterion of fairness calls the researcher's attention to the need of being fair to all study participants and upholding their rights. This criterion's implementation is influenced by issues such as "How fair will my research actions be?" Will they apply the same standard of care to all research participants? Will my activities demonstrate favoritism or discrimination against any of the participants?

As a result, in the part on ethical issues for your higher degree research project, you should exhibit optimal ethical conduct by demonstrating an awareness of what is acceptable and incorrect behavior while doing the study. This concept is based on the belief that "all persons have dignity that must be respected, and that they have a fundamental human right to make decisions or choices which you as a researcher must respect" (Alise and Teddlie, 2010: 4). The application of ethical concerns focuses on four principles that must be followed while working with people and data.

4.3.3.Privacy

Determine what information the participants who were used in the data collection process will be expected to reveal to you or others about themselves, their associations, or organizations under this concept. It evaluates the circumstances and

protections that will be in place for data collection and analysis (Kivunja and Kuyini, 2017: 3). What, for example, may participants keep private and not be required to divulge to you or anybody else?

4.3.4. Accuracy

This concept analyzes who is accountable for information's authenticity, integrity, and correctness. Similarly, it examines how you, as the researcher, would cross-check with participants to ensure that you have correctly collected the data (Kivunja and Kuyini, 2007: 3). It also specifies who will be held liable for any data inaccuracies. And, if someone is wounded, how will they be compensated? Moreso, if someone is wounded, how will they be compensated.

4.3.5. Intellectual Property

This concept requires you to examine who will own the data. Is the data going to be paid for? If so, what are the right and fair fees for data exchange? Who will own the routes of information dissemination, such as publications and media? (Kivunja and Kuyini, 2017).

4.3.6. Accessibility

This concept takes into account who will have access to the data. How will the data be protected and secured? Researchers and participants will have access to the data under what conditions and with what safeguards? It will address the question of h ow will access to the information will be gained (Kivunja and Kuyini, 2017: 4).

4.4. POSITIVISM

The positivist paradigm of studying social reality is founded on the intellectual principles of August Comte, a French philosopher. According to him, the greatest way to comprehend human behavior is by observation and reason; genuine knowledge is based on sensory experience and may be attained through observation and experiment (Jansen and Warren, 2020). At the ontological level, “positivists believe that reality is supplied objectively and can be measured using attributes that are independent of the researcher and his or her tools; in other words, knowledge is objective and quantifiable.” Positivistic scholars use systematic methodologies to

normalize the knowledge creating process and improve clarity in the description of parameters and their relationships. Accordinly, Henning, Van Rensburg and Smit (2004: 17: 4), noted that "positivism is concerned with discovering and expressing truth". Positivism is concerned with uncovering truth and presenting it by empirical means.

The positivist stance, according to Champely (2018), asserts that “scientific knowledge consists of facts, but its ontology regards reality as independent of social production”. If the study analysis is based on a balanced and unchangeable reality, it is most likely that the researcher can take a 'objectivist' stance:

> *"If the research study is based on a stable and unchanging reality, the researcher can take a 'objectivist' stance: a realist ontology - a belief in an objective, real world - and detached epistemological stance based on a belief that people's perceptions and statements are either true or false, right or wrong, a belief based on a view of knowledge as hard, real, and acquirable; they can employ methodology that relies on control and manipulation of reality".*

Positivism considers human behavior to be passive, regulated, and determined by external factors. This, in general, serves as the educational foundation for 'conventional' teaching techniques or "strategies also along with constructivist approaches in a complementary manner". According to Prochaska (2017: 32); and Hwang (1996: 343-56), positivist thinking is associated with a wide range of ideas and activities, including; Comtean-type positivism, logical positivism (non-realism), behaviorism, empiricism, and cognitive science. Lafaye de Micheaux and Tran (2016), noted that “although the positivistic paradigm dominated educational research for a long time in the latter half of the twentieth century, it was challenged by critics from two alternative traditions – interpretive constructionism and critical postmodernism” – due to its lack of subjectivity in interpreting social reality.

Objectivity, according to its detractors, must be replaced with subjectivity in the process of scientific research. “Alternative theoretical, methodological, and practical

approaches to research are provided by constructionism and critical postmodernism" (Munafò, et al., 2017). In its purest form, Gephart (1999: 5), the realism viewpoint embodies the classical positivist tradition. However, the postpositivism scholars like Brown, Dressler, Eaton and Jacobsen (2015: 231); Phillips, (1990: 8), indicated that the ideal is a modified objectivist perspective that claims that, while the object of our inquiry exists outside and independent of the human mind. Nuijten et al., (2016), states that it cannot be perceived with total accuracy by our observations; in other words, complete objectivity is nearly impossible to achieve, but it is still pursued as an ideal to regulate our search for knowledge. Aschwanden (2018: 6), critical realism ontology is represented here. Thus, the "positivist emphasis on experimental and quantitative approaches has been supplanted or supplemented to some extent by an interest in employing qualitative methods to obtain broader information beyond easily quantifiable factors" (Stark and Saltelli, 2018: 34-35)

4.5. INTERPRETIVISM

Interpretive researchers think that reality is made up of people's subjective perceptions of the outside world; as a result, they may hold an inter-subjective epistemology and the ontological conviction that reality is socially produced. McNiff (2016: 46); Willis (1995) defines interpretivists as anti-foundationalists who think there is no single valid path or technique to knowing. Walsham (1993) contends that there are no 'right' or 'incorrect' hypotheses un the interpretative tradition. Instead, Hendricks (2016), noted that they should be evaluated based on how 'interesting' they are to the researcher as well as people active in similar fields. They try to draw their conceptions from the field by doing in-depth research on the topic of interest.

According to Gephart (1999), "interpretivists believe that knowledge and meaning are acts of interpretation, and so there is no objective knowledge that is independent of thinking, reasoning people". Whereas Myers (2009), is of the view that "interpretative researchers' assumption is that access to reality (whether given or socially produced) is only possible through social constructs such as language". Awareness, and shared meanings (Martens, 2015; Eichelberger, 1989). The interpretive paradigm is supported by observation and interpretation. To observe is to gather information about occurrences, whereas to interpret is to make sense of that information by making

conclusions or determining the match between the evidence and some abstract pattern (Amrhein and Greenland, 2018: 31)

It seeks to comprehend things by the meanings that individuals ascribe to them (Deetz, 1996). According to Reeves and Hedberg (2003: 32), the "interpretivist" paradigm emphasizes the need of contextualizing analysis. Wright (2019), noted that the interpretative paradigm is concerned with understanding the world as it is via individuals' subjective experiences. They employ meaning-oriented (rather than measurement-oriented) approaches like as interviewing or participant observation, which rely on a subjective interaction between the researcher and the participants. Interpretive research does not specify dependent and independent variables in advance, but rather focuses on the whole complexity of human sense making as it arises (Bates, D., Mäechler, Bolker and Walker, 2015; Kaplan and Maxwell, 1994). This is the interpretative method, which seeks to understand the subjective motivations and meanings that drive social behavior.

The goal of interpretivists is not to create new theories, but to examine, evaluate, and modify existing ones. Phenomenological techniques are especially successful at bringing to the forefront people' experiences and perceptions from their own perspectives, and thereby challenging structural or normative assumptions (Bell and Jones, 2015: 39). This research is based on the interpretivist paradigm. According to Benjamin et al. (2018), the objective of the investigation, the nature of reality (ontology), the nature of knowledge and the interaction between the inquirer and the inquired-into (epistemology). Besides, the technique utilized are the features of interpretivism as used in this study (Cantrell, 2001). This methodology's essential phrases are participation, cooperation, and engagement (Henning, van Rensburg, and Smit, 2004).

In the interpretative method, the researcher does not stand above or outside the activities, but rather is a participant observer (Carr and Kemmis, 1986: 88) who participates in them with "activities and discerns the meanings of actions as they are expressed within specific social contexts".

4.6. POSTMODERNISM IN CRISIS

Critical postmodernism is a synthesis of two distinct worldviews: critical theory and postmodern scholarship (Breakwell, Wright and Barnett, 2020). “Critical Theory is a German tradition founded by the Frankfurt School on the German philosophical and political thinking of Marx, Kant, Hegel, and Max Weber” (Xie, 2015: 20). Postmodernism is a school of thought that arose in part because of the work of French intellectuals such as Lyotard, Derrida, and Foucault (Breakwell et al., 2020: 3). Though developed from many “points of view, they are broad rubrics for intellectual movements rather than specific ideas, yet they are critical components of social semiotic analysis”. Critical Postmodernism takes a less radical perspective and is a developing field of research that goes beyond the ostensibly radical postmodernism (Spradley, 1979).

This paradigm is a liberation force that is engaged in an ongoing battle with oppressive authorities and tries to bring about educational transformation (Revees and Hedberg, 2003: 33). Critical academics believe that social reality is historically constructed and that individuals make and replicate it (Breakwell et al., 2020: 3; Myers, 2009: 71). Although people can deliberately work to improve their social and economic conditions, critical academics acknowledge that their power to do so is limited by many types of social, cultural, and political dominance (Camerer, et al., 2018). As a result, critical education scholars strives to surpass commonly held ideas, "values, and social structures by making these structures and the issues they create visible, fostering self-conscious critique, and cultivating emancipatory consciousness in scholars and society members in general" (Kincheloe and McLaren, 1994: 138-157).

The goal is to publicly criticize the status quo, to focus on the tensions and constraints of contemporary society, and to pursue cultural, political, and social reform that will eradicate the roots of alienation and dominance (Champely, 2018). Thus, the critical theory paradigm invites evaluators and instructional designers to investigate and evaluate the cultural, political, and gender assumptions that underpin an educational product's or program's efficacy (Reeves and Hedberg, 2003: 7). Critical theory seeks to deconstruct the "hidden curriculum" or "text" in order to discover "truth" and "understanding within the social context" (Green and MacLeod, 2016: 33). According to Gephart (1999), "the goal of critical postmodernism is social change in order to

replace current systems of power and dominance by allowing for alternative systems of power and dominance for social reform participation among persons previously excluded and dominated."

4.6.1. THE INTERPRETIVE PARADIGM

The present study is grounded in the interpretive paradigm. By definition, interpretive research is a research paradigm based on the belief that social reality is not singular, but it is shaped by human experiences (Croucher & Cronn-Mills, 2018: 29). Engel and Schutt (2016: 54) note that in the interpretive paradigm researchers believe that individuals are complex, meaning everybody in the world diversely experiences a similar reality and therefore cannot be investigated in the same way. According to this paradigm (interpretive paradigm), measurement is complicated; hence, qualitative research focuses on the thoughts, processes, feelings, and emotions of the participants (Engel & Schutt, 2016:54). This paradigm has been selected because the envisaged study aims to capture the feelings and experiences of secondary school learners in the non-availability of teachers in the critical subjects (mathematics and physical sciences) in rural high schools in the King Cetshwayo District in KwaZulu Natal.

4.7. RESEARCH DESIGN AND METHODOLOGY

The methodology is defined as a way of data collection for research purposes (Munafò et al., 2017; Babbie and Mouton (2001). To achieve the study aim, a qualitative research approach was adopted. The descriptive method was used to analyse the data collected. Research methodology refers to specific tools used to answer the previously formulated research questions and to meet the objective of the research. The research design refers to the broader plan of how the study will be carried out. Details of the employed research methodology and design are further explained in detail in Chapter 3 of the dissertation.

4.8. RESEARCH APPROACH

This study is framed within a qualitative research approach**.** According to Wilhelmy and Köhler (2021:1), qualitative research is described as a method that seeks to explore, describe, and explain people's experiences, behaviors, interactions, and social contexts without using statistical procedures or qualifications. The main focus of

qualitative research is to generate descriptive data, which is usually people's own written or spoken words in their natural setting (Crick, 2021: 395). Flick (2018: 23) adds “qualitative research is conducted if the study aims to collect more data from the target population through stories”, thoughts as well as experiences. Since this study intends to explore challenges faced by secondary school learners in the non-availability of teachers in the critical subjects (mathematics and physical sciences) in rural secondary schools in the King Cetshwayo District in KwaZulu Natal. A qualitative approach was adopted to explore the experiences and challenges facing children who are heading their households. Hence, for that reason, a qualitative research approach is the best approach for this study. Further detailed discussion is provided in this Chapter 3 of the dissertation. In the next section, I present the research design of the study.

4.9. RESEARCH DESIGN

The research design refers to a “plan or strategy, which moves from the underlying logical assumption to specifying the selection of respondents, the data gathering techniques to be used, and to how data analysis” will be performed (McNichols and Stubben (2018:227). The case study research design helps the researcher to focus on one idea within a confined space. Moreover, this is a flexible research design since it provides an opportunity to collect data in different ways like through interviews, documents, and observation (Esra & Sevilen, 2021:12). For this study, a case study research design will be used because it permitted the participants to explain and fully answers questions without being limited to one-word answers. This study is framed by a qualitative design. Creswell (2014) describes a research design as the plan of how the researcher systematically collected and analyse the data that is needed to answer the research question.

4.9.1. Target Population and Sampling Procedure

The target population for this study comprised of rural-based high school teachers from King Cetshwayo district, which has five circuit management centres of the district and the schools which are divided into the cluster of ten. This study employed the model of non-probability sampling as the research population, that was used to target participants who are mathematics and physical science teachers within the King Cetshwayo district in KwaZulu-Natal. The study was conducted in 10 rural schools in the study area for data collection. One teacher was selected from each school for the interview session.

4.9.2. Data collection

Due to the qualitative nature of the study, data for the study was collected through structured one-on-one interviews with the key informants who are mathematics and physical science teachers. In this study, the means of data collection was done through in-depth interviews with respondents who teach mathematics and physical sciences in the King Cetshwayo district. Two types of face-to-face interviews, individual and group interviewing, are defined by Braun and Clark (2006). The study also distributed questionnaires to a group of participants, which was done randomly among the teachers.

4.9.3. Data Analysis

The data collected through interviews were combined and analysed through content data analysis. This was done to obtain a perception of the factors responsible for the low-rate performance of learners in critical subjects. In-depth interviews, according to Creswell (1998), provide respondents with the liberty to express their views in their own words. The individual interviewing allowed every respondent to say out their line of thought without being influenced by group psychology. Purposive sampling was used to target participants who are mathematics and physical science teachers within the King Cetshwayo district in the KwaZulu-Natal province. The basis for using the purposive sampling technique was that it allowed the researcher to select the respondents who had better knowledge of the low-rate performance of learners in the critical subjects in the 10 rural schools. This was advantageous in that precise contexts

of the purposively chosen cases were made rather than attempting to generalise from the broad population.

4.9.4. The Process of Data Analysis.

The researcher used content analysis because it defines data that is commonly used in qualitative data. The data analysis includes the method of order, structure, and significance for the collected data, according to De Vos (2005). The data was combined, classified and interpreted employing qualitative content analysis according to trends developed from research questions. The results were then matched by literature understandings so that the research questions and the study goals were authenticated and addressed.

4.9.5. Delimitations of the Study

The study was conducted with teachers that are within the King Cetshwayo District rural community, while focusing on the effect of non-availability of teachers in the critical subjects such as mathematics and physical sciences in rural secondary schools, in relation to learner's performance rate.

4.10. TRUSTWORTHINESS

Even though many opponents are sceptical of qualitative research's credibility, standards for assuring rigor in this type of study have existed for many years. Guba's structures, in particular, have gained popularity and are the topic of this work. In this case, researchers are attempting to meet four requirements. When it comes to credibility, investigators try to show that they are presenting a truthful picture of the phenomena under investigation. To enable transferability, they offer enough material about the fieldwork context for a reader to evaluate whether the current environment is similar to another scenario with which he or she is aware and whether the findings may be justifiedly transferred to the other setting. Meeting the dependability requirement is

difficult in qualitative work, but researchers should endeavour to make the study repeatable by a future investigator. Finally, in order to obtain confirmability, researchers must take efforts to establish that findings arise from data rather than their own biases.

4.10.1. Strategies for guaranteeing trustworthiness in Qualitative research

Positivists frequently dispute the reliability of qualitative research in general, maybe because their conceptions of validity and reliability cannot be addressed in the same manner in naturalistic work. Nonetheless, several authors on research methods, most notably Shukla (2020: 3); Silverman (2001), have demonstrated how qualitative researchers can incorporate measures that address these issues, and investigators such as Pitts (1994), have tried to answer the issues of validity and reliability directly in their own qualitative studies. Many naturalistic researchers, on the other hand, have decided to use distinct nomenclature to disassociate themselves from the positivist paradigm. Guba is one such author, and he presents four criteria that he feels qualitative researchers should examine to conduct a reliable study (Shukla, 2016). According to Gunawan (2015), Guba's constructions match to the criteria used by tackling similar difficulties as the positivist investigator in the following.

- *credibility (in preference to internal validity);*
- *transferability (in preference to external validity/generalisability);*
- *dependability (in preference to reliability);*
- *confirmability (in preference to objectivity).*

Although Lincoln noted in the mid-1990s that the entire field of qualitative research was "still growing and being defined" (Cox, 2015: 17) Guba's notions have been widely accepted. This study examines the criteria in depth and recommends provisions that the qualitative researcher might use to satisfy them. The tactics advised are “based on Shenton's experience conducting a qualitative PhD study on the information-seeking behavior of school-aged children” (Cowling, 2014: 21).

