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Submitted in fulfilment of the requirements of the degree of

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with the title:

The role of instructional leadership in the implementation of mathematics curriculum changes in the intermediate phase.

FACULTY OF EDUCATION

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DECLARATION

I, John Elphas Masina, declare that the work presented in this report is my own.

This thesis is presented towards the fulfilment of the requirement for the qualification:

DOCTOR OF EDUCATION

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with the provisional title:

THE ROLE OF INSTRUCTIONAL LEADERSHIP IN THE IMPLEMENTATION OF MATHEMATICS CURRICULUM CHANGES IN THE INTERMEDIATE PHASE.

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DEDICATION

This work is dedicated to:

- ❖ My late mother, AnnahNondzanjanaMathebula, who planted in me the love of education and further learning.

- ❖ My wife, Lungile G Masina, for lovingly encouraging me to go on with my studies and her for financial and emotional support throughout this strenuous learning process.

- ❖ My daughters, Nonkululeko, Boitumelo, Ntokozo, Asunder and my granddaughter Keamugetswe and my only son, SiceloAndile, for their assistance with computer skills

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ABSTRACT

Despite the vast research by South African researchers about the implementation of curriculum change in mathematics classroom in early childhood education, little is known about the perspective of the role of school based instructional leaders in creating an environment for continuous professional development for mathematics teachers.

The images that emerged from the literature is the poor performance of learners in mathematics, the poor quality of mathematics teachers and inability of mathematics teachers to implement curriculum innovations and the impact of apartheid upon the teaching and learning of mathematics. Overcrowded classrooms and lack of parental involvement are some of the factors associated with challenges and threats facing implementation of the proposed techniques and strategies of teaching to ameliorate learners' competences in knowledge and cognitive skills in mathematics. There are recommendations based on empirical studies highlighted by literature, which points to solutions to the threats and challenges of mathematics teaching in early childhood, particularly at intermediate phase (middle schooling education). The synthesis of literature established a synchronic connection in the conceptual understanding of the role of the heads of mathematics department and instructional leadership in the context of creating an environment conducive in schools, for effective delivery of curriculum innovation and continuous professional development.

The argument in this study is that effective curriculum management should be the responsibility of the top-down and bottom-up networks and collaboration. The heads of mathematics department as school based instructional leaders should focus their activities on the matters of curriculum delivery and continuous professional development of mathematics teachers. Heads of mathematics departments should account to the layers of curriculum management beyond their school premises on their activities, such as, mentoring, coaching and professional development of teachers and about the professional practices of their colleagues regarding learners' poor performance as well.

There were strong evidence in the analysis of data collected by means of questionnaire and in depth interviews from three case studies designed for the study that:

- limited support given to teachers to understand the importance of maximising active participation in learning activities and selecting teaching strategies for inclusive classroom environment
- Little encouragement of teachers from heads of the mathematics to apply the teaching and learning strategies and techniques proposed for implementing innovations in the mathematics curriculum.
- lack of uniformity among HMDs regarding the performance of their instructional leadership roles of creating environment conducive for continuous professional development of mathematics teachers.
- Inadequate clarity on the purpose of instructional leadership among Heads of Mathematics department in intermediate phase, which impedes collaborative engagement, and sharing of common vision in the department regarding what ought to be the mechanisms for implementing innovations of mathematics curriculum in their daily classroom practices.

This study is part of the growing body of research into the clinches` that hinder the implementations of curriculum changes in mathematics classrooms in early childhood education.

The recommendations made in this study contribute to the ongoing research towards finding solutions to the limited support to mathematics teachers in rural and township schools. The study used Valsiner's theory of socio-cultural learning and Senge's five Disciplines to analyse data, which resulted in the identification of areas, which Heads of mathematics departments should focus on, to promote the effective implementation of strategies and techniques proposed by mathematics curriculum innovation (CAPS) in order to enhance learning of mathematical knowledge and skills in the intermediate phase.

Glossary of Acronyms

SCK... Subject Content Knowledge

SPCK... Subject Pedagogical Content Knowledge

HoDs... Heads of Department

IP... Intermediate Phase

CAPS... Curriculum and Assessment Policy document

DBE... Department of Basic Education

DoE... Department of Education

NCS... National Curriculum Statement

C2005... Curriculum 2005

QOTL... Quality of Teaching and Learning

PLC... Professional Learning Community

LCK... Leadership Content Knowledge

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Chapter 1 Overview of the Study

1.1 Background to the study

Transformation of education in South Africa began after liberation in 1994. Curriculum designers took a special interest in investigating the discourse of teaching and learning subjects such as Mathematics and Sciences; under the dispensation of a democratic, multi-cultural and non-racial administration. A historical perspective established from literature indicated that during apartheid educational administration, Mathematics and Sciences curricula were underpinned by segregationist, philosophical and ideological principles. This philosophical ideology influenced the production of poorly qualified teachers of mathematics who reported to be incompetent to implement curriculum innovations in mathematics classes (Chisholm, 2000, Khuzwayo, 2003, Graven, 2004, Vithal & Skovsmose, 1999 and Volmink, 2009). NECC (1992) in its recommendations for a Curriculum Model for a democratic society in South Africa commonly known as CUMSA advised that upgrading of teachers should be the main focus of curriculum development for a democratic educational dispensation.

Relevant literature indicates that instructional leadership and continuous professional development were conceptualised within the framework of curriculum research and development after the Outcomes Based Education curriculum was introduced in 1997 for the democratic education dispensation in South Africa (Chisholm *et al.*, 2002 Educational Labour Relations Act, 2003 and Volmink *et al.*, 2008). The policy framework for continuous professional development with specific reference to mathematics teachers encapsulates: teacher in-service education and training and workshops organised by subject advisory structures at national, provincial and district

levels (Graven, 2004 and Spaul & Simkins, 2011). The congruence in the findings highlighted by several empirical studies conducted during the advocacy of mathematics curriculum innovation suggested that mathematics teachers in early stages of schooling often lack the ability to understand the principles underpinning mathematics curriculum innovations and its pedagogical strategies (Bransilal *et al.*, 2017, Simkins & Spaul, 2011, Graven, 2004 and Chisholm, 2005). The minister of Basic Education expressed the view that:

South Africa is significantly underperforming in education in general, particularly Mathematics teaching and learning. Mathematics teaching is often poor quality, with teachers not able to answer questions in the curriculum they are teaching, one indicator of the challenge. Often national testing is misleading as it does not show the major gap at lower grade levels,” Motshekga told education experts at a three-day Mathematics Indaba held in Pretoria. <https://citizen.co.za/news/south-africa/1373191/>.

The statement of the Minister of Basic Education and the analysis of the reports produced by the Centre for Entrepreneurs Development (CED, 2011) and Systemic Evaluation, known as Annual Assessment (ANA, 2013), all confirmed poor results on the performance of early grades learners in mathematics.

This study is cognisant of the fact that previous researchers in the field of mathematics education conducted research to explore the strategies and approaches which could contribute to the effective teaching and learning of mathematics in early stages of schooling. Relevant literature indicated that recommendations from empirical studies were made to address challenges and threats facing teaching and learning of mathematics in South Africa (Graven 2004; Mudaly 2013; Spaul & Simkins, 2011, Vithal *et al.*, 2005 and Bansilal *et al.*, 2017). The argument in this study is that the

recommendations of the researchers are of little significance if those in instructional leadership positions do not incorporate such innovative recommendations in the school based continuous professional development programmes for mathematics teachers. Recommendations gathered from literature highlight that mathematics teaching and learning in South Africa should be taught in the socio-cultural and linguistic context of the learners (Vithal *et al.*, 2003 and Skovsmose & Vithal, 2001). The contextualisation of teaching and learning of mathematics within the socio-cultural context of the learners through school-based curriculum development should take place under the instructional leadership of those in the position of heads of mathematics departments (HMDs).

Researchers in mathematics teaching in South Africa and overseas tested various approaches to teaching and learning of mathematics: Modelling, Diagrammatic and Visualisation (Mudaly, 2013; Graven, 2004 and Bransilal *et al.*, 2017). (Bansilal *et al.*, 2017 and Killen 2015). Such investigators into curriculum design recommended approaches such as; learner-centred learning; discovery-based, inquiry-based and problem-based solving and co-operative strategies to improve acquisition of mathematics conceptual knowledge and cognitive skills. The value of the learner-centred strategies is considered to be of great significance in the learning of conceptual knowledge and skills in mathematics lessons' in the context of real-life problems and scenarios. HMDs are considered in this study to be the audience for the findings highlighted by these researchers, and the key players in ensuring that recommended strategies and techniques or approaches for effective teaching and learning of mathematical knowledge and skills are part of school-based continuous professional development.

This study was conducted within the framework of continuous professional development for mathematics teacher but the lens of school-based school support, guidance and coaching for teachers is used to explore the role of HMDs to improve the quality of teaching and learning of mathematics knowledge and skills in early stages of schooling. The intention is to establish the role of HMDs in providing effective instructional leadership on matters of classroom practices, approaches to pedagogical strategies and creating environments conducive for teaching and learning of mathematics. The notion of progressive strategies was a trend identified from the analysis of literature, and provided guidelines for transforming and implementing the national curriculum in classrooms. It was evident in the review of literature that constructivist principles are gaining support in research undertaken by academics in the field of Mathematician and developers of mathematics curriculum (Bansilal *et al.*, 2017, Department of Basic Education, 2008 and Mudaly, 2013). Since these strategies form integral parts of the daily teaching and learning of mathematics, HMDs are obliged to engage in serious continuous professional development; for the benefit of the teachers in their departments and learners. The contributions of researchers in mathematics education to the progress of strategies and methods that could assist learners to develop an interest in mathematics are considered in this study, to be the foundation of continuous professional activities organised by HMDs. HMDs in the intermediate phase classes are considered in this study to spearhead the process of developing professional knowledge required for the implementation of alternative strategies. HMDs are school-based curriculum specialists and instructional leaders (DoE, 1998) who are charged with the responsibilities to empower mathematics teachers with the knowledge and application of techniques and approaches recommended for teaching and learning of mathematics knowledge and skills to

learners. HMDs are expected to ensure that teachers of mathematics instructional practices are compliant with the goals and aims of the national curriculum (Educators Employment's Act, 1998, Department Basic Education, 2011, Department of Higher Education, 2015 and Mokhele & Jita, 2010).

It is assumed, in this study that HMDs are up abreast with the contributions of researchers in the field of mathematics that pertain to empirically proven approaches to learning mathematics in the various contexts of South African schools. This assumption is based on the view generated from the instructional leadership role that HMDs are agents in the pioneering and testing of progressive strategies recommended for the teaching and learning of mathematics in early the stages of schooling.

The literature review compiled for this study established that researchers investigated the significant roles of HMDs but the focus of the research was on school management and administration. The findings highlighted by previous researchers inform this study about the leadership styles of HMDs and the influence of the leadership styles of HMDs upon the restoration of a sound culture of teaching and learning in schools (Msila, 2011 and Bambi, 2013). The difference in this study is that instructional leadership of HMDs is based upon the premise of the instructional leadership role of HMDs in school-based continuous professional development for mathematics teachers in the intermediate phase/

The review of international and local literature pertinent to this topic highlighted that researchers in Mathematics Education (ME) relate lack of cognitive skills and conceptual knowledge among learners of mathematics to the following factors. And these are inadequate mastery of mathematics curriculum changes of the 21st century as

well as the pedagogical implications for mathematics teachers (Kilpatrick *et al.*, 2001; Kristin *et al.*, 2011, Ball *et al.*, 2001 and Schoenfeld, 2002). Graven (2004) and Simkins and Spaul (2011) note that the curriculum changes introduced in the Outcomes Based Education initiative were beyond the abilities of teachers who were, expected to implement OBE in classroom practice in South Africa. There have been endeavours to review curriculum changes, from Curriculum 2005 (C2005), National Curriculum Statement (NCS) and recently the Curriculum and Assessment Policy Statement (CAPS) which is the espoused curriculum. One-week workshops conducted for teachers have been condemned by researchers for being insufficient to train teachers about the fundamental ethos of OBE or constructivism which is, completely alien to the textbook system installed by government from 1948-1994 and which many teachers and teachers of teachers fall back upon. Such workshops are held over and above the contextual challenges facing each school's implementation of the innovations (Chisholm, 2000, 2009; Jansen, 1997 and Hoadley and Jansen, 2009). Inadequate facilitation and lack of suitable material were reported by researchers to be the main weaknesses of the training workshops planned and organised to teach teachers about mathematics curriculum changes in the espoused school curriculum (Jansen and Christie, 1999 and Chisholm, 2000).

Killen (2012:45) indicates that quality in teaching and learning is, determined by competent knowledge that reflects mastery of the subject content knowledge, teaching strategies and the cognitive development of learners. This is what this study considers to be a significant gap in the process of improving quality of teaching and learning of mathematics in the so-called historically black schools in 'townships' and rural areas. The interventions of the national department of education to review mathematics

curriculum did not capacitate mathematics teachers. The declining performance continued under the watch of the school-based instructional leaders.

Researchers highlight various challenges that threaten the implementation of the national department's initiative to improve learner performance in Mathematics, but not much has been established concerning the impact of HMDs upon addressing these challenges. The input of HMDs to address poor performance of learners in mathematics has not been established. HMDs as leaders of instruction in mathematics should be provided a platform to express their own views and opinions regarding performance of learners in their schools.

HMDs use certain models to support teachers under their leadership with curriculum knowledge and skills required for the effective implementation of curriculum reforms. HMDs bear the responsibility to apprise teachers of these models for effective teaching and learning. Researchers in curriculum development and its implementation in schools (Chisholm 2000; Jansen & Christie, 1999) emphasise that teachers were unable to implement curriculum changes owing to the demands posed by the national curriculum policy and lack of information from HMDs.

The documentation on curriculum change pioneered by the Department of National Education (1998, 2005, 2008 and 2011) emphasises the pivotal role of assessment in the process of teaching and learning. Assessment is viewed as an integral part of the process of teaching and learning. Documentation on adaptation of curriculum changes provided guidelines for assessment. HMDs are expected to demonstrate competence in issues of integrated assessment systems to ensure that teachers understand the importance of continuous assessment. According to Killen (2005) the knowledge of continuous assessment entails the competence: to conduct baseline assessment,

formative, summative and diagnostic assessment as well as to report on the results of these assessments. Another crucial issue pointed out in DoE (2005) regarding the challenge threatening the implementation of mathematics curriculum change in the classroom is teachers' competence to select and organise content knowledge and learning material that is not congruent with the differentiated cognitive learning abilities of learners' in their elementary stages of developing conceptual knowledge in mathematics (Graven 2004).

HMDs need to ensure that curriculum changes are effectively implemented in the classroom. Balanced interpretation of espoused curriculum changes is critical to realising the envisaged mathematics learner. HMDs are the key role players in school-based curriculum development. HMDs need to supervise, support or mentor and supervise the implementation of the espoused curriculum innovations for the national subject curriculum goals. Changes to the Mathematics curriculum introduced in the Curriculum 2005 in 1997 required a complete shift in the conceptualisation of Mathematics in the school curriculum. First, the emphasis was on learning outcomes, contextualisation of teaching and acquisition of mathematical concepts, skills and competences. Second, curriculum innovations introduced a new system of assessment which required teachers to apply various strategies of assessment including: baseline, formative, summative and diagnostic assessment. The curriculum changes in mathematics required HMDs to ensure that assessment of learning was continuous and holistic. Assessment is intended to be an integral component of teaching and learning. The concept of continuous assessment in mathematics teaching and learning required HMDs to develop a new mind-set: away from traditional content-based assessment to outcomes-based assessment. The paradigm shifts expected teachers to focus the teaching of mathematical knowledge upon predetermined learning outcomes. The

planning and organisation of knowledge to attain learning outcomes had to be inclusive and learner-centred. The principles of inclusivity and learner-centredness are the key organisers and guidelines for identifying and prioritising learning outcomes, assessment criteria, content and teaching and learning strategies. According to DoE (1995) the national curriculum transformation school-based curriculum development under the leadership of heads of subject departments should consider school contextual factors which are: accessibility of teaching and learning resources, needs of the learners in the context of the socio-economy of the community and of the country. According to Carl (2012: 121) various human factors impede such a vision: recalcitrance from the old guard, poor leadership and defective skills, divided attention, personal and psychological qualities, added administrative duties, individual and mutual differences in preparedness, variety of educational philosophies, defective understanding and self-confidence among implementers, and absence of encouragement and motivation.

1.2. Problem statement

The contrast established from literature between the innovations of the department of education and the recommendations of researchers indicate that there is a disjunction between mathematics teachers and instructional leadership at different levels. Claims emerge such as: *the majority of grade six mathematics teachers in South Africa cannot answer a question that their learners ought to be able to answer based on grade 6 curriculum*. Motshekga <https://citizen.co.za/news/south-africa/1373191/>.

McCarthy and Oliphant (2013:5) raised concerns about accountability of school-based instructional leadership of HMDs on the threats facing effective teaching and learning of mathematical knowledge and skills in early childhood education. Taylor (2011) reports that poor performance in mathematics in most schools in SA is largely due to the poor subject knowledge of teachers and the role of patronage or nepotism in the appointment of teachers in schools. These claims provide the rationale and the background to this study, which sets out to explore the approaches applied by HMDs to provide continuous professional development to teachers of mathematics in the intermediate phase.

According to the policy framework for Whole School Evaluation, the Integrated Quality Management systems (IQMS), HMDs have a responsibility to organise support and assistance required by teachers to improve competences in subject knowledge as well as pedagogical strategies (ELRC Collective Agreement No. 8 of 2003 and Government Gazette: Vol. 433, No. 22512 - 26 July 2001). These two policies explain the main instructional role of HMDs with special reference to teacher professional development: to evaluate an educator's performance; to identify specific needs of

educators for support and development; to promote accountability and to prepare the environment for teacher development (ELRC Collective Agreement No. 8 of 2003: 6).

The literature review compiled for this study established that the issue of continuous professional development of mathematics teachers was regarded in the context of advisory structures at different levels: national, provincial and districts. The ministerial task team blamed provincial and district-based subject advisory personnel for inadequate support for teachers. Nothing in the reports (DBE, 2011 and DoE, 2002), actually points to the role of the school-based instructional leadership in terms of the challenges facing teaching and learning of mathematics. The position of instructional leadership is critical and assigns HMDs the responsibility to account not only to the national department, but more significantly to the teachers who expect guidance, support and continuous professional development from their leadership.

This study argues that researchers have overlooked the potential for HMDs to implement CAPS mathematics teaching and raise pass rates so far. This study shows that HMDs are of critical importance in the implementation of mathematics policy, raising pass levels and socio-economic development in South Africa. This land requires citizens who can compete in the fast global economy and for that to be a reality, young learners require high-level cognitive and application skills in mathematical knowledge: logic, critical thinking, creative thinking, counting, computation skills and advance technological expertise in graphic design skills.

Researchers highlight the challenges facing the implementation of curriculum reform in schools in South Africa are related to *inter alia*; incapacity of teachers to teach the subject content knowledge proposed in CAPS; the inadequacy of teachers' subject pedagogical content knowledge; constraints in the accessibility of suitable resources

(Chisholm, 2000; 2005; Hoadley & Jansen, 2009, Clarke *et al.*, 2004, Spall, 2011, Sickens, 2013 and Bennie & Newstead, 1999). Threats facing the implementation of innovations proposed in the mathematics curriculum mainly include teachers' misconceptions and misinterpretation about what innovation entails. Teachers and HMDs are still uninformed about the principles of Freirean constructivism, which supports the ANC policy for social reconstruction and egalitarian priorities. Teachers and HMDs across the country fall back upon textbook learning as a failsafe method. Graven 2004:185) comments:

A view of learning that determines the role of teaching is problematic and is, I believe, especially problematic in current curriculum change in South Africa. Many teachers have interpreted the new curriculum and its emphasis on learner-centredness, cooperative learning and group work to mean that they do not really need to teach. This is particularly problematic in mathematics classrooms where such interpretations mean that teachers no longer share algorithms and procedures with learners.

The findings highlighted by Graven (2004) about inadequate understanding of the essential nature of constructivist, learner-centred pedagogy relate directly to responsibilities of school-based instructional leaders or HMDs. Few HMDs grasped the proposed pedagogical approaches to teaching and learning of mathematics, the shift in a teacher's role from teaching to supervising learners practising book-based activities and the neglect of teaching and mastery of conceptual knowledge of mathematics. The tendency of mathematics teachers to leave learners to carry out learning activities on their own is reported in research findings (Graven & Lerman, 2003, Graven, 2004 and Centre for Development and Enterprise, 2013).

This study assumes that HMDs can radically improve teachers' continuous professional development and address challenges facing the implementation of Mathematics curriculum changes. This assumption is based on the Department of Education introduced instructional leadership positions for providing school- based coaching, support and supervision for the implementation of mathematics curriculum changes and innovation at schools. Research points out that curriculum change without transformation of teachers' beliefs about the subject content knowledge and the approaches of teaching comprise a barrier to reaching curriculum goals (Fullan, 2006, Carl, 2010 and Goos, 2009). In spite of various factors contributing to the outcry about learners' poor performance in Mathematics, this study identifies the gap in the professional support system for teachers and learners as the problem. The research conducted in this study seeks to prove that HMDs can empower and capacitate teachers and learners to construct knowledge and collaborate in the acquisition of new skills in Mathematics.

Parker (in Grayson 2009: 62) argues for the significance of school-based professional development by instructional leaders across the subjects;

... teachers that are deployed in schools are dysfunctional; they can soon unlearn what they have been taught in their preparation and take on the characteristics of the rest of the teachers in the school, or leave the system altogether. Unless there is a critical mass of professional teachers in a school and there is good leadership, it is very difficult for new teachers to acclimatise and develop into professionals committed to their learners and their careers. Thus, we have to assist teachers in the system to take responsibility for their practice and continuing professional learning. It is noted that this is not essentially about the resources that a school has; it is about ethos and commitment, although the physical and material conditions of a school do have a major effect.

This perspective emphasises the role of school-based support for mathematics teachers. It is in this regard that HMDs can play a role in leadership: to provide continuous professional guidance and mentoring to Mathematics teachers. HMDs require staff development programmes to address teachers' professional development needs and to adapt to the local socio-cultural environment of the school.

Carl (2010) emphasises that the curriculum renewal climate requires well-trained personnel to provide leadership. This view points to the capacity of HMDs to perform multi-tasks: developing subject content knowledge for learners, and empowering and supervising teaching, learning and assessment. It is incumbent upon HMDs to ensure that teaching and learning of mathematics in a CAPS compliant classroom: (i) is sensitive to the socio-cultural attitudes of the learners, (ii) addresses the issue of differentiated styles of learning and (iii) breaks down barriers to acquisition of adequate conceptual knowledge and cognitive skills. This study argues that HMDs can generate strategies and approaches suitable to engage and to persuade teachers to adopt progressive methods proposed in the current mathematics curriculum for intermediate grades. HMDs are expected to exercise their instructional leadership position to influence teachers of mathematics to conduct various assessment methods when teaching and assessment policies are developed for a particular phase.

Research shows that instead of implementing the recommended strategies of teaching and learning in the guidelines, teachers apply their minds to pedagogical practices (Harley & Parker, 1999; Muller, 2000; Chisholm, 2002 and Taylor & Vinjevold, 1999). Jansen and Christie (1999) blame the chaos that prevailed in many classrooms upon the misconceptions and lack of pedagogical knowledge for implementing curriculum changes in classrooms practice. This research intends to obtain perspectives of both HMDs and teachers about the strategies and approaches which have been devised to

address the lack of conceptual knowledge of pedagogy for implementing curriculum innovations in classrooms. Muller (2000:14) indicates that challenges in the teaching and learning of mathematics include pedagogical issues and misconceptions around subject content knowledge.

Volmink (in Grayson (2009: 58) stresses the importance of developing Mathematics content knowledge and pedagogy:

The latter is dependent on personal commitment and continued professional learning, as well as teachers' access to powerful forms of knowledge, including a broad and deep understanding of their area of specialisation (subject/learning area/phase) both in-and-for itself and in-and-for teaching.

HMDs, in accordance with their job description in the Employment of Educators Act (EEA) in Educational Labour Relations Policy (ELRC, 2003: 6) have to encourage and engage teachers in Continuous Professional programmes to upgrade subject content knowledge and pedagogical knowledge. The whole school development initiative which includes teacher appraisal and development states that heads of subject departments have to collaborate with teachers in identifying the professional developmental needs of individual teachers (ELRC, *ibid.*). HMDs are expected to ensure that identified areas of weakness discussed with an individual teacher are addressed; by providing necessary resources and support to teachers who struggle to grasp constructivist ideas and new curriculum initiatives and stipulations. The policy indicates that teachers who require support concerning subject content knowledge and pedagogical knowledge, should attend training workshops. Researchers from the Centre of Development and Enterprise, (2013:8) claim on the basis of learners' poor

performance in the Annual National Assessment (ANA) results that inefficiencies in Mathematics teaching and learning originate between grades 4 and 9.

Issues that jeopardise successful implementation of innovations in the mathematics curriculum include: (i) mathematics teachers who do not know their subject well enough, (ii) learners' low marks in mathematics nation-wide and (iii) teachers who genuinely or falsely, claim to misunderstand changes to the curriculum for mathematics at the intermediate phase. This investigation into these three issues focuses on the role of HMDs/ Carl (2010) asserts that curriculum development and planning at school level entail collegiality among staff members and sound instructional leadership. This study focuses upon the role of instructional leadership in particular.

1.3 Research questions

- To what extent do HMDs assist teachers to accept changes proposed in the Mathematics curriculum and assessment policy statement (CAPS) for the intermediate phase?
- How do mathematics teachers respond to pedagogical approaches promoted by the HODs for the teaching and learning of Mathematics in the intermediate phase class?

1.4 Aim of the study

This study aims to interrogate the role of HMDs to capacitate mathematics teachers about approaches and strategies to improve teaching and learning of Mathematics curriculum; known as CAPS in intermediate classrooms.

1.5 Objectives of the study

This study intends to:

- a) identify different perspectives on pedagogical approaches to the teaching of Mathematical concepts and skills in classrooms under the leadership of HMDs
- b) determine the interactions between the HMDs and teachers in their socio-cultural contexts and
- c) construct a realistic model for implementing new ways of teaching and learning mathematics.

1.6 A brief overview of the theoretical framework

The theoretical lens used in this research is based upon the work of socio-cultural theorists such as Valsiner (1997, Goos (2009), Iffah (2017) and Blanton (2005). Valsiner's Zones Theory enabled the researcher to focus on interrelated zones that were involved in this study. Valsiner's theory originated from the socio-cultural work pioneered by Lev Vygotsky which, declares that the development of cognition is possible through social interactions. The zone of Proximal Development (ZPD) is viewed to be a continuum in human cognitive development: exhibited in the process of teaching and learning. Valsiner's zones theory adds two zones: Zone of Promotion Action (ZPA) and Zone of Free Movement (ZFM). Goos (2009) believe this theory enables a researcher to understand differences and interdependences in interactive

learning in the school environment between teachers and their instructional leaders. Blanton (2005) employed this theory to study the interactions in implementing new knowledge and skills to in-service mathematics teachers. Findings indicated that the Zone of Promotion Action could be rejected, accepted or ignored. Rejection of constructivist techniques and skills was identified as teachers who preferred to continue with their traditional methods of textbook teaching: referred to as -Zone of Promotion Action. Acceptance of new skills, knowledge and techniques were referred to as + Zone of Promotion Action. The last category is pseudo-Zone of Promotion Action or-Zone of promotion Action.

The empirical research for this study drew upon the work of socio-cultural theorists to explore the role of HMDs in facilitating changes to the mathematics curriculum as stipulated by CAPS. No HMDs are expected to play a leadership role in implementing changes, and in dispelling false prejudices; such as that Mathematics is the preserve of a few abstract thinkers (Adler & Reed, 2002; Volmink, 2009 and Vithal & Skovsmose, 1997).

The Educational Labour Relations policy (2003 C66) asserts that HMDs are expected to:

Engage in class teaching; be responsible for effective functioning of the department, to ensure that the subject matter, learning area and the education of learners is promoted in a proper manner.

The policy (ELRC: *ibid.*) states that HMDs ought to;

Control the work of educators and learners in the department concerning, development of assessments activities and keeping learners' progress records or mark schedules,

Provide guidance and coordinate on the latest ideas on approaches to the subject, methods of teaching and learning, techniques suitable for effective teaching and learning of the subject content knowledge and skills.

Effectively convey new strategies to the staff members concerned

Co-operate with colleagues in order to maintain a good teaching standards and to collaborate with educators of other schools in developing and conducting extra-curricular activities.

Take on a leadership role in respect of the subject, learning phase and to take into account orientation, regional courses, new approaches, techniques, evaluation in their fields.

Zone theory assisted the researcher to identify variables in this study:

- (i) New strategies for teaching and learning mathematics were classified as Zone of Promotion Action (ZPA);
- (ii) Interactions (for instance, approaches to collegial and collaborative effort to implement new strategies of teaching and learning of mathematics) were the second variable; referred to as Zone of Free Movement (ZFM)
- (iii) Goals of teachers and heads of department for improving pedagogical and subject content knowledge were categorised as Zone of Proximal Development.

1.7. Literature Review

The conceptual framework used in this thesis was established after a critical review of literature germane to approaches for teaching and learning Mathematics. Literature

reveals conceptions of instructional leaderships in various contexts and it is important to present the conceptual understanding of “instructional leadership in this study”. Researchers apply this concept in the context of school management (Hoadley *et al.* (2009: 385) describe instructional leadership in the context of curriculum management where it is seen as a whole school responsibility and where instructional leadership is used. Other researchers who are associated with a similar conceptualisation of instructional leadership are: Bush (2004 and 2003); Miller (2001) and Moore (2009). The role of the HMDs in this view is to assist principals in the management and administration of schools’ the term middle managers is used to define their responsibilities.

The second conceptual view of HMDs describes their role and bureaucratic position in the school management structure in terms of curriculum specialists or managers. It is description that relates the position to instructional leadership. Education Labour Relations Council (ELRC) (2001: c6) stipulates the functions and responsibilities of heads of department to be more curriculum oriented than administrative. The position of instructional leaders encapsulates roles of support, guidance, capacitating, empowering professional development, coaching, mentoring and supervision.

The philosophical beliefs associated with traditional and progressive theories about teaching were analysed for data analysis and interpretation of findings about HMDs and teachers’ pedagogical identities. Perspectives on learning styles and teaching theories directed the researcher to issues of educational psychology as set out by: Skinner, Piaget, Lev Vygotsky and the gestalt psychologist, Woolfolk (2014). The review of literature for this study examines approaches to instructional leadership presented by researchers into implementation of curriculum change: Ornstein and Hunkins (2014), Fullan (2006), Carl (2010) and Killen (2005 and 2015).

Theoretical and conceptual frameworks for this study are discussed under the following subheadings:

1.7.1A Critical perspective of the philosophical foundations for mathematics curriculum in South Africa

A synthesis of ideas and critical perspectives on developments in curriculum research in South Africa before the new political and educational the researcher perceived dispensation to be of importance; to understand how critical the role instructional leadership is to transform teaching and learning of Mathematics. Mathematics Education teaching specialists, internationally and locally highlight that mathematics teaching and learning in South African schools is outdated compared to other countries (Skovsmose, 2003; Vithal & Volmink, 2005; Taylor, 2011 and Graven, 2005). Skovsmose (2003) indicates that conceptualisation of subject content knowledge by mathematics teachers reflects absolutist perspectives strategies, which are too abstract. Concepts and skills are taught out of socio-cultural context. Khuzwayo (2005) shows that teaching of mathematics in South Africa was used as an ideological tool for instilling apartheid principles of segregation and racism before liberation in 1994. Teaching of mathematical knowledge had never been for effective and meaningful learning in black schools. The situation presented in this historical perspective explains the realities that contributed to challenges facing mathematics teachers today. The issue of unqualified and under-qualified teachers of mathematics in South Africa is a direct after-effect of the apartheid education system (Graven, 2004, McCarthy & Oliphant, 2013, National Education Crisis Committee, 1992 and Simkins & Spaul, 2011).