4.10.2. Credibility

In terms of research credibility, one of the most important criteria addressed by positivist researchers is internal validity, which seeks to verify that their study measures or tests what is truly intended. According to Merriam, the analogous notion for qualitative investigators is believability, which deals with the issue, "How consistent are the findings with reality?" (Cowling, 2014; Shenton, 2002: 34). Assuring credibility, according to Lincoln and Guba, is one of the most important components in developing trustworthiness (Adams, Game and Bode, 2014). To increase their confidence that they have correctly captured the phenomenon under investigation, researchers can make the following preparations: a) employing well-established research procedures in qualitative research in general, and information science in particular.

A researcher recognizes the importance of including "appropriate operational metrics for the concepts under consideration" (Gunawan, 2015: 8). Thus, to the greatest extent possible, the specific processes used, such as the line of inquiry pursued during data collection sessions and data analysis methodologies, should be drawn from those that have been successfully used in previous comparable projects. The study conducted by Shukla (2020: 5), has proven particularly significant in the examination of information-seeking behavior.

4.10.3. Transferability

Merriam defines external validity as "the extent to which the findings of one research may be transferred to other settings" (Allen, 2017: 39]. The concern in positivist work is frequently establishing that the outcomes of the task at hand may be applied to a larger population. Because the findings of a qualitative research are specific to a small number of specific locations and persons, demonstrating that the findings and conclusions are relevant to other contexts and groups is impossible. Many naturalistic inquirers, according to Erlandson et al., feel that, in fact, even conventional generalisability is never conceivable since all observations are defined by the specific settings in which they occur (Norman and James, 2020: 26).

Robson and McCartan (2016), argue that, while each case is “unique, it is also an example within a larger group and, as a result, the idea of transferability” should not be

dismissed outright. However, such an approach should be used with caution since, as Gomm, Hammersley, and Foster recognize, it appears to minimize the impact of the contextual aspects that influence the case (Nowell1, Norris, White and Moules, 2017: 4). Bassey suggests that if practitioners think their conditions are comparable to those detailed in the study, they should apply the study's findings to their own situations (Creswell, 2014: 44). Norris, White, Nowell, Mrklas and Stelfox (2017), make a similar case, arguing that it is the investigator's job to offer enough contextual information about the fieldwork sites to allow the reader to make such a transfer.

Thee aurthours further presents the argument that because the researcher only understands the "sending context," he or she cannot draw transferability conclusions. Many qualitative researchers have embraced this viewpoint in recent years. After reading the explanation of the setting in which the work was done in the research report, readers must decide how far they may be confident in transferring the data and conclusions offered to other scenarios (Norris, White, Nowell, Mrkla and Stelfox, 2017). It is also critical that a sufficiently detailed description of the phenomenon under investigation be provided to allow readers to gain a thorough understanding of it, allowing them to compare instances of the phenomenon described in the research report with those that have emerged in their own situations. Similar experiments using the same methodologies but undertaken in various locations might be very useful in determining the extent to which findings may be true of people in other circumstances.

4.10.4. Dependability

When it comes to dependability, positivists use ways to demonstrate that if the study were done in the same environment, with the same methodologies, and with the same participants, identical findings would be reached. As Connelly (2016: 12). point out, “the shifting character of the phenomena scrutinized by qualitative researchers makes such provisions challenging in their work”. Robson and McCartan (2016: 6), “emphasizes how the investigator's findings are linked to the study's circumstances, claiming that "published descriptions are static and fixed in the'ethnographic present”. Scholars emphasize the tight relationship between credibility and dependability, stating that in reality, demonstrating the former goes a long way toward assuring the latter

(Norman and James, 2020; Connelly, 2016). This can be accomplished by employing "overlapping procedures," such as focus groups and individual interviews.

To discourse the question of dependability more precisely, the methods inside the analysis should be detailed, “allowing a future researcher to duplicate the work, if not necessarily obtain the same conclusions” (Allen (2017: 34). As a result, the research design may be regarded as a "prototype model." This level of detail according to Allen (2017), also helps the reader to examine the extent to which suitable research techniques were followed. To provide readers with a complete grasp of the methodologies and their success, the text should include parts devoted to;

- *the study design and its implementation, detailing what was planned and done on a strategic level.*
- *operational detail of data collection, covering the minutiae of what was done in the field;*
- *reflective evaluation of the project, evaluating the success of the inquiry method performed (Momoh, 2021: 7).*

4.10.5. Confirmability

In terms of confirmability, scholar like Patton links scientific objectivity with the use of equipment that do not rely on human talent and perception, and acknowledges, however, the difficulty of achieving true impartiality, because, because tests and questionnaires are devised by humans, the researcher's biases are unavoidable (Patton, 1990). Bhandari (2022: 6), argued that confirmability is the qualitative investigator's incomparable concern for objectivity. Steps must be made here to guarantee, to the greatest extent feasible, that the work's findings are the consequence of the informants' experiences and thoughts, rather than the researcher's qualities and preferences (Shukla, 2014). To lessen the influence of investigator bias, the importance of triangulation in encouraging such confirmation must be emphasized once more. According to Connelly (2016), a fundamental criterion for confirmability is the amount to which the researcher confesses his or her own biases.

To that aim, the assumptions that underlay judgments made and methodologies used should be recognized in the study report, the reasons for favoring one strategy over others clarified, and flaws in the procedures used noted. In terms of outcomes, preliminary notions that were eventually not supported by evidence should be presented. Much of the information in these areas might be obtained from the continuous "reflective commentary (Shukla, 2020)." Again, full methodological description allows the reader to judge how far the data and constructions derived from it may be accepted.

4.11. ETHICAL CONSIDERATIONS

The researcher observed all ethical issues that require an ethical justification, which proves that there was no harm done to the participants during the process. Researchers like Cohen and Marrison (2004), attest to the fact that there should be no harm to the respondents. Besides that, the respondents should know the purpose of the study and guarantees confidentiality in the research. Participants must be made aware that their involvement in the study is voluntary and that they may disengage at any stage if they feel like doing so. All ethical issues were considered and followed critically to ensure that participants' privacies are not invaded or coerced into participating in the research without their free will.

In social research and communication research, ethical consideration can be broadly classified under two main headings, mainly the preservation of human subjects' rights and the ethics of writing. According to David and Resnik (2015), "Education in research ethics should be able to help researchers grapple with the ethical dilemmas they are likely to encounter by introducing them to important concepts, tools, principles, and methods that can be useful in resolving these dilemmas". In other words, this research project conformed to the moral, ethical, and legal standards of scientific inquiry. Ethics that are referred to the evaluation of the human condition and terms of their values, this research involved the use of both values and ethics. Ethical considerations entail the

evaluation of paths of action guided by individual, social, and cultural beliefs and experiences based on ‘moral’ principles.

Members of a society's values are ideas and opinions about what is significant, right or wrong, good or bad. The study did not harm anyone while exploring the challenges encountered by the availability of mathematics and physical science teachers in rural secondary schools in the King Cetshwayo district area. The researcher fully complied with the following research principles: the right to privacy, the right to maintain self-respect and human dignity, confidentiality, anonymity, and protection from the potential misuse of research findings. The researcher also desires to say that I have read the University's policies and procedures on research ethics, as well as its policies and procedures on controlling and combating plagiarism, and that I am fully aware of their contents.

Given the foregoing, the researcher certifies that, to the best of his or her knowledge, his or her research does not fall into any category that necessitates any further ethical requirements beyond those listed above. The researcher followed the broad principles outlined in the University's rules, as well as the obligations that the policies impose on me, to minimize any potential ethical or other risks.

4.11.1. Informed consent

To get the consent of the participants for this study, the researcher did not only apply for permission from the King Cetshwayo district for the research, but a transmittal letter was produced to the school principals to introduce and explain the purpose of the research and interviews during data collection. While also demanding permission to conduct study in their schools. Participants were also given an honest explanation of the research's purpose, as well as a request for their voluntary involvement in the study. The study employed both verbal and written communications with the respondents who participated in the research.

4.11.2. Confidentiality and anonymity

To protect the identities of the participating schools and the participants, the names of the participants were hidden, and the settings were changed. This was done in accordance with the advice that researchers have a responsibility to protect the confidentiality of the informants from other group members and to keep the individuals hidden from the public.

4.11.3. Privacy and empowerment

It is critical that research participants do not feel misled if their responses are misinterpreted or if they believe they have been misled into participating in the study. As a result, their involvement was negotiated rather than compelled, ensuring that they participated as voluntary and empowered participants who were fully aware of all processes used during the research as well as during the analysis and interpretation of their responses.

4.12. Conclusion

The current chapter looked at the research methodology and the procedures undertaken to conduct the research. Research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic. In research, the methodology section allows the reader to critically evaluate a study's overall validity and reliability. The methodology section answers two main questions: How was the data collected or generated? How was it analyzed? Denzin and Lincoln (2011) define research design as plans that will guide the collection of data and its analysis. The study combines both exploratory and descriptive methods with a qualitative research paradigm. The study discussed the research paradigm in terms of its epistemology, ontology, methodology and axiology. This method gave room to collect enough data on the challenges faced by secondary school learners with the absence of qualified teachers in the critical subjects of mathematics and physical sciences in rural secondary schools in the King Cetshwayo District in KwaZulu Natal.

The chapter also addressed the ethical issue and informed consents for the selected participants, the trustworthy, credibility, reliability and transferability, and conformibility.

CHAPTER FIVE

DATA PRESENTATION AND ANALYSIS

5.1. INTRODUCTION

This chapter presents the data collected and analysed. Data was analysed accordingly in a thematic structure to respond to the various research questions in line with the research objectives. The study aimed to examine the complexities in the availability of mathematics and physical science teachers in rural secodary schools within King Cetshwayo District in KwaZulu-Natal. The objectives were to explore the various factors that are affecting the supply of qualified science teachers in the rural secondary schools of the King Cetshwayo District and the demand for science teachers in South Africa. It also explored whether the availability of professional mathematics and science teachers in the rural secondary schools of the King Cetshwayo District affect learner's performances. Significantly, the research adds to an existing literature and body of knowledge by accessing the role of secodary school teachers and poor performance challenges faced by learners in rural-based schools.

This is seen to be a result of the non-availability of science materials which may have affected the performance rates. This research looks at the complexity in supplying qualified teachers to the rural-based high schools; it located possible ways to motivate teachers to take up employment to teach in this area. The research results recommend policy frameworks from its findings to the department of education for implementation in improving performance rates. The research investigated the teachers' employment procedures to see what problems are associated with it, which may have contributed to the non-availability of science teachers in the rural areas of the King Cetshwayo district. Furthermore, this study advanced the research problem with a holistic qualitative design, based on a Critical Realist perspective, in an interdisciplinary research field.

The methodology was based on a case study analysis, in an attempt to understand what factors are responsible for the low-rate performance of learners in the rural-based high schools in the King Cetshwayo district, the research unit of analysis. The main units of observation are based on the examination of the complexities in the availability

of mathematics and physical science teachers in rural high schools within the King Cetshwayo District. The next section presents the data collected, and is followed by a discussion of findings.

5.2. PRESENTATION OF THE DECODED INTERVIEWS

MAIN THEME	SUB-THEMES
Factors affecting the supply of science teachers	**Teacher struggles (resources and infrastructure),**
	Teacher practices and pedagogy (what they do in the classroom)
	Responsibilities of the state

4.1.1. Teacher struggles (resources and infrastructure),

What are the factors that affect the supply of science teachers in the rural secondary schools of the King Cetshwayo District?

Interview	Responses
Participant 1	*The problem that makes teachers not want to come to our rural schools is because most teachers want urban areas. After all, the town is close by. In rural areas, the nearest town is so far away. You also find that in the rural area's teachers struggle with accommodation.*
Participant 2	*I have been a teacher for thirty years; I have been the deputy principal for this school for eighteen years. I studied theoretical engineering and I have physical science advanced certificate and B.Ed Honors. I believe we have enough physical science and mathematics teachers in this school. However, what affects the attraction of teachers here is the environment which doesn't promote the love of the science subjects. So, you see learners become demotivated and we have few students taking the subject*

Participant 3	*I teach mathematics and biology and life sciences. I have taught for nineteen years, and I have a diploma in education, as an educator, you need to keep upgrading so I have an advanced certificate n den honours degree in education. Learners are not performing well, and we have five teachers, so I do not know exactly why students do not do well because we go the extra mile with these learners.*

Participant 4	*I have a diploma in chemical engineering, and I have PGCE majoring in mathematics and physical science, I am the HoD and been teaching for eleven years. For our big school, we only have three mathematics teachers for grades eight to grade twelve and four teachers for physical science. Most of these teachers have qualifications for FET teaching level especially for physical science but for mathematics, only two are qualified.* *The rural environment makes it difficult for us to retain school teachers because it is difficult to teach physical science without resources. Just imagine trying to teach the child about atoms or the beaker from just mere imagination. It even becomes difficult for learners to grasp content. That's why the performance is dismal.*
Participant 5	*I have B.Ed (Mathematics and Physics) at FET level, I have been teaching since 2018, I am post level one. We do have mathematics and physical science teachers but some of the teachers are afraid to teach grade twelve classes because of the pressure it comes with. So, in total, we have four qualified teachers, and they are two physical science teachers to which we got above 75% pass rate while mathematics has two teachers which we got only 33%.*

Participant 6	*I majored in physical science for SPTF levels, and I further majored in geography and biology. I also have advanced certificated in mathematics literacy. I'm currently the HoD for mathematics and physical science for the past sixteen years and I have been teaching for the past twenty-nine years.*
Participant 7	*I have an honours degree in mathematics and physical science with six months of experience in teaching physical science.*

Participant 8	*I am a qualified teacher and I chose this career as a calling in B.Ed Mathematics and accounts thirteen years ago. I currently teach FET and GED levels. I think the school has enough mathematics teachers my HoD teaches mathematics and we're both qualified and in terms of physical science, I think we do have sufficient teachers. The only problem is that the level of performance in the school is very low, so the motivation they can provide is to first remind the teachers is that teaching is a calling. We need to understand that if the rural community struggles and the entire country even suffers too.*

Participant 9	*I have a secondary diploma with an advanced certificate, so I also have twenty-three years' experience of teaching in general, but I have fifteen years of physical science teaching and I am also the HoD. In my school, I think we have enough mathematics teachers and inadequate physical science teachers for the longest of times, I was the only physical science teacher, only after lockdown did, we then get another physical science teacher, but still, we're not enough.* *The parents should also support us when learners have extra lessons. Support from the subject advisors when the teachers do not know certain sections is also highly recommended and it would it easy for the learners. I would advise the school to minimize these principal's meetings during school hours. I would also recommend they limit the doctor's visits from doctors without borders and they can spend the whole day which then ends up distracting the entire classes.* *I mean, I understand the health of the learners is also important, but those constant visits can cause some unnecessary disturbances. I would also recommend they minimize the pastor's visits may be to once per month because they take a lot of precious time. We need them but they should just be regulated.*

Participant 10	*I have a BSc. Degree. I have been teaching mathematics for two years and physical science for three years. Since we teach both mathematics and physical science, I do not think we are enough. I am the only one teaching mathematics and physical science in the entire school.* *Science subject educators are loaded with work, and this affects the learner's performance because when you get tired you cannot focus. I recommend that the government provides enough teachers, they can even outsource teachers from other schools.*

4.1.2. Teacher practices and pedagogy (what they do in the classroom)

How is the availability of mathematics and science teachers in rural high schools linked to resources in the teaching environment?