It was established from the review of literature that competent teachers of mathematics demonstrate an understanding of factual knowledge, conceptual knowledge and procedural knowledge of the subject content knowledge. Academics and researchers emphasise the significance of engaging teachers in epistemological processes of knowledge production in this subject, in order to equip teachers with strategies to be used in the construction of mathematical knowledge in classrooms. Academics argue that Mathematics is about numbers, algorithms and logic but these three aspects are not generated and applied in an intellectual vacuum or outside the context of real-world experiences. Problem solving activities for developing mathematical knowledge and skills have to be in accord with learners' real-life problems (Adler & Bowie, 2009; Bansilal *et al.* 2013 and Mudaly, 2013).

Those involved with the subject content, adopt or develop certain philosophies that are undergirded by epistemological and ontological principles. It is possible that even in transmitting or transferring mathematical knowledge and skills, certain beliefs accompany the pedagogical approaches presented. The work of Ernest (1991), Adler & Reed (2002), Volmink (2009), Vithal *et al.* (2000) and Khuzwayo (2000)) provide this study with knowledge of local philosophical perspectives applied in Mathematics classrooms, the nature of the subject and the pedagogical approaches used to teach it. A broad perspective of the problem of implementing new curriculum was established from a critical synthesis of the work of Ernest (1991) and Skovsmose (1994).

The literature review compiled for this study points to contesting philosophical views about the nature of Mathematics as a school subject and its value in the development of human cognitive skills. Critical analysis by Jansen (1999), Chisholm, (2002), Enslin (1991) and National Education Investigation Policy (1992) and Khuzwayo (1999) provide historical and philosophical perspectives of key issues. Analysis pointed to

divergent schools of thought with respect to the philosophical foundations of mathematics; the traditional or conservative view of ontology, which describes Mathematics as an abstract and objective field in its nature. The researchers who advocate this traditional view are classified under the following categories: abstractionism, intuitionism, structural realism, realism, and absolutism (Ernest: 1991: 45).

Progressive thinking in mathematics is noted from readings of Vithal *et al.* (2005), Ernest (1991) Taylor and Vinjevold (1999); Vithal and Volmink (2005), Killen (2015); Skovsmose (2003), Vithal (2003) and Adler and Bowie (2009). Progressive philosophies are categorised according to their emphasis on ideas, thought and views of the nature, aim and knowledge production in the field of mathematics: social constructivism, social relativism and ethnocentrism. These philosophies dispute the conservative thinking of occidental intellectuals who regard Mathematics as the preserve of a gifted few. Synthesis of these contrasting views on ontological and epistemological understandings surrounding mathematics created a critical instrument for assessing data and findings. Knowledge of the foundations of mathematics knowledge enabled the researcher in this study to gauge: the nature of mathematics content knowledge, the aim of teaching it, goals and purpose of the subject, relevant and adequate methods for teaching. This knowledge helps teachers and HMDs to understand changes in Mathematics. The position of leadership in a department entails reflective thinking and continuous professional and academic upgrading of knowledge so that teachers, HMDs and principals keep abreast of advancements in the field of Mathematics (Volmink (2009) and Parker (2009). Instructional leaders at school level should spearhead the transition from traditional to progressive ideas, thought and views. These views and recommendations were highlighted by Schulman (2004), Adler *et al.* (2002), Volmink (2009), Graven (2005) and Parker (2009) who emphasise

the importance of continuous professional development of mathematics and science teachers.

1.7.2 Critical synthesis of psychological theories underpinning pedagogical content knowledge for the CAPS mathematics curriculum

Mathematics is determined by specialised pedagogical content knowledge, which provides the principles of teaching and learning of numerical illiteracies, conceptual knowledge, procedural knowledge and meta-cognition (Ball *et al.*, 2005; McGregor, 2008 and Hill *et al.*, 2011). The conceptual framework developed for this study included analysis of various psychological perspectives of theories of learning mathematics or numerical knowledge, such as Howard Gardner's theory of Multiple Intelligences which asserts principles for learning styles for promoting mathematical intelligence among learners, (Woolfolk, 2014 & Ornstein & Hunkins, 2014). Other important theoretical principles governing learning styles and teaching strategies were drawn from the work of more orthodox educational psychologists: behaviourists and cognitivists. New trends in teaching and learning of mathematics that influenced curriculum transformation in South Africa are discussed in the Literature Review section of this study (Killen, 2005, 2015, Carl, 2010, Adler, Slonimsky & Reed, 2002, Muller & Young, 2005 and Spady, 2001).

1.7.3 Models of Quality teaching and instructional leadership

The perspectives pioneered by Fullan (2006) and Models of Instructional Leadership in the work of Ornstein & Hunkins (2014) were considered to be of value for data analysis. These models deal with new ideas, new skills and approaches to teaching and learning. This study focuses on issues of socio-cultural interactions in different local environments: so models of leadership are regarded as important. The conceptual

framework included a synthesis of progressive and traditionalist schools of thought. Progressive views are represented by the work of Killen (2005, 2015) and Ball *et al.* (2005). The works of other prominent researchers such as Kilpatrick *et al.*, (2001), Hill *et al.* (2008); Ball *et al.* (2005) and Kristin *et al.*, (2011), Park, (2000); and Schoenfeld, (2002) in mathematics education were critically compared and integrated.

1.8. Significance of the study

This empirical research argues that HMDs can implement CAPS priorities and contribute to better mathematics teaching, higher pass rates and more egalitarian, constructivist imperatives and values in the classroom. Stonehouse (1975, in Kelly 2010: 66) suggests that a curriculum blue-print is no more than a hypothetical statement which is tested by teachers in the classroom practice. HMDs to the findings of this study could lead to further research into interventions for addressing threats to the effective and efficient school based professional development and implementation of constructivist initiatives.

The study contributes to the theory and practice of instructional leadership for progressive pedagogical strategies in the teaching and learning of mathematical conceptual knowledge and procedures.

1.9. Research design and Methodology

This research project adopted descriptive and explanatory approaches to guide procedures of data collection and analysis. According to Cohen *et al.* (2015) descriptive research encompasses the collection of a wide range of opinions or views about a certain phenomenon.

1.9.1 Design

Ethnographic research was designed in three case studies to answer descriptive and explanatory research questions. There were two categories of participants in the study: the HMDs and mathematics teachers of intermediate phase grades four to six. The selection of the participants in two stratified or categorised samples focused on three case studies: rural, township and suburb schools to answer the descriptive research questions.

To what extent do HMDs promote the adaptation of CAPS pedagogical approaches to teaching and learning of Mathematics in intermediate phase?

How do mathematics teachers respond to the pedagogical approaches promoted by the HODs for the teaching and learning of Mathematics in the intermediate phase class?

- The responses of participants were expected to relate to the factors or elements that HMDs identified as areas of weakness or strength in the implementation of proposed strategies in CAPS.
- Responses were required to indicate measures taken by HMDs in their leadership role for engagement and collaboration with teachers to address areas of challenge in teachers' classroom practice.

Data were sought about HMDs' and teachers' understanding of the value and the benefits of CAPS compliant teaching strategies for teaching mathematical knowledge and skills to intermediate learners.

- Responses were sought to highlight the leadership approaches used by HMDs to convey strategies to the members of staff in the department as well as guidance and coordination of ideas on the proposed methods of teaching and learning in the CAPS document.

Researchers in educational research, Cohen *et al.* (2005); Henning *et al.* (2004) and McMillan and Schumacher (2006) emphasise the importance of explanatory research into patterns that emerge from data. These researchers point out that, questions require explanations, which can only be provided through qualitative methods.

Explanatory design: The second phase of the empirical research answered the questions that emanated from the quantitative data. Mathematics teachers and HMDs were able to elaborate on the responses given to the questionnaire, which required probing. Information expected from participants to address this question was associated with the following: the views and opinion of the strategies used by HMDs in conveying CAPS compliant strategies for teaching mathematics.

1.9.1.1 Selection of participants in the focus groups was based on three case studies.

Purposive sampling was applied in selecting teachers of Mathematics and HMDs for in-depth interviews. Sub-samples were formed from the large samples in each case study: Case studies A, B and C.

1.9.2 Methodology

A mixed methods approach was employed: between qualitative and quantitative research methods. For the explanatory research, a qualitative method was used to elicit in-depth information from the focus groups selected from the large samples.

1.9.2.1 Quantitative methods

The survey was conducted among a group of volunteers who participated in a sample of thirty-eight HMDs and eighty Mathematics teachers.

1.9.2.2 Qualitative methods

The focus groups formed from the main sample of HMDs and Mathematics teachers were used for eliciting qualitative data through structured interviews. The questions for interviews were prepared before the interviews were scheduled.

1.9.2.3 Target population

The study targeted HMDs and teachers who specialised in the teaching of mathematics at intermediate level in South Africa. The intermediate phase is perceived to be critical in the teaching and learning of mathematics because it is transitional between foundation phase and senior phase. Research indicates that some schools prefer to teach mathematical literacies and concepts in mother-tongue in the foundation phase; whereas in the intermediate phase learners are introduced to English as medium of instruction.

From the pool of volunteers of the HMDs and teachers, the sample of forty-eight participants was selected. The sample of eighty teachers was constituted from the teacher population who volunteered to participate in the study.

1.9.2.4 Strategies for sampling

The sampling strategies recommended by McMillan and Schumacher (2006:124) for descriptive and explanatory research is stratified random sampling. The division of the sample group into strata enabled the researcher to achieve representative participation of the population.

The sample of forty-eight HMDs was constituted by means of stratified random sampling, which entails the use of certain criteria; location and experience in instructional leadership.

The first criterion used to select participants was gender. The second criterion was location of schools or places of work. The total number of HMDs in this case study was six females and six males. The third criterion was the phase supervised by the HMDs. All participants were supervising teaching and learning of mathematics in intermediate phase. The total number of HMDs per case study was twelve.

Case Study A: The first category of participants from rural schools was the sample of HMDs. There were six females and six male HMDs who were selected from the rural schools under district X in KwaZulu-Natal province. The second category of participants was teachers of mathematics. The sample of thirty teachers was selected from intermediate phase from the same schools. Gender representativeness in the sample was not considered because some schools had more females than male teachers did. The teachers of mathematics and HMDs were selected from the same schools.

Case Study B: consisted of participants selected from so-called 'township' schools in the district Y in northern KwaZulu-Natal. Participants were approached via the school principals after permission was granted by the Department of Education. This case

study had two categories of participants: HMDs and teachers of mathematics. There were six HMDs from each of the two 'townships' in district Y which took part in the study. The total number of teachers was thirty: fifteen teachers were selected from each township. The rationale for having two townships was that they were different in nature: one township is surrounded by informal settlements and non-South African citizens populate it whereas the other township is made up of middle class South African citizens.

Case Study C: the participants who constituted this study are working in suburban schools and they are under the district Y, but the circuit is different. The same number of participants was selected for this case study. The category of HMDs and teachers of mathematics comprised the two sets of samples.

1.9.2.5 Research Instruments

1.9.2.5.1 Questionnaire

A structured questionnaire was used to collect quantitative data from the sample of mathematics teachers and HMDs. The questionnaires consisted of both close and open-ended questions. The questionnaire sought to elicit data to answer the research questions.

Two different questionnaires were administered to the two categories of participants: one questionnaire for the mathematics teachers and the other one for the HMDs in each case study.

The questionnaire was administered to fifty heads of HMDs who participated in the sample. A different questionnaire was distributed to another sample of eighty-three teachers teaching mathematics in the intermediate phase. The researcher arranged visits

to schools in townships and to those in rural areas. The questionnaires to HMDs and teachers were administered concurrently.

1.9.2.5.2 Interviews

The interviews were conducted with the focus groups in each case study, after the questionnaires were collected from the participants. The interviews were conducted in a group of five HMDs in each case study.

The second focus group, comprising ten mathematics teachers selected from the main sample in each case study, were interviewed. Interviews focused upon six questions, which were designed to elicit data, concerning:

- (i) The experiences of teachers in adapting the strategies recommended in the CAPS curriculum guidelines for teaching mathematical content knowledge and skills, such as problem solving, teaching for differentiated learning in mathematics lessons and using a variety of assessments to enhance learning.
- (ii) Teachers' preferences for teaching methods and learning styles for mathematics lessons
- (iii) Assistance, support and guidance provided by HMDs to teachers in the practice of teaching and learning in classrooms.

The data collected by means of interviews with teachers were purposed for triangulation. Teachers could have different perspectives to that of the HMDs on matters related to guidance, support, engagements and leadership styles. The perspective provided by teachers facilitated a balanced understanding of the role of HMDs in executing their leadership; as stipulated in the Employment of Educators' Act

(EEA) 1996 (ELRC, 2003) in the teaching and learning of mathematics content knowledge and numerical skills.

1.9. Ethical considerations

Ethical considerations were of great importance for issues such as; access to schools, recognition of gatekeepers and permission to conduct research. The following measures were taken; first, the application for ethical clearance was sent to the research committee of the institution after the head of the education department in KZN had granted permission. Second letters to school principals were sent and arrangements were made for appointments to discuss the purpose of the research. Third, consent letters were distributed to all volunteers who were elected to form the sample group. Consent letters assured participants of anonymity, freedom to answer questions freely without fear, and that they were not coerced to answer questions should they feel not willing to do so.

1.10. Validity and reliability of instruments

The validity and reliability of the questionnaire were tested in a group of five teachers in the school at which the researcher is posted and among the HMDs in two schools. Any inconsistencies and ambiguities in the questions were identified. Any grammatical mistakes were corrected before the questionnaire was printed and distributed to the larger sample group. The process of testing reliability and validity of interview questions was conducted on a smaller scale; the interview questions were posed to three different individual teachers at the school where the researcher teaches. Validation for reliability of question assisted the researcher to set the time limits for completing each

question. The researcher learned that some of the questions were confusing and needed to be simplified. After testing the validity of both instruments, the instrument was sent to the supervisor and ethical clearance committee for endorsement.

1.11. Delimitation of the Study

The province of KwaZulu-Natal has seven educational districts and twenty-three circuit offices. The study selected six circuit offices under two districts: ILembe and Emapngeni. Empangeni is the largest district in the northern KwaZulu-Natal province and it has four circuits under its jurisdiction; of which some are in remote rural areas such as Nkandla, Eshowe; the other two are the Mthunzini circuit and Lower Mfolozi circuit. From ILembe district, schools under the administration of Maphumulo and Lower Tugela Circuits were used for this research. Schools under the Maphumulo circuit, Nkandla and Eshowe, were regarded as rural; whereas schools selected from Lower Tugela, Mthunzini and Lower Mfolozi areas were considered as township or semi-urban schools.

1.12. Process of data analysis and data presentation

The process of data analysis began with the counting of questionnaires and coding of raw data. Henning *et al.* (2004:105) state that the process of qualitative analysis of data works back and forth. Raw data are always a source of reference; even after the patterns and themes are identified. The researcher archived the transcriptions of verbal responses; these records were used to substantiate patterns of thought and trends identified from the analysis.

A deductive approach was applied in the analysis of data. Zones Theory was used as a critical lens to understand the interactions of HMDs and teachers in their socio-cultural environments. The ideas, thoughts and views advocated by Valsiner (1997), Goos (2009) and Blanton (2005) about social relationships between the two variables, change and implementation, in socio-cultural contexts determine the success or failure of the process to attain desired goals. The beliefs and aspirations about Mathematics teaching and learning outlined in CAPS represent 'change'. Interaction between HMDs and teachers examines whether the aspiration and beliefs pioneered by the current curriculum are attained. Attainment of mathematics' curriculum goals could indicate the positive and effective role of HMDs in co-ordinating and providing teachers with necessary support to implement a variety of alternative strategies in teaching and learning.