Interview	**Responses**
Participant 1	*I have a B. Ed degree in mathematics and physical science post level 1 with three years of teaching experience. I currently teach mathematics and physics from grade ten to grade twelve. I think we have more than three mathematics teachers but for physical science, I am the only one who has been teaching since 2018. To improve the performance of rural learners, I think we should not ignore the number of learners per class in as much as there are few students per class, we need more teachers especially for senior grades.*

	We might even recommend the specific teacher for mathematics paper one and the other teacher for mathematics paper two and I

	think our pass rate will increase. If we do like that maybe in two years, we will reach 80%. In terms of resources, what we currently have is not enough at all, the SMT should help in organizing extra lessons or even ask teachers from other schools who are doing well to come and assist. The SMT should further pay if there is money to be paid to those teachers. However, the government should make available computers especially with the technology era we are in. *Imagine our learners do not even have cell phones, for the few that have cell phones they do not even have data. So, if the government can provide us with computers and computer laboratories for learners to google certain topics and understand them better.* *Furthermore, most learners here in the rural areas are coming from very poor backgrounds, so for stuff like calculators and dictionaries may be the government also assist. You know I have*

	come across a student who has never seen or who has never operated a calculator in grade eleven.
Participant 2	*Sometimes the rural environment demotivates the teachers, and we spoke to the SGB to motivate the teachers because most of our teachers are here for two to three years before they leave, except for the few teachers who have been for over five years. It is difficult to keep science subject educators in rural schools because they are in demand everywhere, so learners in rural areas regularly get student teachers.* *DoE is turning a blind eye to building a laboratory since we do not even have a lab to equip the school with science facilities because with the shortages of resources science subjects' educators do not want to come here.*

Participant 3	*The DoE should organize competitions and workshops for teachers to go the extra mile. The government and the other stakeholders on the other end should find ways to improve the outcome of the education system for the learners, by organizing laptops to expose learners to technology. The community should support the school by protecting our computers.* *The doe should then put alarms to protect our resources. I have also noticed that because of the rural environment teachers come and go, so with science educators being in demand, you find that they go elsewhere with better infrastructure.*
Participant 4	*The DoE should also monitor and evaluate the assessments because the standard is too low since some of the tests will not be strongly monitored. Schools in urban areas doing well are monitored well, so the DoE must take action to increase the pass rate. Technology is also important, schools in Gauteng are doing well because they have tablets and learners progress well and it also helps teachers, so the DoE should look into it.*
Participant 5	*My school only has one means of transport, if you miss that bus then there is no way you will go to work. If the bus is late, you will start class late. My observations are that although students fail, mathematics has no practical but physical science needs practical's, so in rural schools, students cannot do practical's and it becomes difficult for both teachers and learners. Because we end up googling and we project through the computer and projector for students to see examples since we do not have laboratories because no teacher wants to come to such school.*

Participant 6	*You realize that even if there are educators, but without resources, it is difficult to theorize everything, science need practical's. It is funny because lest years, I had a summer school with the grade*
	twelve class and it was the first time they were seeing the beaker. The standard of living in rural towns affects the location that teachers choose, so no one would want to choose rural over urban. The other thing is that the government should make funds available for university students who want to become teachers in rural areas.
Participant 7	*I believe most qualified teachers want to be in towns because rural communities are far, and you do not have resources to work with.*
Participant 8	*So far as the education system is concerned, the teachers are not enough, and this affects the ultimate performance and pass rate.*
Participant 9	*The science laboratory is not even there so you tell me, how do we even do experiments, the roofs in classrooms are leaking and we have broken windows everywhere. When we have the laboratory, it makes the teaching experience more fun. The government should also provide and or upgrade the infrastructure and when they do that, they should then provide teachers in these schools. The government should also try and provide scholar transport for learners so that they arrive on time and do not miss classes.*

Participant 10	*Since there is a major need for science educators, how do we motivate them to come to the rural communities when we do not have resources. Imagine some rural communities do not even have electricity, to begin with, so how do we use cell phones or laptops. The government should provide small things like calculators. I do not have resources and I have to use YouTube or google videos to show how the experiment is done, this becomes very challenging in not having infrastructure.*

4.1.3. Research Question 3.

How can mathematics and science teachers be motivated to accept employment in the rural-based high schools of the King Cetshwayo District?

Interview	**Responses**

Participant 1	*The teachers in rural areas can be motivated by offering them enough support, this will mean the doe providing enough resources for science teachers to be able to deliver results. The government should also supply the rural teachers with rural allowance because unlike urban teachers who travel short distances to work, rural teachers will travel long distances maybe even an hour to get to work.* *The government should also provide rural based teachers with bursaries specifically for them if they went to further their studies to attract more teachers to rural areas. The community must also work hand in hand with the teachers by supporting the school, even providing their time or even energy since we know they do not have money. I think my community is also doing much because they offer homes to learners who stay far away, and they currently offer a backyard room for free to stay.*
Participant 2	*So rural school teachers should network with schools that have good science subject educators and even rope in NGOs to assist where possible. The DoE and the principal should incentivize educators to attract them to rural areas, imagine if the teacher has to drive their car to deep rural towns, if they get the chance to leave, they will, but these incentives will at least attract them. The government should also bring in portable laboratory kits to make sure these learners are educated come exams because we need engineers, right?*

Participant 3	*The DoE should give science educators in rural towns, extra incentives to retain them in those schools.*

Participant 4	*Science teachers leave us here in rural towns because they become frustrated by teaching without resources or clear models. Imagine talking about chemical reactions without showing them, so teachers leave the rural schools, and this affects the total performance. The community has a role to play, they can provide accommodation to teachers and learners coming from far away. The community can also provide security around the school to protect resources.*
Participant 5	*The other thing the government should do is to try to add more funds to resources like laptops/ models where learners can see the human body of a skeleton because if the teacher says the human hand has so many bones, you do not even have the model to count them on and show the learners.* *The government should also provide learners with more university funding because you find that they do not even have application fees to apply to universities. The government needs to provide the schools with more transport for both the teachers and the learners, this will help us stay longer during and after school hours.* *We also need to be digitalized it would help our learners too since our rural communities are poor and they do not have infrastructure and libraries. Let us not forget that teachers, learners, and parents, we all have important roles to play.* *If they want to motivate teachers, the DoE should try to raise the bursaries, and these should strictly be for rural-based learners with*

	requirements that if you get funded you come back to teach in the rural towns. *The DoE should organize workshops with the university for the training and development of these science subject educators in rural towns.*
Participant 6	*One thing is that teachers should take the career as a passion not just to earn money due to the shortage of employment. The government should also put more incentives with the rural allowance, just like they do for medical doctors in rural areas.*
Participant 7	*I feel like the government needs to show how they can help teachers and make them realize that teaching is not just for the money but for learners. Regarding the DoE, it should be more involved in the circuits and take a stand to be more active in the schools.*
Participant 8	*The DoE should work hand in glove with the community to make it possible for all to work in a conducive environment. The DoE should also monitor and evaluate the systems because you can have qualified teachers, but performance needs constant monitoring and evaluation in terms of the formative and summative assessments.* *The community should be involved too in guiding themselves to protect the school knowing that the school is theirs. My general view is that these learners should be taught well to make sure that one or two will be able to give back to their rural communities.*

Participant 9	*If you underline the word rural before you even go there, you get a bad picture and most teachers in science subjects do not even want to go to those schools. You think round huts, no electricity,*
	and no roads. I know one mathematics teacher back in 2004 who came and left after a day because she could not cope with the rural environment, and she felt glamorous. So, what I think the government should do is to upgrade the infrastructure especially the roads even if you buy a car, it will end up damaged so you would rather choose greener pastures instead.
Participant 10	*The standard of living in rural communities makes no one wants to teach or live here, because I mean who would want to worry about how they will get to town, it's a struggle out here.*

4.1.4. Research Question 4.

To what extent does the availability of mathematics and science teachers in the rural high schools of the King Cetshwayo District contribute to learner's performances?

Interview	**Responses**
Participant 1	*The lack of availability of teachers affects students because for example if we struggle on one topic, we take forever end there is no distribution of knowledge, and one lack of understanding in one chapter will affect the outcome of the learner's performance.* *The non-availability of teachers affects the pass rate because for one to tech physics alone is unfair for the students, if I don't know one chapter, I end up telling them to refer to the textbook and imagine when the question comes in the exam, its dismal failure.* *If we continue like this even the pass rate in two to three years from now will drop drastically. We need at least two physical science and three mathematics teachers otherwise we will always have poor performance in rural areas. The SMT should organize*
	workshops through the DoE to share information between teachers to help improve the performance of the students. *We should also set mock final exams and award the learners with certificates to motivate them. I have personally told the learners, anyone who gets 80% in my subjects, I will give them a trophy.*

Participant 2	*My view is that on the availability of science educators in the rural schools, the government should provide in-service training to improve their skills, in the 90's we would get trained by the university and it would help us a lot because improving teaching and learning is an ongoing process. So, all the relevant stakeholders should come together to find the solution needed.* *The community should support by bringing safety into the school especially when we have afternoon classes which go on till late. The community can also provide cottages for our matric learners who stay far away to make sure they are close to school, and they arrive on time for school and exams.* *The government should provide technological support, because for instance if the child is hungry, the school provides food, but internet and transport, these things the school cannot give you. We also need protection; you find that some of these learners are slightly older, and they become violent.*
Participant 3	*We have two science teachers for grades ten and eleven and I think they are enough. However, the learners do not do well in mathematics when most times we even ask other educators to come and assist but still et the end of the year they fail.* *We do not have teachers because science educators choose where they have resources, fortunately, my school has laptops*
	which were donated by an organization with Wi-Fi to help students, we hope that our students will do better.

Participant 4	*The non-availability of teachers affects teacher's performance because they cannot teach the subject if they do not have qualifications for it, so learners lose focus on the entire subject. Sometimes the problem cascades from primary schools where social science teachers teach mathematics. So, I think if the student lacks science subjects at a young age, there is no way they can catch up when they are in high school.*
Participant 5	*The problem is the scarcity of science educators, and this is because the primary school level does not take science subjects seriously. With the scarcity and demand of science educators, you find that no one wants to go to rural areas.* *The other issue affecting the performance is the pass one – pass all policy. The school management should further make sure that the teacher, teaches from grade eight to grade twelve so that the teacher can best learn the challenges being faced by each student.*
Participant 6	*I don't think the school has enough mathematics and science teachers, even if they are qualified, but the manpower is not enough at all. You find that we have three mathematics teachers and one for physical science, so this affects the workload distribution.* *The DoE should input monitoring and evaluation means to make sure the results are increased because the current conditions in rural schools are terrible. The other stakeholders such as the community need to provide us with support security. Because if we get laboratory facilities and infrastructure, the community needs to*

	know that they own it and therefore they need to protect everything within.
Participant 7	*I do think we have enough mathematics teachers; the only problem is that students have the fear of taking mathematics and physics by the time they go to university; they do not want to take science or mathematics classes.*
Participant 8	*The government can also introduce team teaching; hence the education will change with the addition of more teachers to ease the workload. The DoE can support the teachers by providing them with the rural allowance.* *In the process, we can also start with developing and nurturing learners within rural areas to become teachers with a passion for the learners. The DoE should improve the pass rate by supporting the school, learners, and the teachers in rural communities by giving the teachers a rural allowance so that the teachers can perform better.*
Participant 9	*The non-availability of teachers affects the performance, which is already low, imagine being the only physical science teacher and if I need help, I would have to go to another school. If we were many then we would be able to bounce ideas. You need to understand unhappy teachers=, unhappy learners. The community should also know that the school is their property, and this will make sure no school property is stolen or vandalized.*
Participant 10	*The community should also support the school to help the teachers and learners perform better.*

5.3. The Discussion of Research Findings

The purpose of this study is to look at the complexity of the supply of critical science subjects of mathematics and physical sciences, while looking at the availability of subject-specific and qualified teachers who are willing to live and teach those subjects in rural-based schools. A few studies attribute the under-development of human potential to the kind of education and training system offered in South Africa particularly the black South Africans to the apartheid legacy. The finding of this study is discussed in the section. The previous study related to the data collected shows that many researchers predominantly focused on teachers to better explain the learning outcomes of students in various subjects. According to Spaull (2013), the success of a country's education system is inextricably linked to the quality of its students. Barber and Mourshed (2007), agree with this. The lack of well-trained teachers of mathematics and science in South Africa is a product of the apartheid legacy. To date, inequalities in education in South Africa have not been adequately discussed.

The move from a white minority-only mathematics programme to one free to all learners (post-apartheid) regardless of colour, meant that the black child will receive an incompetent teacher (Madela, 2016). As a result, the view of mathematics as challenges can be well understood when one considers the conditions that shape students' perceptions of mathematics and what influences their success (Madela, 2016). Another aspect that leads to poor mathematics success is the question of the language of instruction (English), which is not the mother tongue of most of the students. According to the Zenex Foundation (2007), one of the discernible core factors influencing mathematics achievement in South Africa is low language skills among teachers and learners. The Department of Basic Education developed a mathematics programme to ensure that all Grade 12 students leave school with numerical knowledge appropriate to social contexts.

The Mathematical literacy of students in Grade 10 has the option of studying mathematics or mathematical literacy. Mathematics, which is widely regarded as

challenging, has been overlooked by most students, as mathematical literacy views itself as a simple numerical skills subject that does not necessitate as much effort as mathematics. According to Spaull (2013), over four years (2008-2011), the percentage of students taking mathematics as compared to mathematical literacy dropped from 56% to 45%, as more students saw mathematical literacy as the simpler choice of the two (Madela, 2016). According to the Centre for Development Enterprise (2014), developments in the number of candidates writing mathematics and mathematical literacy indicate that in 2010, 263 034 learners wrote mathematics for the National Senior Certificate, but this number fell to 104 033 in 2013.

In contrast, the number of students writing mathematical literacy exams has increased from 280 241 in 2010, to 324 097 in 2013. This demonstrates that the number of students enrolling in university courses in science, technology, medicine, and engineering is diminishing, and as a result, the country will continue to face a skills shortage in these fields. Above that, the success of those who enrol in mathematics is not particularly high. It is worth noting that the reasons behind the poor success rate and dwindling numbers of students in mathematics are many and vary depending on the background. South Africa has been named one of the countries with the lowest mathematics results. According to the Trends in the International Mathematics and Science Study (TIMSS), South African students do the worst out of all 21 middle-income countries that participated (The Centre for Development and Enterprise, 2013); this is a significant concern.

The constraints influencing learner success in mathematics, according to the Centre for Development Enterprise (2014), are dynamic, interconnected, and often structural. It is also claimed that these include, among other things, a shortage of school infrastructure and funding, high-class sizes, insufficient teacher instruction, low learner dedication and discipline, and insufficient parental participation. These restrictions embody the country's history; they serve the apartheid government, which promoted educational discrimination through the Bantu Education Act of 1953. When learners are introduced to these difficulties, their attitudes, and perspectives on the topic change. These influence their subject choices and, later, their job choices. Furthermore, there is evidence of a decrease in student enrolment in higher education

courses in mathematics, astronomy, technology, and engineering in South Africa, where pessimistic attitudes toward mathematics (and science) are often cited as contributing factors (Mutodi & Ngirande, 2014).

The above knowledge poses the question of does the complexities of the availability of mathematics and physical science subject teachers inform the poor performance of learners in the rural-based high school in the King Cetshwayo district? It is critical to place how mathematics helps students make sense of the world at the centre of any discussion about a global curriculum through mathematics. What kind of experience does a student have that allows them to utilize mathematics to contribute to the global community, and what kind of mathematics material do students need to tackle complicated problems in a complex world (Darling-Hammond, 2020)? It must be established or acknowledged that all the respondents interviewed in this research are qualified educators with several years of experiences and some of them have held a various leadership position in high school.

The study aims to examine the complexities in the availability of mathematics and physical science teachers in rural high schools within the King Cetshwayo District, as there remains a failure rate that is high among learners, in the critical science subjects, which continues to be a danger in the South African education system. The few learners who manage to get through high school and who are aspiring to pursue a career in mathematics when they arrive at the university are often met with daunting and pervasive problems. According to (Stols, et al., 2015), these problems start with camped learning spaces, this is where learners shove for a room in classrooms initially meant to accommodate 30 or 40 (IMU, 2014). Few students are taking mathematics and science-related subjects at the universities as degree qualification, which seems to affect the supply of teachers in rural-based high schools. In certain cases, this has led to schools discontinuing the teaching of mathematics and physical science (DoE, 2001).

Many under-qualified or untrained teachers who teach in overcrowded and inadequately equipped classrooms have exacerbated the poor or low standards. There

are a variety of perceived school-based elements that can influence learners' performance, such as the availability and utilization of teaching and learning facilities, as well as environmental and socio-economic issues. However, I could not find literature indicating how these and other factors may be affecting the availability of mathematics and science teachers in the area. Learner performance is seen not to improve in the rural schools within the King Cetshwayo, there is a need to understand how complexities in the availability of mathematics and physical science teachers. The major challenge, therefore, is finding genuine, relevant, and noteworthy examples of global or cultural contexts, this study looks at various factors that help to improve, deepen, and exemplify an understanding of the mathematics subject. A scholar stated that the global era will demand the skills above from the people, which the education system ought to provide learners with the wherewithal to be proficient in them (Alessandra, 2017).

This means that recognizing the contributions of various cultures is also part of knowing the globe. In terms of the physical science subject, The National Academy of Sciences (2018), states that science teaching is a complex activity that lies at the core of the vision of NAS of science education that is being presented in the teaching standards. Scholars like Stols, et al., (2015), note that today many hundred learners are assigned to that same room that is jammed elbow to elbow, harmonizing on projections, or even as far as standing along the classroom walls in the university. Particularly in francophone nations, where little emphasis is paid to applied, transdisciplinary, or industrial mathematics, the subject matter frequently focuses exclusively on the traditional divisions of pure mathematics, which are algebra, geometry, and analysis (Stols, et al., 2015).

The teaching standards of physical science provide criteria for constructing conclusions about the progress toward the vision national academy of sciences, while they define what teachers of physical science at all grade levels should understand as well as what they can do (Mandla, 2016). Regarding the query into the extent of the availability of mathematics and science teachers in the rural high schools, a respondent commented that the government should provide in-service training to improve their skills. The respondent further articulated how in the 90s, teachers would get trained by the

university and it would help them a lot because improving teaching and learning is an ongoing process. So, all the relevant stakeholders should come together to find the solution needed. The respondent added that the community should support by bringing safety into the school especially when we have afternoon classes that go on till late.

The community can also provide cottages for our matric learners who stay far away to make sure they are close to school, and they arrive on time for school and exams. The government should provide technological support, because for instance if the child is hungry, the school provides food, but internet and transport, these things the school cannot give you. The researcher gathered from the respondents that there is a form of insecurity in the communities where most schools are located, hence the teachers fear their lives and therefore require protection and assured safety in the learning environment, where they offer their services.

> *We also need protection; you find that some of these learners are slightly older, and they become violent.*

To highlight the significance of teachers in teaching physical science in education, these standards are presented first. Globally, it is important to understand that what learners in high schools learn is greatly influenced by how they are taught. The conclusions about the content and activities in which the teachers make are in line with their interactions with the learners, the selection of valuations and the conducts of mind that teacher (Clarke, 2012). Physical science teachers should have both theoretical and practical knowledge, as well as skills in science learning and teaching. It is critical to analyse how the mathematics sematic subject could assist learners in making sense of the world at the heart of any argument on a global curriculum through the mathematics sematic topic.

The purpose of this study was to investigate the complexities of the supply of critical science subject teachers. During the apartheid era, education and training in South Africa were characterized by the underdevelopment of human potential, particularly among black South Africans. The teaching and learning of mathematics, science, and

technology were the most affected, according to the Department of Education (DoE) (2006). However, studies demonstrate that in South Africa, there are significant shortcomings in the teaching and learning of mathematics and physical science subjects (Howie, 2003).

What makes this research more significant is that no existing research has been conducted in this area that shows the root source of learners' poor performance in the critical science subjects (mathematics and physical sciences) in the King Cetshwayo District. The perceived school-based elements that are likely to contribute to learners' performance in rural-based schools, such as the availability and utilization of teaching and learning facilities, the environment, or socio-economic factors, motivated this study.

5.4. Research Objective 1

To explore factors that affect the supply of qualified science teachers in the rural secondary schools of the King Cetshwayo District: The Demand for Science Teachers in South Africa

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To achieve this objective, the researcher investigated the factors that affect the supply of science teachers in the rural high schools of the King Cetshwayo District. In understanding the factors that affect the supply of science teachers in the rural high schools in South Africa, such as the King Cetshwayo District, it is noted that in the past few decades, the focus on educational change has been prevalent. Education systems around the world have struggled to meet the real needs of the times. The challenges and opportunity in the current era in mathematics education in Africa are still at a struggling level according to a wide variety of both regional, national, and international assessments (International Mathematics Union, 2014). Though there have been occasions where remarkable progress has been experienced since the 2009 report by the International Mathematics Union.

The IMU (2014), states that the Africa Mathematics Project, which is supported by the Simons Foundation is one of those success stories, the mainstream challenges remain however with a low pass rate from learners. In the quest to move the South African education system beyond the legacy of apartheid, this study noted that over 25 years since South Africa gained freedom and became a democratically independent society, there remains a colossal disproportion of inequality in the provision of quality and affordable education for all its citizens across every society (Scott, 2019). Findings show that the black South Africans were among the majority who find it extremely challenging to have access to affordable and quality education and training at all stages of the education system. One participant noted that:

> *The problem that makes teachers not want to come to our rural schools is because most teachers want urban areas. After all, the town is close by. In rural areas, the nearest town is so far away. You also find that in the rural area's teachers struggle with accommodation.*

Other factors that contribute to the learners' low performance in various science subjects include the education of the learners' parents or guardians, and by extension their economic status, learner's factors – which include motivation and attitudes, school type, and the characteristics of the teachers (Kibet, et al., 2012; Makgato & Mji, 2006; Mwaba, 2011).

> *I teach mathematics and biology and life sciences. I have taught for nineteen years, and I have a diploma in education, as an educator, you need to keep upgrading so I have an advanced certificate n den honours degree in education.*

In Kenya for instance, physical science subjects such as biology, which is a science, has enormous practical applications in our daily lives. Conversely, in other science subjects just like mathematics, the performance in both science subjects at the national examinations has been recorded to be relatively low (Sikolia & Sikolia (2016). As a result, in July 1998, the Kenyan government started the Strengthening of mathematics

and Science in Secondary Education (SMASSE) project in partnership with the Japan International Cooperation Agency (JICA) (Sikolia & Sikolia, 2016). The SMASSE has subsequently begun in-service training of all serving teachers in critical subjects such as mathematics and science, according to the researchers, with the express goal of making them better teachers.

According to an updated IMU assessment "The 50-plus nations of Africa display tremendous heterogeneity in size, population level, richness, and culture". Poor working conditions, work overload, cultural obstacles, a lack of recognition, communication barriers with learners, and a lack of cooperation are all examples of poor working conditions (Muzah, 2011; Chux, et al., 2013; Vassallo, 2014; Mbajiorgu, et al., 2014).

> *Learners are not performing well, and we have five teachers, so I do not know exactly why students do not do well because we go the extra mile with these learners.*

Scholars have articulated that “challenging the past and moving beyond the legacy of apartheid is how the South African Department of Education plans to work towards social justice and equity with the introduction of the new curriculum titled Curriculum 2005" (Asmal, 2005; Heather, 2014). The first step in addressing the past is to eliminate blatant racism in educational systems, but there are other socioeconomic inequities that must be addressed to prevent future racial inequalities in education. "The Apartheid system fostered educational inequities through overt racist practices", according to Ocampo (2004). The Bantu Education Act of 1952 ensured that Black people would receive an education that limited their educational abilities and allowed them to remain in the working class (UCT, 2004). This policy has a direct impact on learning content to aggravate socioeconomic inequality by limiting access to higher education.

Apart from the content, apartheid legislation had an impact on students' educational abilities (Scott, 2019). Whites were required to attend school from the age of seven to

sixteen, asians and coloureds from the age of seven to fifteen, and blacks from the age of seven to thirteen (US Library of Congress, 2004). The less schooling students receive, the fewer job opportunities and opportunities for additional education they will have. Reforming these policies in the post-apartheid period was a sensible step towards social equality because they assured that the content and amount of schooling reinforced racial inequality. The financial disparity in education has also been evident. The Bantu Education Act established distinct departments of education for each race, with Black schools receiving less funding and White schools receiving more (UCT, 2004). Uneven funding has resulted in inequities in learning settings since funding determines the amount and quality of learning resources, facilities, and instructors (Baker, 2019).

> *I have a B. Ed degree in mathematics and physical science post-level 1 with three years of teaching experience. I currently teach mathematics and Physics from grade ten to grade twelve. I think we have more than three mathematics teachers but for physical science, I am the only one who has been teaching since 2018.*

> *To improve the performance of rural learners, I think we should not ignore the number of learners per class in as much as there are few students per class, we need more teachers especially for senior grades.*

> *We might even recommend the specific teacher for mathematics paper one and the other teacher for mathematics paper two and I think our pass rate will increase. If we do like that maybe in two years, we will reach 80%.*

A respondent said,

> *The SMT should further pay if there is money to be paid to those teachers. However, the government should make available computers especially with the technology era we are in. Imagine our learners do not even have cell phones, for the few that have cell phones they do not even have data.*

So, if the government can provide us with computers and computer laboratories for learners to google certain topics and understand them better. Furthermore, most learners here in the rural areas are coming from very poor backgrounds, so for stuff like calculators and dictionaries may be the government also assist.

The respondent further mentioned cases where learners have never seen a computer, because of inadequate funding or under-equip of high schools, particularly at the rural-based communities.

You know I have come across a student who has never seen or who has never operated a calculator in grade eleven.

These finding show that the present situation in the rural-based high schools is not matching this very ideal. However, the apparent role of a scientifically motivated, “young generation is undeniable for the sustainable economic growth of any country” (John, 2019: 3). Among the various science subjects including mathematics and physical sciences in the South African school curriculum, it is noted that physical sciences have a conspicuous role in defining learners' acceptability into various in-demand university degrees with a specific field in science and technology.

5.5. Research Objective 2

To explore motivation possibilities of attracting mathematics and science teachers to accept employment in the rural-based high schools of the King Cetshwayo District.

The big quest was how mathematics and science teachers can be motivated to accept employment in the rural-based high schools of the King Cetshwayo District, to ensure

that qualified subject teachers are evenly deployed to all schools, regardless of the location (urban or u=rural). To begin with, the state of critical subjects such as physical science and mathematics in South African schools today has often been characterized as a national tragedy, as learners have performed very poorly in comparative tests of science. As a result, there is poor performance in mathematics internationally, at the regional level and even at local benchmark texts. This seems to be true at primary and secondary school levels, according to the Academy of Science of South Africa (ASSAf) (2010), there is an averaged result mask of a very extensive disproportion between learners.

This is where, “a small minority continue to make significant progress in these subjects, while the majority fail to perform at appropriate levels” (ASSAf, 2010). As a result, the number of potential scientists, engineers, health practitioners, and future mathematics and science teachers, is severely constrained. This, therefore, reduces the ability of South Africa to be internationally competitive, which in turn impacts its ability to provide the foundation or structure needed for the wellbeing of the South African majority.

> *My view is that on the availability of science educators in the rural schools, the government should provide in-service training to improve their skills, in the 90’s we would get trained by the university and it would help us a lot because improving teaching and learning is an ongoing process.*

Another challenge is the antiquated lecture-style of teaching, which allows for limited student interaction and discourages group learning. Poorly aligned teaching with learners' requirements, as well as an out-of-date curriculum that is out of step with current job realities (IMU, 2014). However, the respondent advocated for the need to have all the relevant stakeholders come together to find the real solution needed, with the possibilities of attracting mathematics and science teachers to accept employment in the rural-based high schools of the King Cetshwayo District. It was further noted that the community should offer their support by bringing safety into the school where teaching and learning take place. Having a safe learning environment for both learners

and teachers, especially when schools organize afternoon classes which go on till late in the evening.

The community can also provide cottages for the matric learners who stay far away to make sure they are close to school, and they arrive on time for school and exams. The finding shows that despite the key role of education in the economic growth of the country and the need for both the government and all relevant stakeholders to get involved. It is well known that South Africa's learners have historically struggled in the physical sciences. This is true both at the national (as evidenced by matric exam scores) and international levels (as evidenced by achievement tests such as the Trends in International Mathematics and Science Study) [TIMSS]).

> *The government should provide technological support, because for instance if the child is hungry, the school provides food, but internet and transport, these things the school cannot give you.*

School learners' baffling performance in South Africa is often confined to black and coloured schools, while performance at historically white and indian schools remains considerably above the national average. The finding from the respondent indicated:

> *The teachers in rural areas can be motivated by offering them enough support, this will mean the doe providing enough resources for science teachers to be able to deliver results.*

This situation was confirmed by Van der Berg, (2008), to constrains both Black upward mobility in the “labour market and the skills required for the economic growth of a middle-income country like South Africa” (Van der Berg, 2008). The education system in the rural-based high schools in South Africa faces a unique set of challenges, according to Nkambule, et al. (2011). This is attributable to a variety of factors, including the schools' geographic location, learners' backgrounds, and learning styles. The South African Department of Basic Education (DBE) drafted a Rural Education Policy

to address the problems, with the goal of enhancing access to education and the quality of education for all students in rural schools (DBE, 2017).

The policy designates rural areas, such as farms and traditional lands, as those with low population densities, low economic activity, and inadequate infrastructure. According to the DBE (2017), the policy outlined:

> *Despite several pro-poor initiatives, which have been implemented since 1994 to promote equity and quality of education in previously disadvantaged schools including rural schools. A large number of rural schools are still characterised by inadequate resources, teacher shortages, absenteeism, learners' dropout from school, and poor educational outcomes"* (DBE, 2017:8).

This is true at both the national (as evidenced by matric exam scores) and international levels (achievement tests such as Trends in International mathematics and Science Study [TIMSS]).

> *The government should also supply the rural teachers with rural allowance because unlike urban teachers who travel short distances to work, rural teachers will travel long distances maybe even an hour to get to work.*

This situation was confirmed by Van der Berg, (2008), to constrains both Black upward mobility in the "labour market and the skills required for the economic growth of a middle-income country like South Africa" (Van der Berg, 2008). It further confirmed that the education system in the rural-based high schools in South Africa faces a unique set of challenges, according to Nkambule, et al, (2011), this is due to the diverse issues which include the geographic location of the schools, learners' backgrounds and learning styles.

> *In terms of resources, what we currently have is not enough at all, the SMT should help in organizing extra lessons or even ask teachers from other schools who are doing well to come and assist.*

In terms of resources, the policy and funding inequalities in South African schools have ensured the difference between accesses to quality education. Only whites were admitted to four Afrikaans-speaking schools and one English-speaking educational institution, while the other five had limited admittance and separated classrooms (US Library of Congress, 2004). Furthermore, there was little financial assistance, and banks refused to lend to blacks or coloureds (KnipeSolomon). This means that even if

In understanding the Educational Inequalities in post-Apartheid South Africa, it was stated that since the apartheid era, many legislative reforms have taken place inside education to try to resolve educational inequality. Integration has taken place in the education system, and school is compulsory for all races (Garson) for nine years.

While Bantu education has formally been abandoned behind, schools are still in de facto isolation. Discussing the environmental factors that could affect learner's performance, a respondent said,

> *The rural environment makes it difficult for us to retain school teachers because it is difficult to teach physical science without resources. Just imagine trying to teach the child about atoms or the beaker from just mere imagination. It even becomes difficult for learners to grasp content. That's why the performance is dismal.*

Another respondent explained how the advancement and provision of technologies have helped to improved teaching and learning in the urban setup, unlike in the rural areas of South Africa.

> *Technology is also important, schools in Gauteng are doing well because they have tablets and learners progress well and it also helps teachers, so the DoE should look into it. The other thing the government should do is to try to add more funds to resources like laptops/ models where learners can see the human body of a skeleton because if the teacher says the human*

hand has so many bones, you do not even have the model to count them on and show the learners.

While township schools are largely black, and rural schools appear to have black and coloured students (Knipe-Solomon), the setting where white South Africans have gone to private schools and suburban schools has a plurality of coloured students. It is difficult to address educational inequality without considering the economic inequities that resulted from apartheid education. Contrasting portions of the labour force remain in the aftermath of the separatist influence of apartheid; against the predominantly white elite skilled force, a huge number of working-class blacks stand out.

The community must also work hand in hand with the teachers by supporting the school, even providing their time or even energy since we know they do not have money. I think my community is also doing much because they offer homes to learners who stay far away, and they currently offer a backyard room for free to stay.

This means that for the education system to achieve its goals, the community must work hand in hand with teachers by supporting school needs, relying less on parents' contributions to obligatory and higher education to better aim at moving past the apartheid legacy. This ideal reform of universal free public education and financial aid for higher education will require finance. Twenty percent of the funds already go to education, the Department of Education must pursue innovative reforms to reallocate resources such as funds or outsourced money through other avenues, such as tourism in townships, and ensure there is the availability of qualified teachers in rural based high schools.

The lack of availability of teachers affects students because for example if we struggle on one topic, we take forever end there is no distribution of knowledge, and one lack of understanding in one chapter will affect the outcome of the learner's performance.

These initiatives will help pursue the objective of moving further than the past and working for a future of social justice, providing qualified teacher and even distribution of resources that will assist the learners in teaching and learning. Equal Education (n.d.), an organization that strives to combat social injustice in education, stated that inequality and historical legacies, as well as their influence in South Africa, require more attention. In the 2016 annual report, it indicated that "despite efforts to improve the system, class and race-linked inequalities persist, unequal educational opportunities remain among the greatest obstacles to equality, dignity, and freedom in South Africa" (Equal Education, n.d). An immensely contributing element to the poor or underperformance in the mathematics and physical science is the low quantity of qualified trained teachers in the rural and peri-urban schools. Findings show that the non-availability of qualified teachers who are willing to take up employment in rural based schools can affect learner's performance.

> *The non-availability of teachers affects the pass rate because for one to tech physics alone is unfair for the students, if I don't know one chapter, I end up telling them to refer to the textbook and imagine when the question comes in the exam, its dismal failure. If we continue like this even the pass rate in two to three years from now will drop drastically.*

Mathematics is the subject that is known to be the mother of all learning or erudition with other subjects, in stemming their perceptions from it, both in the fields of arts and sciences.

> *We need at least two physical science and three mathematics teachers otherwise we will always have poor performance in rural areas. The SMT should organize workshops through the DoE to share information between teachers to help improve the performance of the students.*

According to Belhu (2017), mathematics provides insight into the human mind's capabilities and serves as a challenge to intellectual curiosity. It's no surprise that anyone who is proficient in mathematics and sciences may also study and perform well in other subjects.

We should also set mock final exams and award the learners with certificates to motivate them. I have personally told the learners, anyone who gets 80% in my subjects, I will give them a trophy.

Consequently, good performance in mathematics is important (Belhu, 2017). The reports released by the IMU in 2014, made a clear cut that these conditions are virtually the same throughout the continent. These challenges are summarized as follows: There are few secondary school teachers and mathematicians with master's and doctoral degrees. Countries are unable to meet the growing need for advanced, up-to-date mathematicians due to a scarcity of academics to train the next generation of leaders. Isolation on both a professional and geographical level, which limits prospects for advancement; low pay, a bad reputation, and a scarcity of mentors; Students are clamouring for a college degree in record numbers; Infrastructure, apparatus, and teaching materials are all old and in need of replacement. A respondent said:

The DoE should give science educators in rural towns, extra incentives to retain them in those schools. The government should also provide learners with more university funding because you find that they do not even have application fees to apply to universities.