The process of data analysis began after all questionnaires from participants were collected. The first set of data was collected by means of a questionnaire from HMDs and teachers, and coded and analysed through the computer programme called Statistical Process Social Sciences (SPSS). The categories and patterns in the data were presented in frequency distribution tables. Summaries of data from tables were presented in pie graphs.

1.12.1 Analysis and presentation of qualitatively derived data

Verbal responses from participants were recorded using an audio tape recorder. Each participant was given a pseudonym for confidentiality purposes at the time of transcribing responses from audio tapes into transcripts. The responses were classified according to the patterns of thought and ideas. A deductive methodology was applied for analysing raw data and formation of categories. The zones identified from the Zone

Theory assisted in the grouping of data under various themes. The first category of data addressed the Zone of Proximal Development (ZPD) for HMDs and teachers. Trends and patterns of thought identified by means of ZPD were presented under themes identified from the data. The second category of data related to the pedagogical identities of participants and it was presented under the heading of Zone of Free Movement (ZFM). The third form of data gathered was data relating to new skills, knowledge and ideas that constituted the Zone of Promotion Action (ZPA). Data classified under the ZPA were critically analysed to identify views that pointed to the rejection (*-zpa*), acceptance (*+zpa*) and pretence of acceptance without implementation, the pseudo-promotion action (*spa*).

Findings were contextualized within the argument of the research question and problem statement of the study.

1.13. Orientation of the study

This study consists of:

Chapter One

This chapter provides a general overview of the study, the researcher's motivation, a statement of the problem, the purpose of the study: its objectives, significance, design and methodology.

Chapter Two

The chapter 1 presents the conceptual framework generated from a review of literature on various aspects related to curriculum innovation and implementation in schools.

Chapter Three

This chapter presents a detailed theoretical framework, which underpins the empirical study which, is used as a platform for analysis of findings.

Chapter Four

This chapter reports upon the procedure adopted for the research design and for data collection. A detailed description of the methodology employed in the empirical study is provided.

Chapter Five

This chapter presents data elicited from the participants by means of three research instruments: in-depth interviews, questionnaires and self-reflection sheets.

Chapter Six

This chapter presents analysis of data in relation to research goals and questions. It provides a detailed discussion of the findings in relation to the literature reviewed.

Chapter Seven

The final chapter presents the main findings, an overview of the research and draws conclusions for policy and practice. It concludes with some recommendations and provides suggestions for future research in the area of the instructional leadership role of HMDs.

Chapter Two: Conceptual Framework

2.1 Introduction

The brief overview of the literature presented in chapter one set out the key aspects that form the conceptual framework for this study. This chapter provides a review of relevant literature for the discussion of the theoretical framework in chapter three, which conditions the presentation and analysis of data, and interpretation of findings in chapters four and five, and the recommendation in chapter six. The literature review covered topics in Mathematics Education ranging from; (i) epistemological and ontological aspects of mathematics conceptual knowledge and specialised mathematics pedagogical approaches; (ii) viewpoints on instructional leadership and continuous professional development in mathematics teaching and learning, (iii) models for learner-centred strategies in mathematics as well as issues of historical perspectives related to mathematics teaching and learning in South Africa.

2.2 Definition of operational concept

2.2.1 Instructional leadership role

The operational understanding of the term ‘Instructional leadership’ used in the topic for this study is conceptualised from Fullan’s theory of curriculum change; according to which all activities pertaining to support, guidance, control and management of curriculum implementation at school level are referred to as instructional leadership and personnel assigned with these responsibilities are termed instructional leaders (Fullan, 2006: 36). In the context of Mathematics, researchers refer to teachers who provide leadership on classroom and curriculum leadership in school as senior

teachers (Parker, 2009 and Graven, 2005). According to the EEA of 1998 in Educational Labour Relations Policy (2003) and DoE (2002), instructional leadership refers to a wide range of classroom practice activities that teachers appointed to this rank ought to carry out: for instance, conducting professional development for teachers in the department, ensuring that teaching and learning of the subject content is aligned with the prescriptions of the espoused curriculum and coordinating practices such as, development of teaching and assessments policies with the cooperation and collaboration of teachers in the mathematics department.

2.2.2 Heads of department

The conceptual understanding of the term Head of Department in this study is derived from the description provided in the Educational Labour Relation Council (2003:c66) and Employment of Educators Act 76 of 1998. The classification of ranks in the school management structure into three levels indicated that in the new educational dispensation, personnel appointed to each rank had a specific role to play in a school. The specified role of the HMDs is laid out in the job description formulated by the EEA 1998 in ELRC (2003: 66) which points out that they are head of the subject and of the phase; appointed to this rank to perform duties and responsibilities in respect of management of teaching and learning, extra and co-curricular activities pertaining to the subject and the phase. According to ELRC (2003: *ibid.*) HMD designates a rank or position of leadership, which is linked to the following instructional role:

To engage in class teaching, be responsible for effective functioning of the department, to organise relevant/ related extra-curricular activities so as to ensure that the subject in the phase is taught properly and learning is promoted in a proper manner, hence, the term head of department is used

interchangeable with instructional leaders in the text. The heads of department are charged with management responsibilities in a phase and the subject (ELRC: *ibid*) to be in charge of a subject, to jointly develop the policies (teaching & learning as well assessment) for the department, to co-ordinate, evaluate assessment and homework, to control the work of educators and learners in the department, to cooperate with colleagues in order maintain a good teaching standard, to collaborate with teachers of other schools.

2.2.3 Mathematics teacher versus teachers of mathematics

Graven: (2004:189) claims that from his study the two concepts “*mathematics teacher*” and “*teacher of mathematics*” have different connotations in the teaching of mathematics.

2.2.3.1 Mathematics teacher is the term that applies to the teachers who studied mathematics at the post grade 12 or matriculation level, who have acquired adequate subject content knowledge and specialised pedagogical content knowledge, in mathematics and consider themselves as mathematically competent to teach mathematics.

2.2.3.2 Teacher of Mathematics is the term used to refer to a teacher who became teacher of mathematics by default. According to Graven (*ibid.*:189) some of these teachers, despite having taught mathematics and headed mathematics departments for many years, lack confidence and competence to be designated HMDs: they are therefore mathematics teachers.

The definitions of these terms provide a socio-cultural context which was invaluable in the various phases of the research project and in the selection of the participants in the sample. These definitions enable the researcher to use the concepts cautiously, during the data analysis and presentations of the findings.

2.2.4Curriculum change

Researchers in curriculum theory, Apple (2009), Pinar *et al.* (2014), Pinar (2004) and Kliebard (2004) perceive of curriculum change as a process whereby the issues of teaching, learning and content are realigned with the paradigm adopted; to redress the shortcomings of the educational system. Kliebard (2004: 24) states:

Curriculum change to social meliorism is based on the power of an individual's intelligence, and the ability to improve intelligence through education, thereby raising a new generation equipped to deal effectively with the challenges of the changing world.

Morrow (2007, cited in Shalem & Pendlebury, 2010:12) describes curriculum change as:

The frames of thinking that shape not only what we do, but how we understand what we are doing. Language and thinking is complex of connection and disconnections or a complex web of concepts and ideas.

Shalem & Pendlebury (*ibid*: 17) describe curriculum change in terms of three main components: content, teaching and learning:

If teachers do not understand what teaching literacy and numeracy is about, if their and our frame of thinking exclude this idea, teachers will

fail the aim of schooling and we will never get quality in the education system.

2.2.5 Continuous professional development

The contributions of Jita and Mokhele (2010) Jovanova and Mitkovska (2010) influence the conceptual knowledge and understanding of school-based instructional leadership in this study. The description and definitions of continuous professional development from these researchers' perspective resonate with the principles of the Quality Assurance programme called Integrated Quality Management System (IQMS) implemented in South African schools.

Continuous professional development is described in Jita and Mokhele (2010: 1763) to be an “approach to prepare practitioners adequately and to improve their instructional and intervention practices when they practice.” Similarly, Jovanova and Mitkovska (2010: 2922) assert: “professional development is more than training, including workshops, seminars, monitoring reflections, observation and performance activities by teachers, but trainers lead teachers to use new methods, techniques and approaches in their practice.” According to Department of Education and Training, continuous professional development is the critical component of Integrated Quality Management System (IQMS). The purpose of (IQMS) in continuous professional development is to identify professional needs of the individual teacher, which subsequently inform the professional development programmes that heads of development organise to address classroom-based practices. The evaluation of performance of teachers is part of the duties and responsibilities of the heads of department and is meant to inform the staff development programme and activities on an annual basis.

The critical analysis of the concepts in this study depict that instructional leadership and continuous professional development are two sides of the same coin. The purpose of instructional leadership and continuous professional development is to ensure that teachers of mathematics are capacitated with adequate knowledge of mathematics and with pedagogical content knowledge: strategies and techniques to improve their instructional practices in classes.

2.3. Perspectives on philosophical foundations of mathematical conceptual knowledge and approaches to pedagogy locally and internationally

Steyn (2008) claims that developing teachers in context is critical because it includes teachers' worldview and concomitant philosophy of life that influence their understanding of the subject content and their practice as well. This assertion provides the background to the discussion of philosophical foundations of the subject Mathematics and perspectives, as well as psychological principles underpinning pedagogical approaches.

2.3.1. Beliefs about the nature of the subject of mathematics

Contesting and divergent views exist about the philosophical foundations of Mathematics content knowledge. Ontological perspectives indicate that philosophies such as absolutism, realism, social relativism, over a period of centuries, attempted to describe the nature of mathematical concepts and how they relate to humankind and the world. The *absolutist perspective* on the ontology of mathematics alienates mathematical knowledge from the physical world (Maddy, 1997; Gold & Roger, 2008 and Borwein 2008). Proponents of this absolutist view understand mathematics to be

the product of logic and reason rather than to do with the concrete world and senses. This cerebral emphasis indicates that mathematics is the product of abstractions of physical entities, which are presented as idealised statements (Linnebo, 2008 and Maddy, 2007). In this view, mathematical concepts are precise, idealised representations of physical objects; through infinity and logic idealised statements can be actualised infinities which apply to integers, and natural and real numbers (Thomas, 2008, Chihara, 2008).

Gold (2008: 10) explained abstractionism as:

Abstractionism advocates that there are mathematical objects, and they exist somewhere outside of space and time. These objects exist entirely independent of people and they do not interact with the physical world in any 'causal' way. We cannot change them nor they can change us and yet we somehow are able to gain knowledge of them. These are ideas in from Plato's theory of forms.

In contrast, *the social relativist* and *social constructivist* uphold the view that mathematical concepts and applications are derived from experience. Advocates of this perspective emphasise that mathematical truths are inductive generalisations from experience and in fact; in this view there are no necessary truths in mathematics and every mathematical theorem may be false and in need of revision. This perspective disputes the certainty principles of the absolutists, which present mathematical knowledge as an abstract entity rather than a range of ordinary objects.

Geometrical knowledge derives from people's experiences with space and is more closely related to physical entities or objects (Maddy, 1997).

2.3.2. Perceptions of mathematical knowledge production

Critical analysis of literature germane to the topic of this project revealed the significance of epistemology. Researchers in the field of mathematics indicate that there are contesting approaches to mathematics epistemology. The contesting views on epistemology reflect the philosophical foundations aligned with absolutism, social relativism and social constructivism. The absolutist viewpoint expresses logic and reasoning as mechanism through which objective, universal mathematical theorems can be achieved (Gold & Roger, 2008, Borwein, 2008). According to this school of thought, inductive and deductive methods are fundamental to the attainment of universal truth. Since mathematics is about abstract objects, it is necessary for the constructing of knowledge to use empirical means to interact with the realm of ideas (Gold, 2008 and Ernest, 1991). The absolutist view on mathematics epistemology advocates that mathematics content knowledge is pure and true, and cannot be questioned; because experts produce it, and proven scientifically true through valid methods. This view of mathematical knowledge production promotes the understanding that mathematical knowledge cannot be disputed or contested, and it is believed to be true. The logic, reasoning and abstract thinking pioneered in this view distances mathematical knowledge from humans and the world of experience (Maddy, 2007 and Ernest, 1991).

A contrast was noted in the epistemological views of the social constructivist and the social relativists, to that of the absolutists. Critics of absolutism point to the production of mathematical knowledge outside the context of the people of real-world experience (Shapiro 2007 and Linnebo, 2004). The proponents of the counter view on mathematical subject content knowledge emphasise that mathematical knowledge is a

result of various mechanisms of human endeavour to find solutions to the problems of the changing world. The social constructivist perspective relates knowledge production of mathematics to social interactions and social cultural context (Skovmose, 1994; Chihara, 2008 and Thomas, 2008).

2.3.3. Views and principles underpinning epistemological approaches in mathematics

The following principles underpin epistemology in mathematics:

(i) Visualisation and diagrammatic elements approach

Diagrammatic reasoning is another aspect advocated in the epistemological process in mathematics, which explains the importance of the senses as it emphasises visual and explanatory goals. The advocates of this theory such as Giaquinto (2007: 12-14) present the following argument:

Mathematic reasoning justifies that use of figures and diagrams in the production of mathematical knowledge. Diagrammatic reasoning in logic and mathematics means that diagrams can and often do play genuine epistemic role in the justification of proof. We claim that visual form of representation can be important, not just as heuristic and pedagogical tools but as legitimate element of mathematics proof. Diagrammatic reasoning figures justification of significant ways in mathematics reasoning.

Tiragallo, (2007:201) states:

Learner expert knowledge of mathematical content knowledge has come to mean the ability to construct and justify mathematical meaning by comfortably oscillating between individual and social ways of visualising or seeing. Diagrams and form of visual representation can be essential and legitimate

component in valid deductive reasoning. Diagrammatic refers to broad visual reasoning, for example, in Pythagorean theorems on diagram

Wise (2006:82) argues:

The power of embodied mathematics fuses intellectual knowledge and its material and sensual dimension together emphasises visualisation.

(Auslander, (2008:62) states that:

The epistemological procedures should check whether the knowledge is supported by proof warrants a regimentation of mathematical practice that makes proof the sole legitimate form of justification in mathematics. The use of deductive proof is an essential feature in mathematics. Mathematics is not just about results rather, a process, which includes definitions, conjectures, examples, numerical evidence, statement of the theorem, modelling, algorithms and proofs as well as heuristic arguments which fall short of proofs.

Theorists of diagrammatic reasoning in epistemic production in mathematics identify five principles:

1. It is a legitimate proof of the Pythagorean Theorem.
2. It is a combination of geometric manipulation of a diagram and algebraic manipulation of non-diagrammatic symbols.
3. Diagrammatic elements play a crucial role in the proof.
4. The diagrammatic elements are primary in two related ways: first, they make the algebraic steps of argument almost transparent, once the diagrammatic steps are in place the algebraic steps are easy to devise. Second, an analogical

linguistic proof would be both difficult to discover and too difficult to remember without the diagrams

5. Visual reasoning is a legitimate means of discovery.

The explanations and discussions of approaches to epistemology from the diagrammatic and visualisation perspective are critical in this thesis; they provide the parameters for understanding teachers' pedagogical approaches. Mathematics as a field of study in teacher education and training equips teachers with various conceptions of ontological and epistemological understanding. Teachers in their practice of teaching use their conceptual knowledge as a frame of reference in teaching the subject. Teachers of mathematics, who understand epistemic knowledge from visualisation and diagrammatic reasoning, ensure that diagrams and objects should be available to facilitate teaching and learning in the classroom; for learners to develop logical thinking and reasoning skills. The five principles cited above could serve as guidelines when teachers design learning activities and when selecting teaching strategies. Mudaly, (2013 & 2014) argues that diagrams and physical objects facilitate the acquisition of knowledge through the processing of material at the concrete or sensory level to the abstract level. Elaborating upon Piaget's theory of cognition, Mudaly (2013) emphasises that the use of diagrams enables learners in mathematics learning to develop meaningful learning of conceptual mathematical knowledge; because they are able to manipulate real objects and diagrams to verify abstract mathematical concepts. Visual strategies in teaching are perceived to be more recommendable than verbal explanation of mathematical concepts (Tiragallo (2007)). The notion of prior knowledge in learning is emphasised in Killen (2015) when he argues that the learner is not a *tabula rasa* or a blank slate; rather each and every

learner has within him or her a rich store of acquired *a priori* knowledge on which learning can develop. Mudaly, (2010:65) claims:

The existing a priori [*sic*] knowledge determines how these mental images are interpreted and communicated in daily life.