The overall success story of mathematics and physical science development in Africa is one of the potentials that is yet to be fulfilled and the position of the teacher. Indeed, one of the key goals of teaching and learning mathematics is to help high school students to gain confidence in utilizing mathematics to evaluate and solve real-world situations (Mazana, et al., 2020). The practices that are in real-life situations, however, though a quite a number of student’s flourish in terms of learning mathematics subjects, many students find it difficult and eventually fail in the subject (Mazana, et al, 2020).

Effective mathematics teaching and learning are critical not just for exam or assessment purposes, but also for equipping students to live in a modern age of science, mathematics, and engineering and to contribute to the social and economic growth of developing countries and the entire world. Mathematics is defined as "the

logical sequence of formulae," which can be condensed to the accumulation of rules and formulae (IMU, 2014). Non-Mathematics applications are not always necessary components of mathematics. In mathematics classes, students study, the elementary circumstances or conditions of mathematics and they continue to calculate everything that comes from other subjects.

> *We have two science teachers for grades ten and eleven and I think they are enough. However, the learners do not do well in mathematics when most times we even ask other educators to come and assist but still at the end of the year they fail.*

According to Sikolia and Sikolia (2016), the understanding of the teacher perception, teachers have the core responsibility for learner's learning and education works in a manner that allows the learners to get something concrete. Something that is fixed and must be understood by the students. The application of educated calculation approaches is very imperative, compared to reason oneself, therefore against this background, the fundamentals just like that may need to be 'memorized' (Fidele, et al., 2019).

The class teacher thus sees him/herself as, "a crammer who trains basics and who functions as a controller for systematic working" (Kaiser & Vollstedt, 2007). The tasks of teachers are of very high significance in this view of mathematics teaching, as it is to primarily serve for the training of fundamental mathematics contents. "The mere function of practice' is important, which means that 'they [the students] practice the same again and again with little variation" (Kaiser & Vollstedt, 2007: 2). While the connection to daily life is crucial, the tasks themselves do not have to be practical. The overall story of mathematics development in Africa is what is regarded as the unfulfilled potential. Based on the exceptional accomplishments of some few individuals and institutions, the International Mathematics Union (IMU) (2014), states that, "no African country lacks talented potential Mathematicians".

In the absence of a stronger educational structure at all levels including qualified subject educators, only about a few of the learners can reach their full potentials. Understanding mathematics as a subject and the application can be developed, to contribute to the advance of a bigger understanding of some of these issues (IMU, 2014). The reform and modification in education and the teacher-training programmes, as well as school curriculum, there seems to be yet many challenges that are facing mathematics education in South Africa. According to Machaba (2017), there is a “strangely low achievement of children in mathematics”. Machaba (2017), states that the poor performance in both mathematics and physical science of children, in the foundation phase has been a concern of everyone. This is because the foundation phase teachers have a vital role to play in “the teaching and learning process of mathematics in schools” (IMU, 2020: 4).

Study shows that being the first teachers who engage with the children with mathematics in primary schools, are anticipated to do several activities to ensure that the learners are fully prepared. They ought to be fully ready to manage with prevailing and future knowledge of mathematics (Machaba, 2017). It is expected that the teachers must be in a position to help develop the children' foundation, with regards to mathematics and sciences subjects through a proper selection and utilization of content. At the foundation phase in schools, according to Bashir, et al. (2018), the teachers are seen as the “front line of mathematics because of their huge responsibility of preparing children for careers that require increasingly demanding levels of mathematics skill and thinking”. The level of education of secondary school teachers is a factor to be considered while discussing the competency level of Mathematics. According to the International Mathematics Union (2020), the educational level of mathematics teachers in secondary school is seen to vary from country to country.

Teachers’ qualifications range from a “bachelor’s or master’s degree at the high end to various certificates and diplomas that may not be in a mathematics specialization” (IMU, 2020). As such, varieties in the level of qualification and field of speciality from degrees and diplomas. This gives an impression of specificity and uniformity; official requirements are not always met. This is sometimes attributed to inherent ‘bottlenecks’ and governments' inability to supply the necessary training resources (Machaba,

2017). In some circumstances, the tight requirements exacerbate the problem. Teacher shortages are frequently alleviated by a strategy known as ‘inferior substitution’, in which a surplus of qualified teachers (in other subjects) and temporary teachers are sent to teach mathematics (Machaba, 2017). Even if they are not properly certified to teach the subjects of mathematics and physical science, they can nonetheless teach it.

5.5.1. National Development Plan Priorities: Mathematics Education

According to the executive summary of the National Development Plan (NDP), mathematics education is one of South Africa's national priorities, with "the demand for an increase in the number of students achieving above 50% in Literacy and Mathematics, respectively" (National Planning Commission, Department of the Presidency, Republic of South Africa, 2012: 2). The legacy of low-grade mathematics education that was supplied to most learners during the previous apartheid government appears to be prominent in most public schools almost two decades since South Africa transitioned from the Apartheid regime to the democratic system (Stols, et al., 2015). According to the results of the Trends in International Mathematics and Science Study (TIMSS) 2011, “South Africa was put among the poorest performing participating countries, as in the case of similar studies in the past" (Spaull, 2013).

Individuals’ lack of mathematics knowledge is linked to the current crucial issues that South African teachers, as well as teachers in many other nations, confront in developing and evolving economies. This is in addition to the necessary skills to apply what they've learned in the classroom to the students (Stols, et al., 2015). It is widely accepted, according to Rowland and Ruthven (2011), that the quality of teaching is ultimately determined by the information that the teacher delivers to the classroom. According to the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) III survey, many South African mathematics teachers have an inadequate comprehension of the curricular topics they are obliged to teach. The discussion of possible remedies to South Africa's mathematics crisis usually generates questions.

This raises the question of what kind of additional support for teachers may be provided and how it could be delivered in a way that would be beneficial to their professional development (Stols, et al., 2015). The weaknesses and strengths of a mathematics teacher at the postsecondary level are varied, but underlying them all is the continuing paucity of certified and professional or skilled teachers at all levels (Stols, et al., 2015). The few students who make it through high school and into university with the goal of pursuing a career in mathematics are frequently confronted with severe and widespread problems. According to (Stols, et al., 2015), these problems start with overcrowded learning spaces, this is where learners shove for a room in classrooms initially meant to accommodate 30 or 40 (IMU, 2014).

Hundreds of students are now assigned to the same room, where they are packed elbow to elbow, harmonizing on projections, or even standing along the university classroom walls. Particularly in francophone nations, where little emphasis is paid to applied, transdisciplinary, or industrial mathematics, the subject matter frequently focuses exclusively on the traditional divisions of pure mathematics, which are algebra, geometry, and analysis (Stols, et al., 2015). Another concern is the outdated lecture method of instruction, which allows for little student interaction and discourages group learning. Poorly aligned teaching with learners' requirements, as well as an out-of-date curriculum that is out of step with current job realities (IMU, 2014). In summary, African nations including South Africa require more support for those who might wish to develop their careers as educators and researchers in the field of mathematics and physical science, also with more collaboration among people and institutions that are seeking to make this happen. The necessary steps to achieve it would be to have a stronger teaching foundation in both primary and secondary schools.

5.6. Research Objective 3

To explore whether the availability of professional mathematics and science teachers in the rural secondary schools of the King Cetshwayo District affect learner's performances

As the researcher investigated what factors affect the supply of science teachers in the rural high schools of the King Cetshwayo District, it was understood from the teachers' perspective that there are complex factors. The factors responsible for the supply of science teachers in rural high schools and its consequences decreases the level of development of a country. Development is a means, by which the society, individuals, or receivers are actively involved in determining what they need and how to provide it for them (Nwafor, 2012).

> *I have been a teacher for thirty years; I have been the deputy principal for this school for eighteen years. I studied theoretical engineering and I have physical science advanced certificate and B.Ed Honors.*

The performance results of rural-based high school learners are remarkably weak in terms of mathematics and physical science subjects. According to the 2016 national matriculation results, only 1 700 (5%) of the 33,511 students who scored above 60% in mathematics were black African students (Stats SA, 2016). Given the fact that black Africans make up about 80.7% of the country's population (Statistics South Africa, 2016), this proportion of quality pass rate is extremely little. In terms of access to higher education, there is a disparity between different population groupings (Stats SA, 2018). In the rural and urban areas, the South African General Household Survey examined between 20 000 and 30 000 homes. The findings indicated that 12% of white people and 11.5% of indians have access to tertiary education whereas the percentages for coloured and black people are significantly low (Stats SA, 2019). South Africa may be a democratic country, however, the area in which the learner resides has an impact on the level of quality education that is received. Physical science is also regarded as a pivotal subject to master as a learner. According to BusinessTech (2017), physical science focuses on examining physical and chemical phenomena through scientific inquiry by applying scientific models, theories, and laws to explain and predict events, as indicated by the National Curriculum Statement (NCS). Science, technology, and

mathematics have become the main economic drivers, in terms of creating employment, job opportunities, and economic growth.

Physics, chemistry, the earth sciences, and mathematics, according to (Chubb & Holmes, 2015), contribute to support our national prosperity, and we must maintain our national commitment to enhance physical sciences and mathematics if they are to recognize opportunities and reap the benefits. The Australian Academy of Science states that science is of substantial economic benefit. In South Africa, learners in those schools that are in rural areas are highly disadvantaged or underprivileged with regards to receiving highly trained and qualified science teachers. This has been a constant issue that requires immediate attention.

> *"I believe we have enough physical science and mathematics teachers in this school. However, what affects the attraction of teachers here is the environment which doesn't promote the love of the science subjects. So, you see learners become demotivated and we have few students taking the subject".*

Mji and Makgato (2006), explained that learners' poor performance in physical science and mathematics is influenced by outmoded teaching methodologies and a lack of basic information, resulting in poor teaching standards. They went on to say that poor standards are exacerbated by under-qualified and unskilled teachers who teach in overcrowded and under-equipped rural classrooms. However, the Grade 12 results are seen to be steadily improving in Kwazulu Natal, according to van der Berg, et al., (2016), Daily News24 (2019), the 2018 physical science pass rate increased to 73.6% from a pass rate of 65.11% in 2018 and a pass rate of 57.76% in 2017. However, the increase in the overall physical science pass rate in Grade 12 includes all the schools in the province. Hence the issues of schools in the rural areas being disadvantaged should not be overshadowed by the constantly increasing overall physical science Grade 12 marks.

5.7. Research Objective 4

To understand the availability of professional mathematics and science teachers in the rural high schools of the King Cetshwayo District, and the effect on learner's performances.

The researcher investigated how the non-availability of mathematics and science teachers in rural high schools is linked to resource factors in the teaching environment, as a militating element for learners' underperformance. According to an updated IMU assessment, South African mathematics education is failing (Reddy al., 2015; DBE, 2014). Finding a way forward to address the numerous obstacles that have been identified as contributing to poor learning and performance in this learning area is therefore critical (Graven, 2016). A respondent commented,

> *We do have mathematics and physical science teachers but some of the teachers are afraid to teach grade twelve classes because of the pressure it comes with. So, in total, we have four qualified teachers, and they are two physical science teachers to which we got above 75% pass rate while mathematics has two teachers which we got only 33%.*

There is extensive research that points to the critical need to address the real challenges of mathematics education, this is particularly in the early years of schooling, where more of the learners already falls two grades behind expectation by the intermediate phase (Graven, 2016; Taylor, 2015). This is accomplished by addressing the need for mathematics knowledge in teaching (Adler, 2005); "improving teaching pedagogies that prioritize sense-making (Venkat & Naidoo, 2012; Hoadley, 2012); "running after-school mathematics clubs aimed at extension and remediation (Graven & Stott, 2012; Stott & Graven, 2013; Carnoy, et al., 2011).

In response to the research objective of the availability of mathematics and physical science teachers in rural high schools -the link between resources in the teaching

environment and learner's failure, the radical change in the approach to education took place in the context.

> *My observations are that although students fail, mathematics has no practical but physical science needs practical's, so in rural schools, students cannot do practical's and it becomes difficult for both teachers and learners. Because we end up googling and we project through the computer and projector for students to see examples since we do not have laboratories because no teacher wants to come to such school".*

In the midst of a significant scarcity of technical and professional skills in science and technology-related fields, as well as concerns about school-leavers' abilities in comparison to those a decade before (Crewe) (2010: 7). According to the DBE (2017), the NSC, notably the requirements connected to mathematics and entrance into higher education (HE), was successful in removing a significant barrier to entry into higher education (HE). Nonetheless, a higher number of entrants has not resulted in a higher number of students progressing in higher education. In South Africa, learners in those schools that are in rural areas are highly disadvantaged or underprivileged with regards to receiving highly trained and qualified science teachers.

> *My school only has one means of transport, if you miss that bus then there is no way you will go to work. If the bus is late, you will start class late.*

The highly disadvantaged or underprivileged with regards to receiving highly trained and qualified science teachers has been a constant issue that requires immediate attention. Learners' poor performance in physical science and mathematics is influenced by obsolete teaching methodologies and a lack of fundamental understanding, resulting in low teaching standards (Mji & Makgato, 2006). Mji and Makgato (2006), go on to explain that poor standards are exacerbated by under-qualified and unskilled teachers who teach in overcrowded and under-equipped rural classrooms. The question of how environmental factors in the availability of mathematics and science teachers are linked to resources in teaching in rural high

schools. In the past few decades, the focus on educational change has been prevalent and insistent as education systems around the world have struggled to meet the real needs of the times. The challenges and opportunity in the current era in mathematics education in Africa are still at a struggling level according to a wide variety of both regional, national and international assessments (International Mathematics Union, 2014).

> *Sometimes the rural environment demotivates the teachers, and we spoke to the SGB to motivate the teachers because most of our teachers are here for two to three years before they leave, except for the few teachers who have been for over five years.*

> *It is difficult to keep science subject educators in rural schools because they are in demand everywhere, so learners in rural areas regularly get student teachers.*

Though there have been occasions where remarkable progress has been experienced since the 2009 report by the International Mathematics Union. The IMU (2014), states that the Africa Mathematics Project, which is supported by the Simons Foundation is one of those success stories, the mainstream challenges remain however with a low pass rate from learners. In Kenya for instance, physical science subjects such as biology, which is a science. Sikolia and Sikolia (2016), articulate that it has enormous practical applications in our daily lives. In contrast, performance in other science topics, such as mathematics, has been reported to be relatively low at national examinations in both science subjects. As a result, in July 1998, the Kenyan government started the Strengthening of mathematics and science in Secondary Education (SMASSE) project in partnership with the Japan International Cooperation Agency (JICA) (Sikolia & Sikolia, 2016). According to the researchers, the SMASSE has now begun to provide in-service training to all serving teachers in essential areas like as mathematics and science, with the sole purpose of making them better teachers. The International Mathematics Union (IMU) (2014), noted in an updated report that the 50-plus nations of Africa exhibit huge variability in size, population level, wealth and culture.

DoE is turning a blind eye to building a laboratory since we do not even have a lab to equip the school with science facilities because with the shortages of resources science subjects' educators do not want to come here.

Not surprisingly, these variations are also seen in educational development, including mathematics development. Even though African countries differ in many ways, they have a lot in common when it comes to crucial topics like institutional and "national factors that promote or hinder mathematics development" (IMU, 2014). The IMU's 2014 findings made it obvious that these situations are nearly the same across the continent. Only 32 percent of Grade 6 mathematics teachers in South Africa have the required subject knowledge in mathematics, according to teacher assessments done in 2007 by the SACMEQ (Southern and Eastern Africa Consortium for Monitoring Educational Quality), (van der Berg, et al., 2016).

When compared to other countries with far larger rates, such as Kenya (90%), Zimbabwe (76%), and Swaziland (55%) (van der Berg, et al., 2016). Another study found that the average mark for a past matric mathematics examination paper was only 57 percent in a group of 253 matric mathematics teachers from the KwaZulu Natal province (Bansilal, et al., 2014). However, the main aim of the study is to examine the complexities in the availability of mathematics and physical science teachers in rural high schools within King Cetshwayo District. The study finds how different environments produce different result in different countries, particularly from many African countries.

The researcher found that the lack of availability of teachers has proportionately affected learners' performance, as a result, that, if they struggle on one topic, it will take up more time to repeatedly teaching the same topic until it is understood by the learners. There is no distribution of knowledge and one lack in the understanding of one chapter will ultimately affect the outcome of the learner's performance. Therefore, the non-availability of qualified subject teachers for subject-specific in mathematics and physical sciences affects the pass rate because for one to teach physics alone is unfair for the students. The teacher ends up telling the learners to refer to the textbook and if

one considers a situation where the very question comes in the exam, it will lead to dismal failure, because of the teacher's inability to transfer the knowledge and help the learners to understand the subject. It was said that if the situation of non-availability of subject teachers who are qualified to teach continue, the pass rate in two to three years from now will drop drastically.

The participants state that there is a need to have at least two physical science and three mathematics teachers, in every school, otherwise the result will never change, and the South African education system will always have poor performance in rural areas. The SMT should organize workshops through the DoE to share information between teachers to help improve the performance of the students. It was highlighted that the learner should be allowed to participate in mock final exams that are set by the teachers and award the learners with certificates to motivate them.

> *I have personally told the learners, anyone who gets 80% in my subjects, I will give them a trophy. My view is that on the availability of science educators in the rural schools, the government should provide in-service training to improve their skills, in the 90's we would get trained by the university and it would help us a lot because improving teaching and learning is an ongoing process.*

The government should provide technological support, because for instance if the child is hungry, the school provides food, but internet and transport, these things the school cannot give you. We also need protection; you find that some of these learners are slightly older, and they become violent.

> *We have two science teachers for grades ten and eleven and I think they are enough. However, the learners do not do well in mathematics when most times we even ask other educators to come and assist but still at the end of the year they fail.*

> *We do not have teachers because science educators choose where they have resources, fortunately, my school has laptops that were donated by an organization with Wi-Fi to help students, we hope that our students will do better.*

This is exactly what Yelkpieri, et al., (2012), state; that it may also be because of the lack of suitable and adequate science material and space to accommodate the learners. The non-availability of teachers affects teacher's performance because they cannot teach the subject if they do not have qualifications for it, so learners lose focus on the entire subject. Sometimes the problem cascades from primary schools where social science teachers teach mathematics. So, I think if the student lacks science subjects at a young age, there is no way they can catch up when they are in high school. The problem is the scarcity of science educators, and this is because the primary school level does not take science subjects seriously. With the scarcity and demand of science educators, you find that no one wants to go to rural areas. The other issue affecting the performance is the pass one – pass all policy. The school management should further make sure that the teacher, teaches from grade eight to grade twelve so that the teacher can best learn the challenges being faced by each student.

> *I don't think the school has enough mathematics and science teachers, even if they are qualified, but the manpower is not enough at all. You find that we have three mathematics teachers and one for physical science, so this affects the workload distribution.*

The DoE should input monitoring and evaluation means to make sure the results are increased because the current conditions in rural schools are terrible. The other stakeholders such as the community need to provide us with support security. If we get laboratory facilities and infrastructure, the community needs to know that they own it and therefore they need to protect everything within.

> *I do think we have enough mathematics teachers; the only problem is that students have the fear of taking mathematics and physics by the time they go to university; they do not want to take science or mathematics classes.*

The government can also introduce team teaching; hence the education will change with the addition of more teachers to ease the workload. The DoE can support the teachers by providing them with the rural allowance. In the process, we can also start with developing and nurturing learners within rural areas to become teachers with a passion for the learners. The DoE should improve the pass rate by supporting the school, learners, and the teachers in rural communities by giving the teachers a rural allowance so that the teachers can perform better. The non-availability of teachers affects the performance, which is already low, imagine being the only physical science teacher and if they need help, they would have to go to another school. If we were many then we would be able to bounce ideas. You need to understand unhappy teachers will result in unhappy learners.

The community have a role to play, as they should also know that the school is their property, and this will make sure no school property is stolen or vandalized. The community should also support the school to help the teachers and learners perform better. Furthermore, in another view, the teachers in rural-based high schools can be motivated by offering them enough support, this will mean the department of education (DOE) providing enough resources for science teachers to deliver the required results. The government is encouraged to also supply the rural-based high school teachers with rural allowance because, unlike urban teachers who travel short distances to work, rural teachers often travel long distances maybe even an hour to get to work. The government should also provide rural based teachers with bursaries specifically for the teachers to further their studies to attract more teachers to rural areas. The community must also work hand in hand with the teachers by supporting the school, even providing their time or even energy since we know they do not have money.

> *I think my community is also doing much because they offer homes to learners who stay far away, and they currently offer a backyard room for free to stay.*

The finding shows that the teachers in the rural-based schools need to network with schools that have good science subject educators and even rope in NGOs to assist where possible. The government is called upon to fund and equip rural-based schools, by bringing in portable laboratory kits to make sure these learners are educated and well prepared for their exams. Because the country needs engineers, and scientists like other countries around the world, such as America, China, Germany and other Africa countries like Nigeria and Ghana with massive medical doctors and engineers, who are exporting their professional services in many countries including South Africa.

The DoE should give science educators in rural towns, extra incentives to retain them in those schools. Science teachers leave us here in rural towns because they become frustrated by teaching without resources or clear models. Imagine talking about chemical reactions without showing them, so teachers leave the rural schools, and this affects the total performance. The community has a role to play, they can provide accommodation to teachers and learners coming from far away. The community can also provide security around the school to protect resources. The other thing the government should do is to try to add more funds to resources like laptops/ models where learners can see the human body of a skeleton because if the teacher says the human hand has so many bones, you do not even have the model to count them on and show the learners. The government should also provide learners with more university funding because you find that they do not even have application fees to apply to universities. The government needs to provide the schools with more transport for both the teachers and the learners, this will help us stay longer during and after school hours.

> *We also need to be digitalized it would help our learners too since our rural communities are poor and they do not have infrastructure and libraries. Let us not forget that teachers, learners, and parents, we all have important roles to play.*

If the government want to motivate teachers to take up employment in the rural area, the DoE should try to raise the bursaries, and these should strictly be for rural-based learners with requirements that if you get funded you come back to teach in the rural towns. The DoE should organize workshops with the university in training and development of these science subject educators in the rural towns. One thing is that teachers should take the career as a passion not just to earn money due to the shortage of employment. The government should also put more incentives with the rural allowance, just like they do for medical doctors in rural areas.

> *I feel like the government needs to show how they can help teachers and make them realize that teaching is not just for the money but for learners. Regarding the DoE, it should be more involved in the circuits and take a stand to be more active in the schools.*

The DoE should work hand in glove with the community to make it possible for all to work in a conducive environment. The DoE should also monitor and evaluate the systems because you can have qualified teachers, but performance needs constant monitoring and evaluation in terms of the formative and summative assessments. The community should be involved too in guiding themselves to protect the school knowing that the school is theirs. My general view is that these learners should be taught well to make sure that one or two will be able to give back to their rural communities. If you underline the word rural before you even go there, you get a bad picture and most teachers in science subjects do not even want to go to those schools.

> *You think round huts, no electricity, and no roads. I know one mathematics teacher back in 2004 who came and left after a day because she could not cope with the rural environment and she felt glamorous.*

> *So, what I think the government should do is to upgrade the infrastructure especially the roads even if you buy a car, it will end up damaged so you would rather choose greener pastures instead.*

The standard of living in rural communities makes no one wants to teach or live here, because I mean who would want to worry about how they will get to town, it is a struggle out there in the rural areas. The standard of living in rural towns affects the location that teachers choose, so no one would want to choose rural over urban. The other thing is that the government should make funds available for university students who want to become teachers in rural areas.

> *I believe most qualified teachers want to be in towns because rural communities are far, and you do not have resources to work with. So far as the education system is concerned, the teachers are not enough, and this affects the ultimate performance and pass rate.*

The respondent noted that the science laboratory is not even there and so how do teacher engage the learner in practical classes or even do experiments, the roofs in classrooms are leaking and there are broken windows everywhere in many rural based schools. When the laboratory is provided, it makes the teaching experience more fun as the teacher will have practical classes with the learners and the learner can learn better through observation and in group classwork. It was noted that the government ought to provide or upgrade the infrastructure and when they do that, they should then provide teachers in these schools. The government should also try and provide scholar transport for learners so that they arrive on time and not miss classes due to transportation problem since not all of them can afford a car.

Since there is a major need for science educators, the question is where we start or how do we motivate them to come to the rural communities when we do not have the required available resources. Imagine some rural communities do not even have electricity, to begin with, so how do we use cell phones or laptops in such an environment. There is much to do but the government can start by providing small things like calculators, electronic gadgets such as computers and iPad or tablets to teachers and learners for teaching purposes. Many teachers state that they do not have the resources needed to accessed YouTube or google videos to show how the experiment is done, this becomes very challenging in not having infrastructure.

Lastly, the participant also indicated the problem of a qualified science teacher in South Africa in general. The problem of scarcity of science educators and has also contributed to the underperformance of learners, this is evident at the primary school level, as they do not take science subjects seriously. With the scarcity and demand of science educators, it is likely to find that no one wants to go to rural areas. The other issue affecting the performance is the pass one-pass all policy. The school management should further make sure that the teacher, teaches from grade eight to grade twelve so that the teacher can best learn the challenges being faced by each student.

> *I am a qualified teacher and I chose this career as a calling in B.Ed Mathematics and accounts thirteen years ago. I currently teach FET and GED levels. I think the school has enough mathematics teachers my HoD teaches mathematics and we're both qualified and in terms of physical science, I think we do have sufficient teachers*.

The main problem is that the level of performance in the school is very low, so the motivation they can provide is to first remind the teachers is that teaching is a calling. We need to understand that if the rural community struggles and the entire country even suffers too. While some participant argued that there is a shortage of qualified teachers in some schools, other respondents acknowledged that they have adequate qualified teachers in their schools. It was noted that the government can also introduce team teaching; hence the education will change with the addition of more teachers to ease the workload. So far as the education system is concerned, the teachers are not enough, and this affects the ultimate performance and pass rate.

5.8. Conclusion

Conclusively, this chapter presents the analysis of the data collected and analysed them accordingly in a thematic structure to respond to the various research questions in line with the research objectives. The study aimed to examine the complexities in the availability of mathematics and physical science teachers in rural high schools within the King Cetshwayo District. The objectives were to explore the various factors that affect the supply of qualified science teachers in the rural high schools of the King Cetshwayo District. It also explored whether the availability of professional mathematics and science teachers in the rural high schools of the King Cetshwayo

District affect learner's performances. Further, the study evaluates the possibilities of attracting mathematics and science teachers to accept employment in the rural-based high schools of the King Cetshwayo District.

Lastly, it looks seek to understand to what extent are the availability of professional mathematics and science teachers in rural high schools at the King Cetshwayo District could improve learner's performance. The study advanced the research problem with the holistic qualitative design, illustrating from a Critical Realist perspective, in an interdisciplinary research ground. The methodology was based on a case study analysis, in an attempt to understand what factors are responsible for the low-rate performance of learners in the rural-based high school.

The study finds that sometimes the rural environment demotivates the teachers, and we spoke to the SGB to motivate the teachers because most of our teachers are here for two to three years before they leave, except for the few teachers who have been for over five years. It is difficult to keep science subject educators in rural schools because they are in demand everywhere, so learners in rural areas regularly get student teachers. The department of education (DoE) is turning a blind eye to building a laboratory since we do not even have a lab to equip the school with science facilities because with the shortages of resources science subjects' educators do not want to come here.

Through the investigation, the researcher finds that the non-availability of science educators in rural schools is complex issues that involve many factors, from a lack of resource, infrastructure, funding, and environmental factors. This, therefore, calls on the government to provide in-service training to improve teacher skills, an example was drawn from the 90s, as teachers would get trained by the university and qualified to teach the specific subjects. It would help the teachers a lot because improving teaching and learning is an ongoing process. It also highlighted the need for all the relevant stakeholders to get on board in finding the solution needed to improve the performance rate of learners in rural-based schools.

The findings also show a lack of security and safety for both the learners and the teachers. The community is encouraged to provide support by bringing safety into the school especially when the school organizes afternoon classes that go on till late. The community can also provide cottages for our matric learners who stay far away to make sure they are close to school, and they arrive on time for school and exams. The government should provide technical and technological support such as internet service to access online materials and libraries and transport for teachers and learners who live far away from where the schools are located. The teacher also states that they need protection, as you would find that some of these learners are slightly older and violent in nature.

In summary, African nations including South Africa require more support for those who might wish to develop their careers as educators and researchers in the field of mathematics and physical sciences, also with more collaboration among people and institutions that are seeking to make this happen. The necessary steps to achieve it would be to have a stronger teaching foundation in both primary and secondary schools.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1. Introduction

The previous chapter presented that data analysis on the data collected from participants. The objective of this current chapter is to summarize the study, present the empirical findings, conclude the study and make recommendations and the limitation of the study.

6.2. Summary

This study started with the aim of examining the complexities in the availability of mathematics and physical science teachers in rural high schools within the King Cetshwayo District. The study was guided by the following objectives: To explore factors that affect the supply of qualified science teachers in the rural high schools of the King Cetshwayo District, to explore whether the availability of professional mathematics and science teachers in the rural high schools of the King Cetshwayo District affect learner's performance, to explore motivation possibilities of attracting mathematics and science teachers to accept employment in the rural-based high schools of the King Cetshwayo District, to understand the availability of professional mathematics and science teachers in the rural high schools of the King Cetshwayo District and the effect on learner's performances.

To accomplish those objectives, the following research questions were asked:

- What are the factors that affect the supply of science teachers in the rural high schools of the King Cetshwayo District?
- How is the availability of mathematics and science teachers in rural high schools linked to resources in the teaching environment?

- How can mathematics and science teachers be motivated to accept employment in the rural based high schools of the King Cetshwayo District?
- To what extent does the availability of mathematics and science teachers in the rural high schools of the King Cetshwayo District contribute to learner's performances?

The study significantly added to an existing body of knowledge on the role of high school teachers and poor performance challenges faced by the learners in the King Cetshwayo District rural schools. Although the research looked at the complexity in supplying qualified teachers to the rural-based high schools, it located possible ways to motivate teachers to take up employment to teach in this area. The research results recommend policy frameworks from its findings to the department of education for implantation in improving performance rate.

The teacher's employment procedure was investigated in this research to see what problem is associated with it, which may have contributed to the non-availability of science teachers in the rural areas of the King Cetshwayo district. Recommendations from the study will be sent to various schools. Chapter one of the study gave an overview and background to the study; it noted that many South African high schools continue to record poor performance among learners in rural areas, particularly in the King Cetshwayo District. It dived into the complexity of the supply of critical science subjects' teachers who are willing to live and teach those subjects in rural-based schools. It went on to explain the historical context of the apartheid era in South Africa, where education and training were characterized by the underdevelopment of human potential, notably among black South Africans.

The study highlighted the major issue of high learner failure rates in important science subjects, which continues to be a threat in the King Cetshwayo districts. It highlights that only a few students are taking mathematics and science-related subjects at the universities as degree qualification, which seems to affect the supply of teachers in rural-based high schools. In certain cases, this has led to schools discontinuing the teaching of mathematics and physical science. Many under-qualified or untrained teachers who teach in overcrowded and inadequately equipped classrooms have

exacerbated the poor or low standards. There are a variety of perceived school-based elements that can influence students' performance, such as the availability and utilization of teaching and learning facilities, as well as environmental and socioeconomic issues.

The researcher could not find any existing literature indicating how these and other factors may be affecting the availability of mathematics and science teachers in the area. While learner performance does not seem to be improving in the rural schools within King Cetshwayo, there is a need to understand how complexities in the availability of mathematics and physical science teachers. The study advanced the research problem with the holistic qualitative design, from a critical realist perspective, in an interdisciplinary research field. The methodology was based on a case study analysis, in an attempt to understand what factors are responsible for the low-rate of performance of learners in the rural-based high schools in the King Cetshwayo district. These include the research unit of analysis, whose main units of observation are based on the examination of the complexities in the availability of mathematics and physical science teachers in rural high schools within the King Cetshwayo District.

In this study, data collection was done through the means of a document and literature review, questionnaires with participants. The information and data were collectively merged, categorized, and interpreted according to patterns established in that, by utilizing qualitative content analysis. The findings were then compared with understandings from the literature to authenticate and discourse the research questions with the study objectives. Chapter two of the study reviewed existing literature and documents that were relevant to the area under study. A survey of scholarly distributions on the theme was directed to extend the comprehension of related ideas and speculations, and to assess past comparative cases. Moreover, accessible documentation from government sources was consulted to represent real local practice.

This chapter began by introducing the chapter as a literature review, then went on to discuss the state of physical science and mathematics in South African schools today,

which has been frequently characterized as a national crisis. The reviewed literature showed that learners have performed very poorly in comparative tests of science and mathematics both internationally and at the regional level and even at local benchmark texts. Findings from the confirmed this reality to be true at both primary and secondary school levels, according to the Academy of Science of South Africa (ASSAf) in 2010. The findings reveal that in South African schools, an averaged score hides a huge disparity amongst students. Most students fail to perform at suitable levels, while a minority of students continue to make substantial progress in certain subjects.

As a result, the number of eligible scientists, engineers, health practitioners, and future mathematics and science teachers is severely constrained. This, therefore, reduces the ability of South Africa to be internationally competitive, which in turn impacts on its ability to provide the foundation or structure needed for the wellbeing of South African majority. The chapter continued by explaining the importance of theory-driven thinking, as its emphasis on the theoretical application of the study with the theory of social constructivism. Individuals' interfaces or interactions with their social-cultural milieu and the greater society, according to the notion, form social worlds. As a result, knowledge emerges through a process of communal compromise and evaluation of individual understanding's practicality.