The issue of teaching strategies and learning styles, which are the focus in this study, are viewed as the means or mechanism of transforming teaching and learning of mathematical conceptual knowledge and cognitive skills. The teachers' ability to understand the need for transforming the traditional teaching methods is perceived in this work to be indicators for implementation of curriculum change. Killen (2015: 98) to be different ways of mediating learning explains the strategies of teaching. Teaching strategies are classified into two categories: teacher-centred and learner-centred.

Killen (*ibid*: 98) distinguishes between learner-centred and teacher-centred teaching strategies.

Teacher centred teaching strategies	Learner-centred teaching strategies
Deductive teaching strategy or Expository teaching strategy Lecture methods	<ul style="list-style-type: none"> • Discovery strategy • Inductive strategy or inquiry strategy • Problem solving strategy • Co-operative strategy • Investigation strategies

Teacher-centred teaching strategies are condemned for ineffective learning: teachers tend to dominate the learning process; creating dependence among learners. Teacher-centred strategies promote memorisation and rote learning because learners are passive recipients of knowledge from teachers. The perception of learning and teaching in Killen (2007 and 2015) is that learning is effective if learners take charge of their learning with minimal control of the teacher. Constructivists describe a similar understanding of the learning process as the learner's active involvement in the process of knowledge construction. Proponents of the constructivist view explain the importance of learning style in teaching and learning; teachers should know that each learner has his or her own style of learning. The learning style, in this sense, refers to how learners prefer to acquire new knowledge (Sternberg, 1999: 8). Research in South Africa indicates that learners' thinking styles contribute significantly to predictions of their achievements across a variety of learning tasks. Each learner has a range of learning styles (Killen, 2015: 99). Dryden and Vos (2010) adopt the Multiple Intelligence Theory of Howard Gardiner to indicate that not all learners in the mathematics class will easily understand numerical symbols and the

operations. This assertion has implications for the teaching strategies that the teacher uses in teaching mathematics, which points to the application of a variety of teaching strategies to enable all learners to understand mathematical conceptual and procedural knowledge. Mudaly (2013) emphasises the use of visual strategies in the teaching of mathematical knowledge. Mudaly argues that visual and diagrammatic strategies enable learners to conceptualise abstract concepts better.

2.3.4. Scientific and empiricist reasoning

Advocates of scientific and empirical reasoning argue that knowledge of mathematics must be supported by proof that warrants a regimentation of mathematical practice (Mudaly (2016). Mathematical knowledge should provide a space for broad empirical reasoning. The inductive approach to mathematical knowledge production is considered by Kurnik (2008) and Rahma (2017) to be the essential way to arrive at the truth. At the heart of this argument is the belief that linguistic representations of the same information can and often do have significantly different properties; thus scientific methods ought to be used for verification of knowledge (Maddy, 1997). The belief and idea that promote algorithms and axioms as fundamental principles in the production of mathematical knowledge are in accord with the notions of absolutism and intuitivism (Ernest, 1991 and Maddy, 2011). The formalist and experimentalist emphasise the importance of propositions to legitimise mathematical knowledge. Maddy (2011) argues that knowledge production in mathematics includes axioms and rules of reference; so mathematical truth is in the continuum hypothesis. In her argument about axiomatization, Maddy (1997 and 2011) emphasises mathematical syntax and semantics, derived from the axioms. This view indicates that

mathematics has its own linguistic structure and that it is on the basis of linguistic structures or axioms that theorems are explained. Giaquinto (2007: 14) notes that those mathematicians, who emphasise the significance of axioms and *a priori* knowledge, show that a theorem can be derived from axioms by means of certain rules in a particular way.

Contesting views about what the theories and principles governing epistemological processes in mathematics should be, show what could underpin the views held by teachers of mathematics about the subject and its content knowledge. The argument as developed in this study is that epistemological principles and definitions are enshrined in the teaching strategies used by the teacher in the classroom practice. Mudaly (2016: 138) states that: “what teachers do is highly dependent on what teachers know”. This emphasis suggests that conceptual pedagogical content which mathematics teachers have acquired from education and training through their experiences in a socio-cultural environment is reflected in their practice in the classroom.

Researchers define mathematics as a science of structures or patterns. The structural account of mathematics requires commitment to the actual existence of structures in the physical world and in the metaphysical realm (Shapiro 1997 and Chihara, 2008). Mudaly (2013) confirms that mathematics is a proof-driven discipline: understanding of relations between variables, acquisition of knowledge and skills about the nature of patterns and structure in various contexts of learning has to focus on providing mathematically coherent proofs. Researchers, who pioneer the epistemological perspective of Mathematics as axiomatic and proof-based, emphasise scientific investigations, and scientific methods for the validation of the process of knowledge

production, and as legitimating mechanism of new mathematical theorems. Mudaly (2013: 37) explains that legitimating of knowledge could be expressed as:

Despite the methods and context within which proof is done, proof has remained the main tool, which mathematicians use for verifying, communicating, explaining, systematising and discovering.

Shapiro, (1997), Chihara, (2008) and Gold & Roger, (2008) recommend that mathematicians should be aware of the fluctuations in the role of proof, and that what is considered a proof can be of use in classrooms. This argument indicates that awareness of the proof can give teachers both a context: (i) in which teachers can set mathematics learning activities for learners to attempt as their proof and (ii) for conceptual knowledge teachers can impart to learners. An awareness of the importance of inductive methods in the development of mathematics is worth transmitting to learners (Niss *et al.*, 20017). Mudaly (2013) claimsthat engagement of learners in the learning process enables them to account for the means and ways by which they arrived at a particular truth or proof. The challenge facing teaching of mathematics in schools is associated with inability and incompetence of mathematics teachers to implement changes brought about by competing discourses in mathematics education. Volmink (2009), Parker (2009) and Graven (2005) stress the participation of pre-service and in-service mathematics teachers in the so-called mathematics Professional Learning Communities (PLC). This participation could benefit teachers' continuous professional development in two ways: one they will be equipped with research-based recommendations on the (i) epistemological and (ii) pedagogical developments in the subject of mathematics.

2.4 Perspectives of theory and practice in Mathematics teaching and learning

Contesting perspectives characterise this area: social constructivism versus absolutism, and diagrammatic reasoning versus empiricist/scientific reasoning. In many complex ways the fluctuations in this debate between mathematicians have dominated teaching and practice. As each school of thought fought for eminence, so curricula around the world responded: not least affected has been South Africa which tended, until liberation in 1994, to imitate the absolutist models, fashions and changes in academic climate set up by European countries such as England or Holland.

Research into mathematics curriculum for teacher education indicates that mathematicians internationally and locally have devised competing perspective referred to as Mathematics Education (ME). Proponents of Mathematics Education view mathematics as the sum of all human activities, designs and constructions, which intersect with the natural world in myriad ways: In this sense, Mathematics is regarded as the product of human interaction with physical objects (Ernest, 1991, 2012 & 2014; Vithal & Skovmose, 1997 and Vithal, 2003). This perspective emphasises the socio-cultural environment, social justice, Mathematics literacy and pedagogy as critical aspects in the ontology and epistemology of Mathematics. Aspects of rationality and reasoning, which are revered by absolutists, in this perspective remain critical for verifying mathematical truth through problem solving, logical thinking and critical thinking (Ernest, 2012). The philosophical foundations of Mathematics Education are traced from progressivism and social constructivism: these are reflected in the advocates' beliefs and understanding that mathematical knowledge cannot be imposed upon learners or students; instead it is constructed in authentic learning environments (Skovmose, 1994 & 2012, Ernest, 2014 and Powell, 2012). Pioneers of this critical view on mathematics

teaching and learning criticise the view of the production of mathematical knowledge within the frameworks of axiomatic principles alone; because it often creates the impression among teachers and learners that mathematics is a rarefied and arcane discipline reserved for the highly intelligent. The notion of Mathematics as a highly specialized or abstract knowledge, to the proponents of ethno-mathematics, decontextualizes the subject content and pedagogy. Within the history of teaching Mathematics in South Africa, this rift between absolutists who regarded Mathematics as an exclusive area of knowledge and those who conceived of Mathematics as an inclusive science with opportunities for all, a predictable association grew between old guard mathematics teachers who preferred the absolutist school and a large group of newly empowered and graduated teachers. Old guard teachers who resisted change considered Mathematics to be the preserve of a few teachers, academics and learners. Such individuals were often trained at tertiary institutions steeped in the Verwoerdian paradigm (1948-1994) that openly stated that blacks would always be hewers of wood and carriers of water (Koers, 1999). The rift between absolutist priorities and ethno-mathematics, between exclusive, racially slanted instruction and an inclusive approach has a particular unsavoury significance and resonance in South African education. The legacy of such divides still perforates the profession; often in unseen and corrosive ways. The new attitudes to Mathematics teaching adopted after 1994 were often subverted by those who unthinkingly assumed that the training they received before 1994 was superior and the truth; without a willingness to embrace a more democratic vision of the discipline, which brings mathematics within the reach, interest and imagination of all. The currents of this historical/political/academic storm run through the central concerns of this thesis: the role of HMDs in implementing new perspectives of Mathematics teaching according to the stipulations and vision of CAPS.

Skovmose and Borba (1997: 17) fully comprehend the political dimensions of the debate:

We find it necessary to struggle against this myth, if our ethical goals are to construct pedagogy that fights oppression in society, since this view of mathematics [absolutism] corroborates the notion that mathematics is free of human influence and above humans. A mathematical problem can be contextualised.

According to the proponents of ethno-mathematics, the humanisation of mathematics in schools and in any teacher education and training institution is possible through a ‘bottom up’ approach which accommodates interrogation and problematising the practices of teaching and learning of mathematics and related issues: such as natural and artificial objects, real and authentic problems (Sinclair, 2008 and Ernest, 2014).

Concerning the three pillars of pedagogical content knowledge: subject content knowledge, the learner and the teacher, researchers into Mathematics Education propose the following:

Subject content knowledge: Mathematics can be brought into the everyday life of human existence; in production, technology, management, communication and other aspects of life. Mathematics should be action based, to serve a range of interests: engineering mathematics, academic mathematics and ethno-mathematics (Skovmose, 2012 and Yasukawa *et al.*, 2015). This perspective assumes that mathematics content knowledge should not be portrayed as unquestionable knowledge about reality. This assertion resonates with the philosophical perspective of constructivism; that mathematical knowledge is formed by human interaction, is fallible, and subject to constant revision and re-conceptualisation. The mathematical formulations of Newton were questioned and revised by Einstein: the heliocentric models of Galileo confounded medieval views of the

earth as the centre of all. Revision and re-imagination, hypothesizing and questioning hypotheses are in the very nature of scientific and mathematical endeavour. Alerting young learners to the uncertainty of this discipline invites the individual to test, question, interrogate and hypothesize for themselves; making them agents rather than receptacles to be filled with facts. Such inclusive Mathematical practice opens up the discipline; allowing all learners to harness their discreet funds of knowledge and link their experience of the natural world to what is being posited in the classroom: learners are free to test, re-assess and examine material. This vision of constructivist learning is in line with CAPS but antipathetic to absolutist tendencies; especially as they often came to be interpreted in South Africa. Research and empirical studies must test theorems and dispute existing theorems, and propose new ones. In the context of this perspective mathematics teachers should be free to choose contexts of teaching and learning mathematical knowledge, skills and competences that relate to learners' socio-cultural environments, thus incorporating learners' own experience in the process of owning knowledge.

From the literature reviewed, Skovsmose, (2005) and Vithal, (2003) and DoE, (2011) in this section, it was clear that mathematics problems should be taught in the context of human life as it is relatable to the immediate experience and cultural/linguistic identities of learners within specific communities; rather than being decontextualized in an exclusive abstract realm. Winning, sparking and sustaining learners' interest is of paramount importance for learner empowerment. Subject content knowledge should promote trial-and-error paths of discovery, and invite learners to question assumptions. Content should be about real-life problems and allow learners to explore solutions; using a variety of methods (Mudaly, 2013). In rural areas knowledge and observation of the land, plants, and animals makes a stable platform on which to build much mathematical

material. In urban contexts, access to internet via smart phones allows another yet sustainable starting-point for learning basic concepts. The teacher needs to model lessons according to the urban or rural contexts of learners; finding exactly where there are points of stimulation and excitement between own experience and classroom presentation (Ernest, (2012& 2015) and Helle, *et al.*,(2010).

Critical analysis of literature revealed the diversity, history and debates embedded in perceptions of mathematics subject content summarised above. The review of literature so far has highlighted alignments between certain resistant groups in the country with absolutist policies, and the struggles of those policy-makers and change agents who wish to make mathematics an inclusive and constructivist discipline as laid out in CAPS. These struggles to implement CAPS policy are interwoven in the history of contesting attitudes, prejudices and assumptions among teachers and academics in Mathematics in this country and elsewhere. Developers of the Mathematics Curriculum and Assessment Policy Statement depict the sentiments advocated by pioneers of new Mathematics Education: as identified in the definition of the subject Mathematics for intermediate phase in DBE (2011: 8):

Mathematics is a language that makes use of symbols and notations to describe numerical, geometric and graphical relationships. A human activity involves observing, representing and investigating patterns and quantitative relationships in physical and social phenomena and between mathematical objects themselves. It helps to develop mental processes that enhance logical and critical thinking, accuracy and problem solving that will contribute in decision-making.

The issue of subject content knowledge is another aspect, which received the attention of researchers in Mathematics Education and the curriculum developers of BDE, (2011: 8-9):

The ME perspective is expressed in (DBE: 2011: 8-9):

A critical awareness of how mathematical relationships are used in social, environmental, cultural and economic relations; confidence and competence to deal with any mathematical situation without being hindered by a fear of Mathematics; a spirit of curiosity and a love for Mathematics, an appreciation for the beauty and elegance of Mathematics; recognition that Mathematics is a creative part of human activity; deep conceptual understanding in order to make sense of Mathematics; acquisition of specific knowledge and skills necessary for:

- the application of Mathematics to physical, social and mathematical problem.

The mathematics curriculum for the intermediate phase specified the *essential mathematical skills* as critical in the teaching and learning of Mathematics: the correct use of the language of Mathematics; number vocabulary, number concept and calculation and application skills; to listen, communicate, think, reason logically and apply the mathematical knowledge gained; to investigate, analyse, represent and interpret information; to learn to pose and solve problems and build an awareness of the important role that Mathematics plays in real-life situations including the personal development of the learner.

The selection of *Mathematics subject content knowledge* for achieving the aims and for the acquisition of knowledge and skills is outlined in DBE, (2011: 9-10).

Numbers, Operations and Relationships; Patterns, Functions and Algebra;
Space and Shape (Geometry); Measurement; and Data Handling

Learner: in a mathematics class, learners' interests, expectations, hopes and aspirations are critical. Acknowledgement and recognition of learners' prior knowledge is emphasised. Skovmose (2014) notes that the "notion of learners' has been suggested in order to conceptualise learner perspectives and interests. Conceptualisation of learners'

perspective entails a repertoire of information pertaining to: economic conditions, social-economic processes of inclusion and exclusion, cultural values, traditions, public discourses and language (Skovmose, 2012, 2015 & 1994 and Vithal, 2003). The perception of a learner envisaged in mathematics is described in the South African context in DBE (2011: 8-9). For instance, the attributes for the mathematics learner are defined as: problem solver, investigator, critical and logical thinker, communicator and interpreter and someone who is aware of the socio-cultural and environment, economic and technological changes in the society and the changing world.

Teacher: Proponents of Mathematics Education post 1994 advocate that a mathematics teacher is someone who has interest and who teaches under certain working conditions. The logic of schooling presents to the teachers' complex sets of regulations, traditions and restrictions. Researchers in the field of Mathematics Education point to conditions of learning in terms of performance and excellent performance Vithal & Skovmose, (1997), Arlo, *et al.*, (2010) and Ernest, (2012 & 2014). It makes sense that poor conditions result in poor performance; whereas good conditions are more likely to yield good performance.

2.4.1 Conceptual knowledge generated through local and international research for effective teaching and learning strategies in mathematics

The contributions of researchers in mathematics subject content knowledge and pedagogy should be taken into cognisance in the staff development programmes for the mathematics teacher in South Africa. Mathematics teachers in South Africa are expected to be life-long learners, subject and phase specialists, and mediators of learning, and developers of learning programmes. HMDs should be aware of curriculum change and implement them in their continuous professional development activities. If teaching and learning of mathematics is to change, HMDs have to keep

abreast with new inventions and innovative strategies and approaches to teaching of mathematics.

2.4.1.1 Diagrammatic presentation and visualization

Proponents of diagrams and visualisation on the epistemological aspect of mathematics, emphasise the use of diagrams and physical entities to develop and to conceptualise concepts and algorithms in mathematics (Giaquinto, 2007:77 and Mudaly 2013: 39). Theorists of the praxis paradigm believe that learners should be active participants in the construction of knowledge through learner-centred strategies such as; exploration, inquiry, group discussions and problem solving. According to Killen, (2015:238-239) constructivists encourage and accept learners' autonomy and initiative, and the following guidelines are recommended;

A teacher should use raw data and primary sources along with manipulative, interactive and physical materials.

A teacher should allow learners to drive lessons, shift instructional strategies and alter content.

A teacher encourages learners to engage in dialogue with the teacher and with one another.

A teacher encourages learners to draw upon own experience in order to spot contradictions in the lesson

A teacher nurtures learners' natural curiosity by knowing about learners' own knowledge and wisdom, and drawing upon it in the lesson of the day

Architects and acolytes of the CAPS 2012 document endorse the Freirean notion of active participation of learners in mathematics activities: all such constructivist

educators acknowledge that mathematical knowledge cannot be sustained in a vacuum of abstract concern but has to be composed and integrated into the lives of learners by sensitively assessing the nature and richness of learners' observations, experiences and inherited wisdom, and relating mathematics knowledge directly and pertinently to the idiom, philosophical frameworks, religions, attitudes, daily lives and languages of learners who are credited with resources of learning (Mudaly, 2013, 2014 and 2010; Skovsmose and Hellenet *al.*, 2010). The concept of visualisation is described in Mudaly (2010: 38) in the context of mathematics epistemology as a mechanism of providing proof. This claim is substantiated by the theoretical principle from Piaget's cognition theory, which states that meaningful knowledge acquisition occurs through the senses (Woolfolk, 2014). Cognition theory explains that basic knowledge processing in the child's brain begins with visual images before the receptors, called schemas convert them into mental knowledge constructs for further internalisation of images into concepts (Dryden & Vos, 2010).

2.4.1.2 Modelling and application Strategy

Modelling in Mathematics is an emerging theory, which explains the methods that are suitable for teaching mathematical concepts and skills in context (Blum, 1993). Advocates of modelling emphasise identification of the context or situation as the first step in a learning process. In this theory, any real world situation provides learners with problems to be solved. The real-world context could be an object or reality chosen by the learner to work out mathematical problems. The interest of the learner and learning styles are a priority; to ensure that learning is learner-centred (Spandaw, 2009). Galbraith *et al.* (2007: 77) argues that construction of knowledge in mathematics is based on the following principles: the reality principle; the model

construction principle; self-evaluation principle; the construct documentation principle and construct generalisation principle.

The reality principle: the situation must appear meaningful to learners and connect to former experiences.

The model construction principle: the situation should create a need for the learners to develop significant mathematics constructs or conceptual knowledge.

Self-evaluation principle: the situation should allow learners to assess their elicited models.

The construct documentation principle: the situation and context should require learners to express their thinking while solving the problems.

The construct generalisation principle: it should be possible to generalise the elicited model to other similar situations.

2.4.1.3 The Gradual Release Model

The role played by the teacher as an instructor and mediator in this model is to observe learners performance in solving mathematical problems and to provide support as learners develop critical thinking skills. The advocates of this model, Stone and Spouse 2003 commented that, it is sometimes true that teachers believe that they need to model instruction and guide learners to ensuring that learners, master mathematical concepts before guided into how application should take place. The analysis of these models in this study provides a backdrop for analysing the beliefs and practices influencing the instructional leadership in mathematics teaching and learning in intermediate phase classes. South African mathematics teachers are trained

by academics each of whom is a product of prejudices, assumptions, taken-for-granted realities, inherited privileges or deprivations, political biases and cultural linguistic priorities. All these factors affect the trainee teacher who imbibes the often unseen, indirect and implied backgrounds of academic instructors at tertiary level. Teachers of mathematics often unconsciously and innocently re-inscribe, imitate or simply repeat the learning, pedagogy and mathematical approaches imposed upon them. Killen (2015) discusses the strategies of problem-solving and group discussion.

Inquiry-based methods

Carl (2010) shows that the CAPS mathematics document expects teachers to re-think teaching and learning from traditional strategies to contemporary strategies which emphasise learner-centred teaching; knowing about the background knowledge, habits, community life and associations of learners. The advocates of the Gradual Release Responsibility model (GRR) provide a simplified conceptual understanding of what teacher–learner engagement should be; for teaching to be a facilitation process. The GRR is conceived within the frameworks of Piaget and Vygotsky.

Piaget's cognition theory emphasises the formation of schema, which are the cognitive structures that enable learners to process knowledge from short-term memory to the sketch board or a working memory where meaning making takes place. Vygotsky's socio-cultural theory explains scaffolding as a learning continuum towards the attainment of the zone of proximal development (ZPD): the GRR emphasises the continuous feedback on learners' performance towards the attainment of the goals. The teacher's responsibility is to guide the learner until the learner assumes his or her responsibility, own learning identity and ownership of knowledge.

Vithal and Skovmose (2003) argue that teaching and learning of mathematics should consider learners' socio-cultural environment. In the context of South Africa, inherited patterns of white hegemony, entitlement, subordination and legalised serfdom of blacks created socio-economic inequalities and attitudinal deficits, which affected learners' performance, particularly in science and mathematics (Volmink, 2008, Skovmose and Khuzwayo, 2003). Centuries of slavery, exploitation and humiliation left thousands of black homes in poverty and drained the confidence, self-esteem and aspiration of black, coloured and Indian learners, their families and communities. Lack of adequate support for teachers of mathematics contributed to teachers' unquestioning adherence to their traditional practices: as confirmed by Carl (2010) and Fullan (2006): curriculum change in blue print does not necessarily translate into practice; without adequate support and guidance for teachers, teachers of teachers, communities and learners within such oppressed groupings.

2.5 Modelling, visualising and diagrammatic strategies and socio-cultural context teaching and learning of mathematics

Researchers into the teaching and learning of mathematics in schools have made proposals about approaches that could improve classroom practice in mathematics classes. Proponents of such a 'modelling' approach explain the nature of the classroom that provides an environment conducive to effective teaching and learning of mathematics. In this perspective, the classroom should provide resources, and equipment such as computers or calculators. In this class learners should actively participate in practical activities from which they learn conceptual knowledge together with procedural knowledge (Galbraith *et al.*, 2007). With respect to the context of the learning content, advocates of modelling claim that mathematical topics

are a source for reflection and are part of human culture. This implies that teachers should not be limited by their socio-cultural environment to teach mathematical concepts alone or in isolation; instead they should use objects and other material at their disposal with which learners in a particular community are familiar, to engage learners in the acquisition of conceptual knowledge and its application. This modelling approach could be manipulated in the mathematics class for the purpose of constructing hypothetical arguments and to work toward a proof. In essence, modelling is the mechanism, which learners use to provide an objective correlative for models of their own conceptual knowledge. Blum (1993) claims that modelling in first-world classrooms has changed learners' perceptions of mathematics from a tedious subject into an active classroom learning experience.

A common perception of modelling in the teaching of mathematics highlights the use of models to provide perception and visualization for acquiring mathematical knowledge and skills. Modelling in mathematics learning is perceived by researchers to validate solutions that learners produce; as a result of their logical reasoning about the problem (Spandaw, 2009 and Niss *et al.*, 2007). Mudaly (2013) suggests that effective learning of mathematical concepts and cognitive skills is enhanced by exposing learners to images from the physical world in which they find themselves, be it rural or urban. Internalization of physical images occurs when schemas or knowledge constructs of a particular image turn into an inner, individually shaped and owned mental image.

The issue of sensory learning is recommended for learners in a mathematics class to provide a visual correlative for an abstract concept. This correlation helps the learner to form her or his own unique equivalent inner notion of both concept and visual object. Visualisation and modelling both recognise that perception and stimuli are

fundamental in the conceptualisation of mathematical knowledge; from which cognitive skills can grow when the knowledge attains an abstract level. These cognitive skills are; reasoning, logic and critical thinking, which manifest as learners provide proof or evidence of their understanding and application of knowledge.

Researchers such as Mudaly (2013: 40) who claims that diagrams are visual images that facilitate perception; which is an act of assigning meaning emphasize the importance of diagrams in mathematics learning. Changing how teachers perceive of learners requires that teachers are aware of three main domains of learning: The Cognitive, Affective and Psychomotor. Drawing diagrams can assist learners in understanding mathematical concepts and hone fine motor skills: eye-hand coordination, accuracy and mechanization. The affective domain is crucial for the intermediate learner. The attitude of learners towards mathematics can improve if competent teachers use strategies: such as modelling, games, puzzles, diagrams and real objects to make mathematics more immediately comprehensible and fun at the same time.

2.6 The qualities of instructional leadership for effective teaching and learning of mathematics in schools

The argument in this study is that HMDs are the key role players in teacher empowerment and capacity building at schools. Education departments both nationally and provincially created these school-based instructional leadership positions to ensure that teachers in schools are provided with support and guidance (DoE, 1998). The duties and responsibilities of the HMDs are focused upon teaching, learning, curriculum implementation and assessment (DoE, *ibid.*). The perspective of the Educational Labour Relations Council (2003:6) is that HMDs should work

collaboratively with teachers in designing mathematics subject teaching and learning policies in the school: relations between HMDs should manifest collegiality, collective effort and collaboration. Janet *et al.* (2014) states that school improvement and effective teaching and learning in collegial effort, learner performance is a shared accountability. This statement is of concern in this thesis, which sets out to inquire into the instructional leadership role of HMDs in improving teaching and learning of mathematics in the intermediate phase of schooling. The focus of the inquiry in the empirical study falls upon the strategies adopted by HMDs to improve teaching and learning of mathematics, and approaches used by the HMDs to enable teachers to abide within the CAPS guidelines.

Researchers indicate that qualities required for effective instructional leadership are critical for any successful teaching and learning Fullan, (2006) and Carl, (2010). Carl (2010: 11) claims: “This will require a participatory leadership style which gives opportunities for encouragement and joint decision making.” Shared Instructional Leadership entails demonstration of certain qualities such as: proactive and innovative thinking, knowledgeability, resourcefulness, enthusiasm, self-reflection, collegiality as well as collaboration and sharing (Stein & Nelson, 2003, Fullan, 2006 and Steele *et al.*, 2015). Mintzberg (2004) suggests that curriculum managers should have a conceptual insight into curriculum changes. Reeves (2006) and Pfeiffer & Sutton (2000) agree with this view: they point out that it is the obligation of the instructional leaders to ensure that they have a proper understanding of the do’s and don’ts of innovations introduced into the curriculum. Researchers of this view emphasise that curriculum leaders in school have to reflect on the outcomes of the teaching and learning; to ensure that changes are reflected in learners’ performance. Curriculum leaders should gather information through inquiry and action research in order to keep

track with developments resulting from curriculum innovations (Stein & Nelson, 2003, Spaul, 2011 and Pfeiffer & Sutton, 2000). Elmore (2004) emphasises that, coupled with inquiry and reflection, is the notion of capacity building which results from collegiality, teamwork, collaboration and sharing of expertise. Fullan (2006) supports the sharing of instructional leadership: he states that the creation of a favourable environment by curriculum leaders allows for positive results in the process of curriculum adaptation or implementation. The idea of collegiality, teamwork and collaboration is emphasised by pioneers of the Overcoming-Resistance-to-Change (ORC) model (Ornstein & Hunkins, 2014). Shared instructional leadership is underpinned by two principles: shared vision and ownership: for curriculum innovation to be implemented effectively to the benefit of the learners. Instructional leaders should first ensure that a sense of partnership prevails among teachers. This partnership enhances the development of a common or shared vision about what ought to be done to accomplish common goals. Partnership can circumvent resistance of teachers to directives imposed on them by authority. A sense of ownership is created and prevails in an environment where every teacher feels recognised and is treated with respect Fullan, (2006), Steele *et al.*, (1998), Marrow, (2007) Elmore, (2004) and Steven, (2004).

Conventional instructional leadership associates the role of instructional leaders or senior teachers with control and administration of teaching and learning. The role of the instructional leader is to make sure that teachers comply with the directives of the educational and curriculum policies. The working relations between teachers and instructional leaders are described in term of superiority and subordination. Teachers under the supervision of the instructor should accept orders from their line managers

and comply with instructions Robinson, (2006), Steele *et al.*,(2015) and Stein & Nelson (2003).

Critics condemn conventional instructional leadership for hampering teachers' proactive and innovative thinking about their teaching and classroom activities. The perceived teacher's status as subordinate is criticised for stripping teachers' professionalism: they are obliged to take orders from their supervisors Carl (2010) and Bennie, (2011).

2.7 Summary

The literature presented in this chapter provides a background for understanding issues underpinning the theories and principles of classroom practice of mathematics in classrooms. The brief overview of perspectives of philosophical foundations of mathematics adumbrates the central beliefs and thoughts inherent in the ontological and epistemological processes in mathematics. Bennie (2011) condemns the view that promotes mathematics as an abstract and abstruse truth attained through logic and reasoning. Teachers who follow the absolutist school are likely to transmit their often unquestioned, unexamined and not reflected upon -versions of mathematical knowledge to learners; without exercising their own abilities to validate or to prove the reality of their brand of mathematical knowledge. Teachers of the absolutist school of thought maintain that mathematics algorithms are to be learned and taught by memorisation, drill and repetition.

According to the DBE (2011), the CAPS curriculum, the envisaged teaching and learning strategies ought to be learner-centred. Learners should play a maximal role in learning by becoming actively involved in acquisition of factual, conceptual and procedural knowledge. Contextualisation of learning by selecting real-life problems

could entice learners to inquire, discover and find solutions as they develop mathematical knowledge and skills. Teachers should understand perspectives in Mathematics Education, for example, constructivism perspectives. Mathematics is a social construct, which has to be constructed and validated as proof in the classroom. **It is indicated by the DBE (2011) that mathematics is a universal language; the language of numbers to be used in classroom to communicate issues from real-life situations.** The Gradual release model points to steps that could be followed by teachers in the classroom. Killen (2007) indicates that teaching is a multifaceted process, which requires careful understanding of the purpose or outcomes of learning in the classroom.

The discussion of the perspective of effective instructional leadership in this chapter was of critical importance for the empirical study.

The role of HMDs in disseminating the constructivist ethos of CAPS and enlightening teachers about the laboratory principles of inclusive thought and practice is emphasised.

Fullan (2006) and Carl (2010) emphasise that HMDs should adopt a leadership style of collegiality, collaboration, partnership and shared accountability. The commitment of HMDs to advance their knowledge of mathematics and pedagogical approaches, are considered in this research as another important quality of instructional leadership. This view confirmed Carl's (2010) ideas, of transformational instructional leaders are those who are well-informed and involved in developments in their discipline and professional practice.