Fundamentally, every conversation or interaction between two or more individuals often provides an opportunity to develop and acquire new knowledge, as well as an opportunity to broaden one's understanding. Teaching and learning as explained above are not without many problems as it was illustrated in the application of social constructivist theory, the benefits and as well as the shortcomings. The social constructivist approach emphasizes communication and negotiation, which invariably assists students in increasing their self-awareness of real-world interactions and issue resolution outside of the classroom. "Students love this technique because they learn better and faster when they are involved in learning projects rather than rote memorization", says Patrick Gleeson(2009)

This strategy prepares students to work together in everyday situations. One of the most noticeable benefits of social constructivism is that it decreases, if not eliminates, learners' emotions of uneasiness and insecurity. This is clarified by the fact that social constructivism provides learners with a self-contained learning environment, which encourages knowledge sharing through cooperation and the development of cognitive skills through learner-centred practices. Many academics have lauded the theory of social constructivism in their numerous works, particularly in the sphere of higher education. However, just like in any other learning theory, there are unavoidable shortcomings. Thus, despite the indicated educational benefits of social constructivist theory, some scholars have articulated their opposition to what constructivism offers as benefits.

Some academics argue that constructivism is not practical enough because some students with less prior knowledge learn faster than others. However, in terms of learning, the constructivist method or theory tries to eschew direct instruction in favour of encouraging students' active participation in the learning process while under the supervision of the teacher. One of the benefits of this style of learning, according to some experts, is learner centeredness – that is, an emphasis on student-centred learning, which may possibly be constructivism's most important contribution. This is seen to be highly helpful since, in a classroom-learning setting, learners might become more interested and joyfully active because cooperation and exchange of ideas with a team is a prominent component.

In the global view in understanding the world through mathematics, it is noted that mathematics in the global perspectives, acknowledges the fact the world has become interconnected, as everyday mathematics has been able to show these possibilities and connections. Scholars predicted that every curricular topic has a global component that might be taught in the classroom. This is repeated over and over in the area that many people find the most difficult to comprehend as being global: mathematics as a subject, aids in the understanding of the world, while people utilize the world to understand mathematics.

This chapter further looked at teaching mathematics and physical science in South African schools. It finds in the literature that the reform and modification in education and the teacher-training programmes, as well as school curriculum, there seem to be yet many challenges that are facing mathematics education in South Africa. There is a strangely low achievement of children in mathematics. The poor performance of learners in both mathematics and physical science in secondary school, in the foundation phase, has been a concern of everyone. This is because in the foundation phase teachers have a vital role to play in “the teaching and learning process of mathematics in schools.

There has been a remarkable amount of concern in Africa when it comes to addressing the issues of teaching mathematics and physical science. Regarding the situation of South African learners' academic performances in the high-stakes National Senior Certificate (NSC) examinations, with a focus on the performance of students from low-income schools, one of the concerns that the South African government has encountered in the post-apartheid era is the country's failure to deliver quality mathematics and physical science education to its 55 million varied population.

The chapter further examined how the immediate environment can be a factor in the rural-based high schools, which could contribute to the non-effective teaching and learning method of both mathematics and physical science subjects. In rural schools, the elements are thought to effect both mathematics and physical science learning, performance, and teaching methods. Physical science is taught and learned in rural high schools through a variety of approaches. The key distinction is influenced in part by the educational environment in which the teachers work. Considering this, most scholars that deal with issues of a lack of resources in schools focus their efforts on researching the lack of adequate equipment, huge classes, and teacher credentials. This is in addition to a very under-resourced educational environment, which includes issues such as a lack of water, electricity, and sanitation.

The research design, area of study, target population, sample and sampling methodologies, data collection methods and tools, operationalization of the variables and constructs employed in this study, and the data analysis method were all

subdivided into six sub-sections in Chapter three. This study employed a qualitative approach. This section explains the research design and approaches to be adopted in the study in a quest to establish the challenges faced with the non-availability of teachers in the critical subjects (mathematics and physical science) teachers in rural high schools in the King Cetshwayo District. A research paradigm is an approach that helps pilot research that has been verified by the researchers for a long and that has been in practice for several years. The constructivism approach was adopted in this study.

The research Design was framed by a quantitative design, which is described as the plan of how the researcher systematically collected and analyse the data that is needed to answer the research question. Notwithstanding the above understanding of how they diverge in defining research design and approach, nevertheless, they both present the same thing; that is, a plan with a direction and purpose. In this study, a quantitative approach was followed to address the core research objective, which is to understand the factors responsible for learners; poor performance in South Africa with complexities in the availability of mathematics and physical science teachers in rural high schools within the King Cetshwayo District.

The targeted population and sampling procedure for the study encompassed rural based high school teachers from the King Cetshwayo district, which has five circuit management centres; the schools which are divided into a cluster of ten. This study employed the concept of non-probability sampling as the research population, and purposive sampling will be used to target participants who are teachers within the King Cetshwayo district in KwaZulu-Natal. The study was conducted in 10 major rural schools in the study area for data collection, with the use of one-on-one live interview in a form of structured questions.

The data for the study was collected through interviews in the form of structured questionnaires. As the nature of the study, it employed non-probability sampling to select the participants for the research study population. This was applied with the use of purposive sampling to target participants who are teachers within the King Cetshwayo district in the KwaZulu-Natal. The researcher interviewed one teacher from

each of the ten targeted rural schools in the study area, for its data collection. This makes it a total of 10 teachers, with the use of one-on-one live interview in a form of structured questions.

The data collected was then analysed through content data analysis. In this study, the data was collected through in-depth interviews with participants teaching in mathematics and the physical sciences in King Cetshwayo to obtain a perception of the low-rate of performance of learners in critical subjects. In-depth interviews, according to Creswell (1998), provide respondents with the liberty to express their views in their own words. On the other hand, two types of face-to-face interviews, individual and group interviewing, are defined by Braun and Clark (2006). The study was conducted in 10 major rural schools in the study area for data collection, with the use of one-on-one live in-depth interview in the form of open-ended questions. Individual interviewing allowed every respondent to say out their line of thought without being influenced by group psychology.

Purposive sampling was used to target participants who are mathematics and physical science teachers within the King Cetshwayo district in the KwaZulu-Natal province. The basis for using the purposive sampling technique was that it allowed the researcher to select the respondents who had better knowledge of the low-rate of performance of learners in the critical subjects in the 10 rural schools. This was advantageous in that precise contexts of the purposively chosen cases were made rather than attempting to generalise from the broad population. The data analysis includes the method of order, structure, and significance for the collected data. The researcher used content analysis because it defines data that is commonly used in qualitative data.

The data was combined, classified, and interpreted employing qualitative content analysis according to trends developed from research questions. The results were then matched by literature understandings so that the research questions and the study goals were authenticated and addressed. Chapter four of the study presented the findings and discussed them accordingly. Chapter four of the study presented the data collected and analysed them in response to the research objectives. As the chapter

presents the data collected and analysed them accordingly in a thematic structure, it was designed to critically respond to the various research questions in line with the research objectives.

The study aimed to examine the complexities in the availability of mathematics and physical science teachers in rural high schools within the King Cetshwayo District. The objectives were to explore the various factors that are affecting the supply of qualified science teachers in the rural high schools of the King Cetshwayo District. It also explored whether the availability of professional mathematics and science teachers in the rural high schools of the King Cetshwayo District affect learner's performances. Further, the study evaluates the possibilities of attracting mathematics and science teachers to accept employment in the rural-based high schools of the King Cetshwayo District. Lastly, it looks at the understanding the availability of professional mathematics and science teachers in the rural high schools in the King Cetshwayo District.

The study advanced the research problem with a qualitative design, from a critical realist perspective, in an interdisciplinary research field. The methodology was based on a case study analysis, to understand what factors are responsible for the low-rate of performance of learners in the rural-based high schools. The study finds that sometimes the rural environment demotivates the teachers, however, the participant noted how they approached the SGB to motivate the teachers because most of our teachers are here for two to three years before they leave, except for the few teachers who have been for over five years. It is difficult to keep science subject educators in rural schools because they are in demand everywhere, so learners in rural areas regularly get student teachers.

Through the investigation, the researcher finds that the non-availability of science educators in rural schools is complex issues that involve many factors, from a lack of resource, infrastructure, funding, and environmental factors. This, therefore, call on the government to provide in-service training to improve teacher skills, an example was drawn from the 90s, as teachers would get trained by the university and qualified to teach the specific subjects. It would help the teachers a lot because improving teaching

and learning is an ongoing process. The study also highlighted the need for all the relevant stakeholders to get on board in finding the solution needed to improve the performance rate of learners in rural-based schools.

Findings also show a lack of security and safety for both the learners and the teachers. The community is encouraged to provide support by bringing safety into the school especially when the school organizes afternoon classes that go on till late. The community can also provide cottages for our matric learners who stay far away to make sure they are close to school, and they arrive on time for school and exams. The government should provide technical and technological support such as internet service to access online materials and libraries and transport for teachers and learners who live far away from where the schools are located. The teacher also states that they need protection, as you would find that some of these learners are slightly older and violent in nature.

6.3. CHAPTER CONCLUSION AND SUMMARY OF THE STUDY

i. CHAPTER ONE:

The objective of the study is to examine the complexities in availability of mathematics and physical science teachers in rural high schools within King Cetshwayo district. This first chapter presented the background of the study. Studies on the South African mathematics and physical science subject in the secondary education system have frequently exposed the dire situation. Regardless of the deficiencies and conditions surrounding mathematics teaching and learning, repeating the inconsistencies in the system will not assist, but the present issues must be solved. Clearly, lowering the quality of successful performance criteria in mathematics at the grade 12 matriculation level to 20% is not a solution. This tradeoff has a psychological cost for kids who want to pursue jobs that involve mathematics.

In chapter one, I argue that teaching is an art, and that teaching mathematics involves ongoing professional development that provides instructors with mathematical material at various levels and how it may be taught in the classroom. Mathematics teaching practice supervision must be preceded by proven micro-teaching sessions on diverse

themes. All maths instructors should have access to publicly available online mathematics open education materials. A revolution in the thinking of mathematics instructors must also be encouraged. The Department of Education may propose reintroducing training institutions to train competent mathematics teachers. Performance in the topic must be independent of politics and guided by conceptual mastery of the subject.

Students will not be taught in this manner for the purpose of passing mathematics at various levels, but rather for comprehension that can aid the student in connecting and applying learned and understood mathematical topics to the improvement of their everyday life.

ii. CHAPTER TWO:

This chapter presented the theoretical framework of the study. Conclusively, this chapter began by describing the importance of theory-driven thinking and its emphasis on the theoretical application of the research with the theory of social constructivism, which states that individuals' social worlds emerge from their interactions with their social-cultural environment and the larger society. As a result, knowledge emerges through a process of communal compromise and evaluation of individual understanding's practicality. Every conversation or meeting between two or more individuals often provides an opportunity to develop and acquire new knowledge, as well as an opportunity to broaden one's understanding.

Teaching and learning as explained above are not without many problems as it was illustrated in the application of social constructivist theory, the benefits, and as well as the shortcomings. This, therefore, involves taking many challenges for both teachers and learners. The implementation of the social constructivist approach based on Vygotsky‘s theories in teaching mathematics and physical science as a skill to learners in the rural-based high schools, cannot be but reliable because teachers act as guides to the learners. While the learners take active participation while learning through an interactional method, which is within a suitable learning classroom with a relaxed and collaborative environment, it is important to make such an atmosphere friendly. This will improve learners’ communicative skills immensely with problem-based learning

practice and reduces their feelings of anxiety and lack of confidence, as they engage in group works and discussions.

The above concept is said to mainly encourage cohesion and teamwork, and therefore support students learning process rather than selfishness and egocentricity. Although it cannot be utilized as a complete learning system due to its weaknesses, however, it supports a learners-centred learning approach using a social constructivist method, which activates learners' attention and inspires cooperative learning.

iii. CHAPTER THREE

This chapter began by introducing the chapter as a literature review, then went on to discuss the state of physical science and mathematics in South African schools today, which has been frequently characterized as a national emergency. The reviewed literature showed that in comparative tests of physical science and mathematics, learners have performed very poorly both internationally and at the regional level and even at local benchmark texts. Findings from research conducted by the Academy of Science of South Africa (ASSAf) in 2010 confirmed this reality to be true at both primary and secondary school levels. The finding shows that there is an averaged result mask of a very wide disproportion between learners in South African schools. Most learners fail to perform at suitable levels, while a minority of students continue to make substantial progress in certain subjects.

As a result, the pool of potential scientists, engineers, health practitioners, and future mathematics and physical science teachers is severely limited. This, therefore, reduces the ability of South Africa to be internationally competitive, which in turn impact its ability to provide the foundation or structure needed for the wellbeing of the South African majority. The chapter continued by explaining the importance of theory-driven thinking, as its emphasis on the theoretical application of the study with the theory of social constructivism. Individuals' interfaces or interactions with their social-cultural milieu and the greater society, according to the notion, form social worlds. As a result, knowledge emerges through a process of communal compromise and evaluation of individual understanding's practicality.

Fundamentally, every conversation or interaction between two or more individuals often provides an opportunity to develop and acquire new knowledge, as well as an opportunity to broaden one's understanding. Teaching and learning as explained above are not without many problems as it was illustrated in the application of social constructivist theory, the benefits and as well as the shortcomings. The social constructivist paradigm emphasizes dialogue and negotiation, which invariably aid students in developing a greater self-awareness of real-world interactions and issue resolution outside of the classroom.

This strategy prepares pupils to work together in everyday situations. One of the most noticeable benefits of social constructivism is that it decreases, if not eliminates, learners' emotions of uneasiness and insecurity. This is clarified by the fact that social constructivism provides learners with a self-contained learning environment, which encourages knowledge sharing through cooperation and the development of cognitive skills through learner-centred practices. Many academics have lauded the theory of social constructivism in their numerous works, particularly in the sphere of higher education. However, there are unavoidable flaws in this theory, just as there are in any other learning theory. Thus, despite the indicated educational benefits of social constructivist theory, some scholars have articulated their opposition to what constructivism offers as benefits.

Some experts argue that constructivism isn't practical enough because some pupils with less prior knowledge can learn faster than others. However, in terms of learning, the constructivist method or theory tries to eschew direct instruction in favour of encouraging students' active participation in the learning process while under the supervision of the teacher. One of the benefits of this style of learning, according to some experts, is learner centredness – that is, an emphasis on student-centred learning, which may possibly be constructivism's most important contribution. This is seen to be highly helpful since, in a classroom-learning setting, learners might become more interested and joyfully active because cooperation and exchange of ideas with a team is a prominent component.

In the global view in understanding the world through mathematics, it is noted that mathematics in the global perspectives, acknowledges the fact the world has become interconnected, as everyday mathematics has been able to show these possibilities and connections. Scholars believe that all curricular areas, including mathematics, have a comprehensive global component that may be conveyed in the classroom. This is repeated over and over in the area that many people find the most difficult to comprehend as being global: mathematics as a topic, aids in the understanding of the world, while people utilize the world to understand mathematics. This chapter also looks at how mathematics and physical science are taught in South African schools. It finds in the literature that the reform and modification in education and the teacher-training programmes, as well as school curriculum, there seem to be yet many challenges that are facing mathematics education in South Africa. There is a strangely low achievement of children in mathematics.

Everyone has been concerned about children's low performance in mathematics and physical science throughout the foundation period. This is because foundation phase teachers play a critical role in the teaching and learning of mathematics in schools. There has been a remarkable amount of concern in Africa when it comes to addressing the issues of teaching mathematics and physical science. Regarding South African learners' academic performances in the high-stakes National Senior Certificate (NSC) examinations, with a focus on the performance of learners from low-income schools, one of the concerns that the South African government has encountered in the post-apartheid era is the country's failure to deliver quality mathematics and physical science education to its 55 million varied population.

The chapter further examined how the immediate environment can be a factor in the rural-based high schools, which could contribute to the non-effective teaching and learning method of both mathematics and physical sciences subject. In rural schools, the elements are thought to effect both mathematics and physical science learning, performance, and teaching methods. physical science is taught and learned in rural high schools through a variety of approaches. The key distinction is influenced in part by the educational environment in which the teachers work. Considering this, most academics that study school resource shortages focus their efforts on concerns such

as a lack of adequate equipment, huge classes, teacher qualifications, and very under resourced school environments, such as a lack of water, electricity, and sanitation.

iv. CHAPTER FOUR

The chapter four of the study looked at the research methodology and the procedures undertaken to conduct the research. Research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic. In research, the methodology section allows the reader to critically evaluate a study's overall validity and reliability. The methodology section answers two main questions: How was the data collected or generated? How was it analyzed? Denzin and Lincoln (2011) define research design as plans that will guide the collection of data and its analysis.