Chapter Three: Theoretical Framework

3.1 Introduction

This chapter discusses the theoretical framework developed to conduct the empirical study. This theoretical framework is based upon Vygotsky's socio-cultural model and is adapted in certain respects to allow for (i) local conditions, (ii) the fact that Vygotsky's theory was formulated some decades ago, and (iii) inclusion of more recent supplementary information that conditions Vygotsky's essential notion of socio-cultural manifestations. This theoretical framework provides a background for: designing the study and for developing research instruments in chapter four. Analysis and presentation of data in chapter five were informed by the theoretical framework and aligned with it. Findings in chapter six and chapter seven were similarly based upon this somewhat adapted Vygotskian theoretical framework to examine the central issue of effective instructional leadership for implementation of the CAPS compliant mathematics curriculum.

3.2 Theories pertinent to assessment of effective teaching and learning of mathematics

A theoretical framework was developed and deployed to (i) gauge how effectively HMDs performed as instructional departmental leaders in implementing the inclusive and constructivist aspects of the CAPS syllabus and (ii) to answer the two research questions in the empirical research. Vygotsky's theory of socio-cultural learning in a subtly adapted form was well suited to gauge the professional performance of mathematics teachers and HMDs. The socio-cultural insights of Lev Vygotsky are widely used as a matrix for calibrating the progress of learners. In the context of this

study, teachers and HMDs are themselves perceived to be lifelong learners. This view is in line with Freirean notions of teacher and learner building knowledge together, learning from each other day by day, year after year: Pinar et al., (2014) and Peterson & Olsson, (2008).

Skinner states that everyone becomes a learner in a new situation: the process of acquiring, responding to, assimilating and finally owning, re-creating new knowledge is a lifelong adventure. Piaget speaks of equilibrium, which is achieved only once new information connects to existing knowledge: referred to by Piaget as mastery. Vygotsky's socio-cultural theory of learning explains the acquisition and assimilation of knowledge primarily in terms of social interaction. The interaction between HMDs, instructional leaders and teachers is considered in this study as an opportunity to share valuable experiences and construct new, authentically possessed knowledge. The new paradigm of mathematics curriculum changes under CAPS, with all its implications for teaching and learning, invokes fresh philosophical beliefs and epistemological attitudes about knowledge construction and pedagogical strategies. The theoretical stances of Piaget and Lev Vygotsky, on learning and cognition, resonate with Senge's five disciplines theory. Senge (2000: 59) notes that learning is an on-going process; for children and adults. Professional educators in particular are lifelong learners: (i) their knowledge base is ever changing to keep pace with the technologically advancing world of science and mathematics, just as (ii) their pedagogy has to be re-considered and adapted radically to match the altering political, socio-economic and linguistic landscape of a country emerging into full democracy.

3.2.1 The Five Learning Disciplines of Senge's theory

Senge's five disciplines of learning explain the learning process in the organization, which in the context of this study is the school. The first *discipline is to share a vision*: this discipline requires collaboration and participation since those involved work out the mind map of their operation. Senge (1990) indicates that the main question that should be answered by everyone in the organization is: What do we want to achieve or create together? Discussions and conversations conducted in the classroom in order to answer this question allow both learner and educator to share information, surprise and challenge each other in an open forum free of the textbook; behind which poorly trained or ignorant teachers often hide. HMDs and teachers need to hold regular meetings to debate their departmental teaching and assessment policies, teaching strategies and other interventions appropriate to implement changes in the mathematics curriculum in the intermediate phase.

Senge (*ibid.*) indicates that an agreed upon and shared vision enables those in leadership to achieve positive visioning, concept- shifting and value alignment. This democratic posture, like constructivist pedagogic intentions are aligned with Freirean principles of liberation and equality but severely antipathetic to the habits of many academics and educators committed to the top-down, hegemonic imperatives of overtly fascist (1948-94) or colonial regimes (1700's to 1994). Regular policy meetings allow HMDs to play a democratic role in their instructional leadership, because teachers share a commonly agreed upon meaning and focus. The department cannot have a vision without mutually respected and established policies, which provide parameters and guidelines for attaining a vision. Teaching strategies and approaches to learning and teaching of mathematics in the intermediate phase could be explicitly articulated by holding such policy meetings.

The second discipline comprises *mental models*: beliefs, values, mind-sets and assumptions that determine the way teachers and HMDs think and act. The shared vision and mental models complement each other, in the sense that, debates and discussion unleash divergent and convergent views, which in the end build a strong perspective, which manifests refined values, mind-sets and beliefs about what ought to be done to implement changes in classroom practice. Carl (2010) claims that effective teaching and learning cannot be attained in an environment where there is a high degree of antagonism and lack of cooperation about what is to be taught and how it should be taught.

The third discipline has to do with *personal mastery*: those individual abilities to manage, regulate and channel self-interest in an organization. An individual's character and personality as a leader need to be mastered in order to accommodate and understand or tolerate others. Fullan's change theory explains that conflict and misunderstanding are part of change; leaders should be competent negotiators in the process. The fourth discipline concerns team learning: In this theory team, learning refers to thinking together, sharing experience, insight, knowledge and skills about how to do things better. According to Senge (2000), team learning develops continuous dialogue between teachers and their leaders and among teachers themselves.

Senge's fifth discipline involves *systems thinking* according to which leaders can learn to analyse situations, events, problems and possibilities to improve conditions.

In the context of this study, this fifth discipline points to the roles of the HMDs as instructional leaders, to ensuring that teachers adhere to the curriculum guidelines when planning of mathematics lesson. The guidelines expect mathematics teachers to

consider learners' needs when preparing learning activities. The HMDs should provide teachers with professional support and guidance in selecting methods and resources, to cooperate with colleagues in order to maintain a good teaching standard in mathematics and to take into account orientation, regional courses, new approaches, techniques and evaluations in mathematics (ELRC,2003: c6).

Antagonists were often absolutists who regarded Mathematics as a fixed abstract area of knowledge, or members of an old guard mentality, which assumed their own training was an inviolable source of enlightenment to be transferred to others, like a baton. Constructivists regard knowledge as a mutually shared building up of knowledge attained through discussion, collaboration and exploration of new intellectual territory. Carl (2010) warns of the temptation to reject change in the mathematics curriculum out of hand; ignoring all the proposed changes by those who are enthusiastic about shared, exploratory learning. HMDs in a democratic South Africa have to respect and implement CAPS policy which fundamentally endorses OBE attitudes towards a Freirean core responsibility of purpose for the many, and that prioritises the subject as a language, a means of communication and mutual understanding; not the static preserve of the few.

3.2.2 Valsiner's Zones Theory and Socio-cultural theory

Research in the field of mathematics education indicates that Vygotsky's theory of socio-cultural learning has contributed to the development of another theory, which is Valsiner's Zones Theory. This theory describes variables in teaching and learning in the context of different yet related zones. Valsiner (1997) describes the interaction between professionals and their environment and learners' adaptation to the context of learning, as zones. The Zone of Free Movement (ZFM) represents the environmental

constraints which limit the freedom to act and think; and the Zone of Promotion Action (ZPA) is a set of activities, objects or phenomena, and area in an environment promoted by adults to instil new knowledge. These activities, areas and objects exist in an environment, in which individual actions are displayed (Iffah *et al.*, 2017: 745). This study considered the Zone of Free Movement (ZFM) to be the extent to which mathematics teachers and HMDs were able to share the knowledge of the subjects and their opinions openly in a democratic and inclusive way congruent with the vision of CAPS. The principles asserted in this theory provide focus to the role of HMDs, to; cooperate with colleagues in order to maintain a good standard of teaching the subject (Mathematics) and to collaborate with educators of other schools in developing and conducting extra-curricular activities” ELRC, (2003) The notion of extra-curricular activities, in this context, could be seminars, workshops and subject meetings in the circuit or in the district.

In finding out why HMDs meet resistance or find receptive audiences when implementing CAPS it is impossible not to take into account the historical conditioning of academe and schools under three centuries of white rule. It is not possible to understand mathematics as if it were an isolated shrine of wisdom: nor can implementation of CAPS policy be separated from mental habits, inherited prejudices and attitudes to a subject such as mathematics, which has been conditioned by the past.

Researchers into the pioneering principles of Valsiner’s Zone theory, Goos, (2009); Blanton, *et al.* (2005); Ponte, *et al.*(2006) and Goos, *et al.*(2007) agree that zones theory is an extension of Lev Vygotsky’s socio-cultural theory. Good *et al.*(2007) include the third zone in Valsiner’s theory in their study of teaching of mathematics in schools.

The figure below illustrates Valsiner's Zones theory from the perspective of Goos (2009) which added the Zone of Proximal Development (ZPD) to the two zones: Zone of Free Movement (ZFM) and Zone of Promotion Action (ZPA).

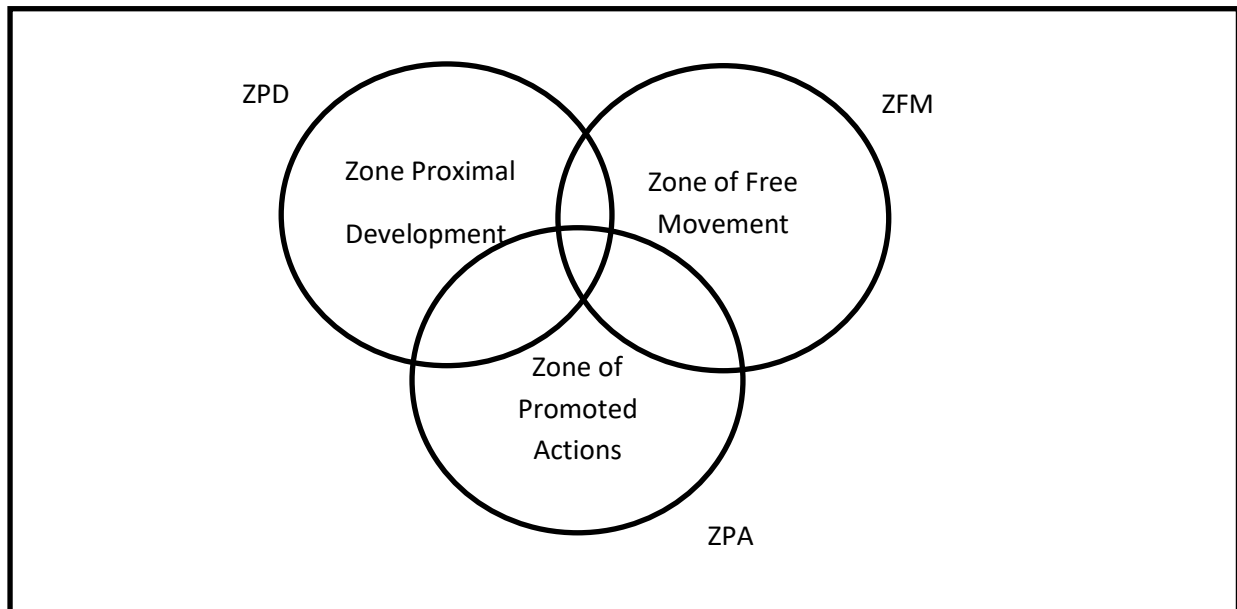


Figure 4: is a diagram adopted from Goos (2009: 295) which explains the three zones.

Proponents of Zones theory and the principle of Zone of Proximal Development advocate that these two are relevant for understanding the socio-cultural dimensions in teaching and learning. Zones theory in this study was adopted on the ground that it explains the variables and their interrelatedness in the practice of teaching and learning. The Zone of Proximal Development as the third zone brings in the issue of professional development and engagement with lifelong learning: e.g. research, action research, engaging in professional learning committees (PLC). Plans for a shared vision for improving the quality of teaching and learning of mathematics developed by HMDs and teachers comprise a Zone of Proximal Development. The plans should

include innovative strategies to enable learners to develop essential skills; as stipulated in CAPS. Learners should be more able to develop the correct use of the language of Mathematics:

to develop number vocabulary; number concept and calculation and application skills; Learn to listen, communicate, think, reason logically and apply the mathematical knowledge gained, to learn to investigate, analyse, represent and interpret information, learn to pose and solve problems, to build an awareness of the important role that Mathematics plays in real life situations including the personal development of the learner (DBE, 2011: 7-8).

Planning and preparation in the department to achieve the aims of teaching mathematics in intermediate phase as the curriculum and Assessment Policy Statement (2011: 8) under a HMD may be termed a Zone of Proximal Development. Such planning or ZPD enhances:

- (i) Critical awareness of how mathematical relations are manifested in social, environmental, cultural and economic relations;
- (ii) Confidence and competence to deal with any mathematical situation without being hindered by a fear of Mathematics;
- (iv) a spirit of curiosity and a love for Mathematics;
- (v) an appreciation for the beauty and elegance of Mathematics; recognition that Mathematics is a creative part of human activity;
- (vi) Deep conceptual understanding to make sense of Mathematics;
- (vii) Acquisition of specific knowledge and skills necessary for: - the application of Mathematics to physical, social and mathematical problems, the study of related subject matter (e.g. other subjects) - further study in Mathematics.

Actions pointing to the acquisition of the skills mentioned above (i-v) imply that a HMD is playing his/ her role effectively.

3.2.2.1 Blanton's Analysis of the Zone of Promotion Action (ZPA)

Blanton (2005) analyses the Zone of Promotion Action in the context of implementation of new skills, new strategies and new conceptual knowledge. The Zone of Promotion Action explains the possibilities of *the rejection of the actions (R-Promotion Action)*, *acceptance of the actions (Accepted-Promotion Action)* and ignored promotion action (*P- Promotion Action*) (Pseudo –Promotion Action).

The Zone of Promotion Action in the context of this study is the domain where teachers are expected to demonstrate the knowledge of learner-centred teaching strategies. Teaching of mathematical conceptual knowledge and numerical cognitive skills should occur in terms of the immediate physical world of the learners, and respect the linguistic, religious and cultural priorities of that particular community or communities from which learners are drawn. Learners must be given learning activities that make plain the skills and competences they are expected to demonstrate at the end of the learning process. Teachers should demonstrate as promotion actions, the knowledge of differentiated learning in mathematics, and how they (Mathematics teachers and HMDs) identify learners with learning difficulties, and the plans they have in place to assist those learners. HMDs and mathematics teachers must state openly themes, which they have prepared to enable learners in a mathematics class to: draw on their own observation of the natural environment. Therefore, for example the concept of (half) and the symbol ($\frac{1}{2}$) and (quarter) ($\frac{1}{4}$) require learners to understand what fractions mean: working with a real object such as an apple and cutting it into

smaller and smaller parts, halves, then quarters, provides learners the opportunity to grasp the notion of fractions in a tangible and visual way.

3.4 Summary

This chapter provides a discussion of the theoretical framework developed and adopted for deployment in the empirical section of this research project. The theoretical framework developed parameters for presenting data on the role of HMDs establishing departments that are enthusiastic about exploring new strategies of teaching mathematics such as problem solving, exploration and self-discovery, group discussion, investigating and role-playing. The other dimension to the role of HMDs is the planning and organizing of mathematics subject content; to provide guidance to teachers to select context that is familiar from learners' socio-cultural environments. The theoretical framework developed for this research project encapsulates cognition principles from Piaget's theory, which explain that internalization of knowledge begins with sensory learning. Visualization is emphasized as key to acquisition of mathematical conceptual knowledge and cognitive skills; understanding, application, analysis, synthesis, evaluation and create. The principle from Lev Vygotsky's socio-cultural learning theory of Zone of Proximal Development (ZPD) together with the two Zones from Valsiner's theory supplemented aspects of the framework; making it possible to identify variables and to explain the focus of the research. Discussion of the research design, methodology and data collection procedures presented in the next chapter is based upon this theoretical framework.