It is worth mentioning that the study combines both exploratory and descriptive methods with a qualitative research paradigm. The study discussed the research paradigm in terms of its epistemology, ontology, methodology and axiology. This method gave room to collect enough data on the challenges faced by secondary school learners with the absence of qualified teachers in the critical subjects of mathematics and physical sciences in rural secondary schools in the King Cetshwayo District in KwaZulu Natal. The chapter also addressed the ethical issue and informed consents for the selected participants, the trustworthy, credibility, reliability and transferability, and conformability.

v. CHAPTER FIVE

Conclusively, the chapter presented the analysis of the data collected through interviews from participants and analysed them accordingly in a thematic structure to respond to the various research questions in line with the research objectives. The study aimed to examine the complexities in the availability of mathematics and physical science teachers in rural high schools within the King Cetshwayo District. The objectives were to explore the various factors that affect the supply of qualified science teachers in the rural high schools of the King Cetshwayo District. It also explored

whether the availability of professional mathematics and science teachers in the rural high schools of the King Cetshwayo District affect learner's performances. Further, the study evaluates the possibilities of attracting mathematics and science teachers to accept employment in the rural-based high schools of the King Cetshwayo District.

Lastly, it looks seek to understand to what extent are the availability of professional mathematics and science teachers in rural high schools at the King Cetshwayo District could improve learner's performance. The study advanced the research problem with the holistic qualitative design, illustrating from a Critical Realist perspective, in an interdisciplinary research ground. The methodology was based on a case study analysis, in an attempt to understand what factors are responsible for the low-rate performance of learners in the rural-based high school.

The study finds that sometimes the rural environment demotivates the teachers, and we spoke to the SGB to motivate the teachers because most of our teachers are here for two to three years before they leave, except for the few teachers who have been for over five years. It is difficult to keep science subject educators in rural schools because they are in demand everywhere, so learners in rural areas regularly get student teachers. The department of education (DoE) is turning a blind eye to building a laboratory since we do not even have a lab to equip the school with science facilities because with the shortages of resources science subjects' educators do not want to come here.

Through the investigation, the researcher finds that the non-availability of science educators in rural schools is complex issues that involve many factors, from a lack of resource, infrastructure, funding, and environmental factors. This, therefore, calls on the government to provide in-service training to improve teacher skills, an example was drawn from the 90s, as teachers would get trained by the university and qualified to teach the specific subjects. It would help the teachers a lot because improving teaching and learning is an ongoing process. It also highlighted the need for all the relevant stakeholders to get on board in finding the solution needed to improve the performance rate of learners in rural-based schools.

The findings also show a lack of security and safety for both the learners and the teachers. The community is encouraged to provide support by bringing safety into the school especially when the school organizes afternoon classes that go on till late. The community can also provide cottages for our matric learners who stay far away to make sure they are close to school, and they arrive on time for school and exams. The government should provide technical and technological support such as internet service to access online materials and libraries and transport for teachers and learners who live far away from where the schools are located. The teacher also states that they need protection, as you would find that some of these learners are slightly older and violent in nature.

In summary, African nations including South Africa require more support for those who might wish to develop their careers as educators and researchers in the field of mathematics and physical sciences, also with more collaboration among people and institutions that are seeking to make this happen. The necessary steps to achieve it would be to have a stronger teaching foundation in both primary and secondary schools.

6.3. CONTRIBUTIONS OF THE STUDY

This research adds to the body of knowledge and literature already available on the role of high school teachers and poor performance challenges faced by the King Cetshwayo District rural school among learners. Because there are not enough qualified science content educators and materials may have affected the performance rates. As this research looks at the complexity in supplying qualified content or subject teachers to the rural-based high school, the study locates possible ways to motivate subject qualified teachers to take up employment to teach in this area. The research results recommend policy frameworks from its findings to the department of education for implantation in improving performance rate. The teacher's employment procedure is expected to be investigated in the findings of this research, this is to see what problem is associated with it, which may have contributed to the non-availability of

science teachers in the rural areas of the King Cetshwayo district. Recommendations from the study will be sent to the various schools.

6.4. The Key Findings

The study finds that sometimes the rural environment demotivates the teachers, and we spoke to the SGB to motivate the teachers because most of our teachers are here for two to three years before they leave, except for the few teachers who have been for over five years. It is difficult to keep science subject educators in rural schools because they are in demand everywhere, so learners in rural areas regularly get student teachers. The department of education (DoE) is turning a blind eye to building a laboratory since we do not even have a lab to equip the school with science facilities because with the shortages of resources science subjects' educators do not want to come here.

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In summary, African nations including South Africa require more support for those who might wish to develop their careers as educators and researchers in the field of mathematics and physical sciences, also with more collaboration among people and institutions that are seeking to make this happen. The necessary steps to achieve it would be to have a stronger teaching foundation in both primary and secondary schools.

6.5. The Empirical Findings of the Study

In respect to the researcher's empirical findings, it is observed that most of the participants who responded to the research questions considered many high schools in South African to be under-equipped with inadequate resources, unqualified subject teachers and less funded. Hence, they continue to record poor performance among learners in the Grade 12 examinations in rural areas, particularly in the King Cetshwayo District. This study looks at the complexity of the supply of critical science subjects' teachers who are willing to live and teach those subjects in rural-based schools. It finds that during the apartheid era, education and training in South Africa were generally portrayed by the under-development of human potential, and particularly the black South Africans.

- The research finds it problematic that teachers are not willing to accept employment in the rural-based schools, due to some factors as most teachers want urban areas, where they can enjoy city life with the provision of social amenities.
- The issues of non-availability of housing, means of transportation are some of the factors that discourage them from accepting employment in rural areas. You also find that in the rural area's teachers struggle with accommodation and the road to the school may not be accessible by vehicles, so they walk.

- The study also finds that the non-availability of qualified subject teachers affects the pass rate because it is considered unfair for a teacher to only engage in teaching physics alone for the students.
- The environmental factors is another issue discovered as to what affects the attraction of teachers in rural areas, which do not promote or inspires a love for science subjects. In this case, therefore, you are likely to experience a situation where learners become demotivated in taking those critical subjects.
- The study also finds that sometimes the environmental factors in the rural areas demotivates the teachers and the SGB asked to motivate teachers in some schools, as most of the teachers are only stay for two to three years before they leave, except for the few teachers who have been for over five years.
- The social factors discouraging qualified subject teachers are considered another issue of concern. Some of the respondents expressed their fears and the level of insecurity in the rural areas, the need to increase security and protection of lives are of paramount importance; some of the learners are slightly older and violent.
- The study also finds that learners are not performing well even where there are up to five teachers, who are teaching science subjects, but it leaves a question as to why students do not do well, the teacher confirms that they go the extra mile with these learners. This could be a foundational problem where the learners had no strong foundational knowledge in those subjects at the foundation phase.
- Lastly, some participants also confirmed to have two science teachers for grades ten and eleven and which are enough, However, learners perform poorly in mathematics, when most times other educators are requested to assist, but they still end up failing.

6.6. Recommendations

As a way of recommendation to provide the lasting solution with the complexities of non-availability of qualified teachers in accepting employments in the rural-based schools, which therefore leads to poor performance from learners, the following are suggested for consideration:

- The teachers in rural areas can be motivated by offering them enough support including incentive packages and allowances, this will mean that the department of education will be providing enough resources to equip the school's science laboratory for science teachers to deliver results.
- To improve the performance of rural-based high school learners, the number of learners per class should be taken into consideration, in as much as there are few students per class, the school need more subject qualified teachers, especially for senior grades.
- It could be recommended to seek for a trained educator for specific subjects such as mathematics paper one and the other teacher for mathematics paper two and this will invariably increase the pass rate, perhaps the record in two years may reach 80%.
- In terms of the distribution of resources, what is currently available in many rural-based schools are not enough, the SMT can be urged to help in organizing extra lessons or even ask teachers from other schools who are doing well to offer an exchange program to assist. The SMT should further pay if there is money to be paid to those teachers as an incentive to motivate them to offer their skills.
- It is recommended that the government should offer technical support and make resource or teaching tools available, such as computers especially with the current technological transformation of the fourth industrial revolution.
- Learners should be given access to cell phones, iPads or tablets, as teaching tools with learning material and educational applications that will help the learners to study by themselves. It is noted that the few learners who might have access to cell phones cannot afford data, so free Wi-Fi can be provided for the school.
- If the government can provide both teachers and learners with the necessary teaching tool, such as computers, science equipment and computer laboratories for learners, they can readily have access to information on certain topics and understand them better.

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RESEARCH INSTRUMENTS

APPENDIX A: Access Letters

Request for permission

University of Zululand
Department of Social Science Education
Private Bag X1001
KwaDlangezwa, 3886
15th November 2019.

The District Director
Department of Education
Corner of Hancock Avenue &
Maxwell Street, Empangeni, 3880

Dear Sir/Ma,

Permission to Conduct Research

I, Mr Vincent Titos Smith with Student Number: 201551088, I am a PhD student currently enrolled at the Department of Social Science Education, University of Zululand. I would like to conduct research using the high schools in your district for my research. I have obtained ethical clearance from my university to conduct the study. The title of the study is **Complexities in Availability of Mathematics and Physical Science Teachers in Rural High Schools within King Cetshwayo District.** The research objectives are:

- ✓ To explore the factors responsible for the shortage of science teachers in the based high schools
- ✓ To explore the availability of Mathematics teachers in rural secondary schools has anything to do with an under-resourced teaching environment.

- ✓ To explore various avenue to motivate science teacher to accept employment in the rural based schools
- ✓ To understand what extent the non-availability of Mathematics and Physical Science Subject teachers in the rural high schools at King Cetshwayo District is contributed to learner's underperformance.
- ✓

I hereby seek your consent to approach the schoolteachers through the principals for access to respond to this project. I will provide you with copies of the interview structured in form of questionnaires, which include a consent form to be used during the research process. Upon completion of the study, I undertake to provide the academic institutions with a copy of the research work. If you require any further information, please do not hesitate to contact me.

Your co-operation in this study will be highly appreciated.

Yours sincerely,

Prof Kutame
Supervisor

Mr. Vincent Titos Smith
Contact: +27839898573
vincenttito8@gmail.com
Candidate

Sign----------

Appendix: B Interview Schedule

INTERVIEW SCHEDULE FOR RESPONDENTS

1. What is/are your qualification(s)?
2. What is your position?
3. How many years of experience do you have?
4. Does your current school have enough science teachers who teach Mathematics?
5. Does your school have enough qualified science teachers who teach Physical Science?
6. What are the factors that affect the supply of science teachers in the rural high schools of King Cetshwayo District?
7. How the non-availability of qualified (degree) Mathematics and science teachers is affecting learner's performance in your school?
8. How can Mathematics and science teachers be motivated to accept employment in the rural-based high schools of King Cetshwayo District?
9. To what extent has the non-availability of Mathematics and science teachers impacted the general performance of your school, in terms of passing rate.
10. What is the possible suggestion that may be recommended to the department of education, the principal and the school managers, on how they could improve performance and passing rate?
11. Do you have any recommendation on how the government and stakeholders could improve the current condition in the rural-based schools for the distribution of both human and economic resources?

i. Learners

……

ii. Teachers

……

iii. Community

………………………………………………………………………………..

iv. Education,system

…………………………………………………………………………..

v.

APPENDIX C: Participant Informed Consent

Participant Informed Consent and Informed Consent Declaration (Participant)

Project Title: **Complexities in Availability of Mathematics and Physical Science Teachers in Rural High Schools within King Cetshwayo District.**

Mr Vincent Titos Smith from the Department of Social Science Education, University of Zululand has requested my permission to participate in the above-mentioned research project.

The nature and the purpose of the research project and this informed consent declaration have been explained to me in a language that I understand.

I am aware that:

1. The purpose of the research project is to examine the Complexities in Availability of Mathematics and Physical Science Teachers in Rural High Schools Within King Cetshwayo District.
2. The University of Zululand has given ethical clearance to this research project and I have seen/may request to see the clearance certificate.
3. By participating in this research project, I will be contributing towards developing a framework for the department of education for which the supply of teachers to increase performance rate in the district in Mathematics and Physical Sciences will be ensured in the employment process.
4. I will participate in the research project by responding to the questionnaires.
5. My participation is entirely voluntary and should I at any stage wish to withdraw from participating further, I may do so without any negative consequences.
6. I will not be compensated for participating in the research, but my out-of-pocket expenses will be reimbursed.

7. There may be risks associated with my participation in the project. I am aware that there are no known risks associated with my participation. However, there is a 0.5% chance of any risk materializing.
8. The researcher intends to publish the research results in the form of papers and book chapters. However, confidentiality and anonymity of records will be maintained and that my name and identity will not be revealed to anyone who has not been involved in the conduct of the research.
9. I will not receive feedback/will receive feedback in the form of …….. regarding the results obtained during the study.
10.

Any further questions that I might have concerning the research or my participation will be answered by Vincent Titos Smith (+27839898573). By signing this informed consent declaration I am not waiving any legal claims, rights or remedies. A copy of this informed consent declaration will be given to me, and the original will be kept on record.

I, …….. have read the above information / confirm that the above information has been explained to me in a language that I understand, and I am aware of this document's contents. I have asked all questions that I wished to ask, and these have been answered to my satisfaction. I fully understand what is expected of me during the research. I have not been pressurized in any way and I voluntarily agree to participate in the above-mentioned project.

……. …….

Participant's signature **Date**

Appendix D: Questionnaires

Complexities in Availability of Mathematics and Physical Science Teachers in Rural High Schools Within King Cetshwayo District.

Please note that it should take you about 10-20 minutes to complete this questionnaire.

Appendix B

Please fill in the following questionnaire. This is an academic research and will be used for academic purposes only, therefore you are ensured strict confidentiality

INSTRUCTIONS

This questionnaire is divided into section A & B. Please complete both sections.

• Mark your answers with an **X** on the relevant box.

• Support your arguments and express your opinions in the space provided.

Questionnaire

Section A

Gender: Female ☐

Male ☐

Age: 18--25 ☐

25--35 ☐

35--45

45--65

Race: African White Indian Other

Level of education/Degree

Primary School	**Secondary School**	**Tertiary Education**

SECTION B

1. What science subject do you teach?

……
……
……
……
……

2. How many years of experience do you have?

……
……
……
……

3. What is your personal experience or challenges in teaching the science subject?

……
……
……
……

4. Do you have departmental support from the school where you teach?

……
……
……
……

5. Are you motivated in teaching your science subject?

……
……
……
……
……

6. Does your school have the required or adequate resource or facility (e.g. science lab or equipment) with a conducive environment for teaching and learning to take place?

……
……
……
……
……

7. What are the factors that affect the supply of science teachers in your high schools?

……
……
……
……
……

8. How is the availability of science teachers in your high school linked to resources management in the teaching environment?

……
……
……
……
……

9. How can science teachers be motivated to accept employment in the rural-based high schools of King Cetshwayo District?

……
……
……
……
……

10. To what extent does the non-availability of qualified science degree teachers in the rural high schools contribute to learner's performance in science subjects?

……
……
……
……

11. What are the possible challenges in getting qualified teachers in a specific field to accept employment in rural area?

……
……
……
……

12. What would you like to suggest to the department of education and school managers on how to improve learner's performance with better results?

……
……
……
……

13. What are factors considered to be best practice in ensuring that the employment process only sorts for qualified teachers in your school?

……
……
……
……
……

14. In what ways do you think the government and stakeholders can improve the current condition in the rural-based schools for the distribution of both human and economic resources?

i. Learners
……

ii. Teachers
……..

iii. Community
……..

iv. Education system ……

The end: Thank you for your participation!

Appendix: E Ethical Clearance Certificate

UNIVERSITY OF ZULULAND
RESEARCH ETHICS COMMITTEE
(Reg No: UZREC 171110-030)

RESEARCH & INNOVATION
Website: http://www.unizulu.ac.za
Private Bag X1001
KwaDlangezwa 3886
Tel: 035 902 6731
Fax: 035 902 6222
Email: LundallN@unizulu.ac.za

ETHICAL CLEARANCE CERTIFICATE

Certificate Number	**UZREC 171110-030 PGD 2019/56**						
Project Title	**Complexities in availability of mathematics and physical science teachers in rural high schools within King Cetshwayo District**						
Principal Researcher/ Investigator	VT Smith						
Supervisor and Co-supervisor	Prof A Kutame		Dr NP Dlamu				
Department	Social Sciences						
Faculty	Education						
Type of Risk	Medium Risk – Data collection – from people						
Nature of Project	Honours/4th Year		Master's		**Doctoral**	**X**	Departmental

The University of Zululand's Research Ethics Committee (UZREC) hereby gives ethical approval in respect of the undertakings contained in the above-mentioned project. The Researcher may therefore commence with data collection as from the date of this Certificate, using the certificate number indicated above.

Special conditions:

(1) This certificate is valid for 1 year from the date of issue.
(2) Principal researcher must provide an annual report to the UZREC in the prescribed format [due date-29 June 2021]
(3) Principal researcher must submit a report at the end of project in respect of ethical compliance.
(4) The UZREC must be informed immediately of any material change in the conditions or undertakings mentioned in the documents that were presented to the meeting.

The UZREC wishes the researcher well in conducting research.

Professor Mashupye R. Kgaphola
Acting Chairperson: University Research Ethics Committee
Deputy Vice-Chancellor: Research & Innovation

29 June 2020

CHAIRPERSON
UNIVERSITY OF ZULULAND RESEARCH ETHICS COMMITTEE (UZREC)
REG NO: UZREC 171110-30
29 06 2020
RESEARCH & INNOVATION OFFICE