Chapter Four: Research Design and Methodology

4.1 Introduction

This chapter discusses the process for conducting the empirical research segment of this investigation, which deals with the potential of HMDs to facilitate CAPS priorities in their departments at selected schools in Kwazulu-Natal. The design of the empirical research is determined by the need to provide answers to the research questions, which emanate from the problem statement of this study:

- To what extent do Heads of Mathematics Departments promote the adaptation of constructivist ideas on pedagogical approaches to teaching and learning of Mathematics in the intermediate phase?
- How do mathematics teachers respond to the ideas on pedagogical approaches promoted by the HMDs for the teaching and learning of Mathematics in the intermediate phase class?

The process of data collection and analysis of data generated intended to meet the aim and the objectives of the study to; critically interrogate the perspectives of the developments in the teaching and learning of Mathematics in intermediate classrooms in the context of curriculum change, known as CAPS.

4.1.1 Objectives of the study

This study intends:

- To identify different perspectives on pedagogical approaches to the teaching of Mathematical concepts and skills in classrooms under the leadership of HMDs
- To determine the perceptions of HMDs and teachers in their socio-cultural contexts for the promotion of collegial understanding of the strategies of teaching and learning of Mathematics according to CAPS
- To determine a model of instructional leadership that can be shared among HMDs to improve the level of accountability for their role in the teaching and learning of Mathematics in the intermediate phase.

4.2 Research Design and Methodology

The empirical part of this study was framed within an interpretive paradigm which enabled the researcher to adapt descriptive and exploratory research designs. The adaptation of these two research designs are explained by Cohen *et al.* (2015) and Henning *et al.* (2004) to be complementary; in a sense that descriptive design encompasses the collection of a wide range of opinions and views.

In the context of this research, *descriptive design* entailed the use of quantitative methods of data collection and stratified random sampling. Ethnographic research was designed in three case studies to answer descriptive and explanatory research questions. There were two categories of population of participants in the study: the HMDs and mathematics teachers of intermediate phase grades; grades four to six. The selection of the participants in two stratified or categorised samples focused on three

case studies: rural, township and suburban schools to answer the descriptive research questions.

Case Study A: The first category of participants from rural schools was the sample of HMDs. There were six females and six male HMDs who were selected from the rural schools under district X in the KwaZulu-Natal province. The second category of participants comprised teachers of mathematics. The sample of thirty teachers was selected from the intermediate phase at the same schools. Gender equality in the sample was not possible because some schools had more female than male teachers did. The teachers of mathematics and HMDs were selected from the same schools.

Case Study B consisted of participants selected from township schools in district Y in northern KwaZulu-Natal. Participants were approached via school principals after the department granted permission. This case study had two categories of participants: HODs and teachers of mathematics. The selection of the participants focused on six HODs from each of the two townships in district Y who took part in the study. The total number of teachers was thirty: fifteen teachers were selected from each township. The rationale for surveying two townships was that they were of different features; one township is surrounded by informal settlements and is populated by non-South African citizens; whereas mainly middle-class SA citizens populate the other so-called township.

Case Study C: participants who constituted this study work in suburban schools and fall under district Y; but the circuit is different. The same number of participants was selected for this case study. HMDs and teachers of mathematics comprised the two sets of samples.

The descriptive data highlighted the patterns of thought which the study required to understand the conditions, circumstances and level of awareness that mathematics teachers and their HMDs have about curriculum change in South Africa. This information was used to search for data through qualitative means.

4.2.1 Questionnaire

The questionnaire was designed for HMDs and teachers of mathematics. The content in the questionnaires for HMDs differed from that for teachers of mathematics. HMDs were required to focus upon issues related to their instructional leadership roles. The content in the questionnaire for mathematics teachers was more to do with their experiences of implementing teaching strategies and learning styles, under the guidance of HMDs.

The questionnaire consisted of thirteen closed-ended questions, which sought to collect data on three main issues. Section A focused on HMDs' biographic data, which were essential for identifying the categories of the participants; so-called township, rural and urban schools. The information provided under this issue was; location of the place of work, qualifications in the subject, experience in terms of years of teaching the subject, and being in charge of the department, and gender. The biographical data provided information describing the context in which HMDs operate, and provided the background against which to assess effectiveness of HMDs in their instructional role.

Section B focuses on HMDs' views and patterns of thought about progressive ideas on pedagogical approaches and implementation. The data classified under this issue

ranged from HMDs' awareness of the new approaches in mathematics teaching and learning; for example, modelling, problem solving, inquiry-based learning, self-discovery and group work or group discussion. The questions expected HMDs to indicate their preferred teaching strategies, and those that teachers in classroom make use of in teaching conceptual knowledge and skills.

Section C of the questions sought to elicit participants' views and patterns of thought concerning the attitudes demonstrated by mathematics teachers towards the proposed approaches to teaching and learning styles to improve learning of mathematical knowledge. The Likert scale was used by HMDs to rate their opinions concerning teachers' responses to new strategies of teaching and learning proposed in the CAPS curriculum guidelines. The approaches adopted by HMDs to engage teachers in department discussions, planning and organisation were part of this section.

The questionnaire for teachers of mathematics required teachers to provide responses to a range of questions pertaining to their opinions, experiences and views about the positive contributions of HMDs' instructional leadership to their professional development in terms of subject content knowledge, pedagogical approaches, and required classroom practice proposed in the CAPS document. The issue of classroom practice encapsulates: classroom management and organisation, assessments, procedures and preparation of resources and material for teaching and learning.

Explanatory Research Design: Several researchers such as Cohen *et al.* (2005); Henning *et al.* (2004) and McMillan and Schumacher (2006) emphasise the importance of explanatory research in identifying patterns within data. Such researchers point out that the benefits of qualitative methods, which were applied in this project to set up the sample and to collect data.

4.2.2 Sampling

The sample for explanatory research was selected from the main sample that was constituted for the descriptive study. The focus group was formed through random sampling. There were nine participants selected to represent the three constituencies: rural, township and urban areas. They volunteered to provide information. Participants in the HMD focus group were selected from nine different schools from each circuit in Districts X and Y. These are the largest districts in the northern KwaZulu-Natal province. The other reason for targeting these districts for the descriptive and explanatory research was their dynamics in terms of the environments in which schools were situated. These districts have circuits in remote rural areas, townships, while some of the schools are in urban areas. Disparities in the environment were considered when deciding on the circuits as well as schools. The three circuits were represented by three HMDs selected from three schools per circuit.

The same strategy was adopted in selecting participants for the sample of the teachers. The participants in the focus group represented the three constituencies: rural, township and urban schools. The sampling targeted teachers who participated in the main sample; meaning the eighty-three mathematics teachers teaching in the intermediate phase.

4.2.3 Interviews

The interviews were conducted with the focus group after the questionnaires were collected from the participants. Interviews with a group of ten HMDs were conducted: the focus group consisting of five heads of department was constituted through a random selection of participants from the main research sample representing rural and

township schools. The interviews were conducted with the participants in the second focus group comprising. Interviews questions aimed to elicit data on issues of: (i) experiences of teachers in adapting the strategies recommended in the CAPS curriculum guidelines for teaching mathematical content knowledge and skills. The questions also elicited knowledge about teachers' understanding of problem solving, teaching for differentiated learning in mathematics lessons and using a variety of assessments to enhance learning. Information about teachers' preferences of teaching methods and learning style for mathematics lessons and assistance, support and guidance provided by HMDs to teachers, where challenges manifest in the practice of teaching and learning in classrooms formed part of the investigation.

The data collected by means of interviews with teachers assisted in the triangulation of data during the process of analysis. The researcher was of the view that teachers could have a different perspective to that of the HMDs on matters related to guidance, support, engagements and leadership styles. The perspective provided by teachers enabled the researcher to establish a balanced understanding of the role of HMDs in executing their leadership role as stipulated in the Employment of Educators' Act (EEA) 1996 (ELRC, 2003) in the teaching and learning of mathematics content knowledge and numerical skills.

4.3 Ethical consideration

Access to schools, permission to conduct research and recognition of gatekeepers were considered. The following measures were taken; first, the application for ethical clearance was sent to the research committee of the institution after the Head of the Education Department in KZN had granted permission. Letters to school principals were sent and arrangements were made for appointments to discuss the purpose of the

research. Letters of consent were distributed to all volunteers who were selected in the sample. These letters of consent assured participants of: anonymity, freedom to answer questions without fear and the knowledge that they were not coerced to answer questions that they did not wish to answer.

4.4 Validity and reliability of instruments

The validity and reliability of the questionnaire was tested in a group of five teachers at the researcher's school and among the HMDs at two schools. The identified inconsistencies and ambiguities in the questions were attended to, such as; questions asked in different ways when seeking the same responses. Grammatical mistakes were corrected before the questionnaire was printed and distributed to the larger sample. The process of testing reliability and validity of interview questions was conducted on a smaller scale; the interview questions were asked of three different individual teachers at the researcher's school. Validation for reliability of questions assisted the researcher to understand how long it took to complete each question. The researcher learned that some of the questions were confusing and required to be simplified. After testing the validity of both instruments, they were sent to the supervisor and ethical clearance committee respectively for endorsement.

4.5 Delimitation of the Study

The province of KwaZulu-Natal has seven educational districts and twenty-three circuit offices. This particular study selected six circuit offices under two districts: iLembe and Empangeni districts. Empangeni is the largest district in the northern KwaZulu-Natal province and has four circuits, some of which lie in remote rural areas such as Nkandla and Eshowe: two townships: Mthunzini circuit and Lower Mfolozi

circuit. From iLembe, district schools under the administration of Maphumulo and Lower Tugela Circuits were surveyed for this research. Schools under the Maphumulo circuit, Nkandla and Eshowe were regarded as rural whereas schools selected from Lower Tugela, Mthunzini and Lower Mfolozi were considered as township or semi-urban schools.

4.5.1 The map shows the six circuits that participated in the survey and focus groups.

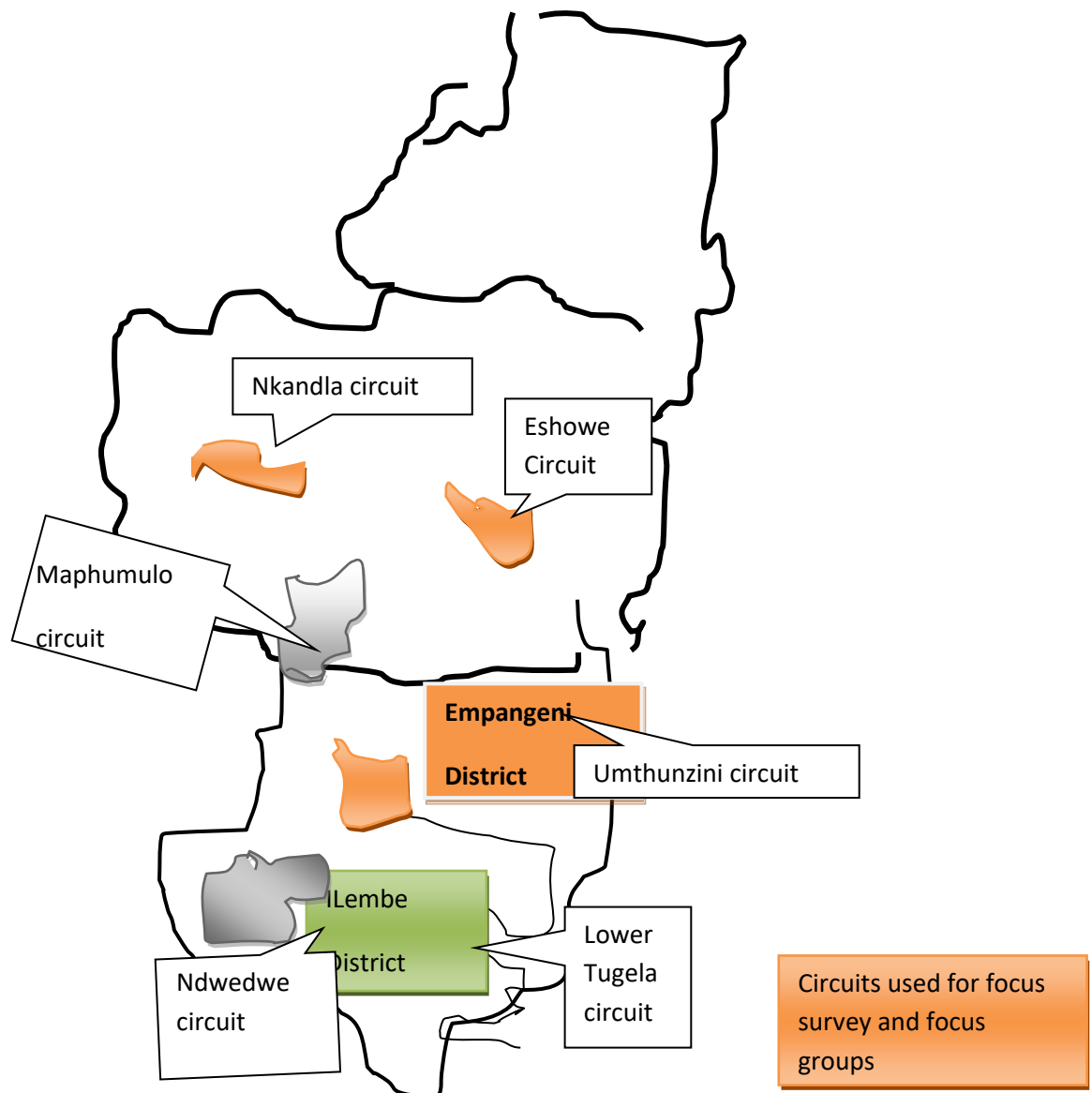


Figure5: The sketch of the map showing the districts and circuits where the empirical study was conducted and the location of school targeted for the study.

4.6 Data analysis and Presentation

There is a plethora of opinions regarding the process of data analysis. This study adopts the description of quantitative and qualitative provided by Schumacher and McMillan (2006). According to these researchers, quantitative data analysis involves: the use of descriptive statistics, which assists the researcher to: summarise, organise and to reduce large quantities of data collected from the survey. Descriptive statistics focus on ‘*what is*’ with respect to the sample (Schumacher & McMillan, 2006: 150-151). In the context of this study, the description of the quantitative data was of assistance in the analysis of the data collected by means of the questionnaire. The data sought to elicit information related to the participants in the sample. The use of frequency distribution tables and graphs discussed in Schumacher and McMillan, (*ibid*: 162) was used to summarise data from the questionnaire from the HMDs and from teachers of mathematics.

Concerning qualitative data analysis, Welman *et al.* (2005:214) emphasise the creation of codes, which are “tags or labels which attach meaning to the raw data”. According to these researchers, the codes can be of various forms: descriptive codes, interpretive codes; and pattern codes. In the case of this study, the codes and their classification were guided by a slightly tailored version of Vygotsky’s Zones theory. There were codes, which related to the Zone of Proximal Development (ZPD): considered more descriptive; in the sense that they highlighted patterns of thoughts about acceptance of change, shared vision and strategies for teaching mathematics. The views and perceptions indicating acknowledgement of teachers’ creativity and enthusiasm in changing methods of teaching were classified as the Zone of Free Movement (ZFM). The perceptions and patterns of thought highlighting the adoption

of new skills, new strategies and cooperating with the HMDs' proposed strategies, as well as complying with the changes, indicated in the espoused curriculum, such initiatives as specific aims for teaching mathematics, contextualised teaching of concepts and skills, and the integration of assessment into the teaching and learning; classified as Zone of Promotion Action (ZPA).

4.6.1 Analysis of Data from the Questionnaire

The questionnaire to HMDs was divided into three sections. The first section was purposed to (i) elicit biographical data of participants, (ii) identify the locations of their places of work and (iii) mark perceptions of instructional leadership roles in the teaching and learning of mathematics in the intermediate phase classes. The questions in this section were closed-ended. The questionnaire that sought to elicit information from the teachers of mathematics in the intermediate phase consisted of closed-ended questionnaires. A quantitative process to analyse the data was adopted by means of the computer programme called Statistical Package for Social Sciences (SPSS). The coding of information assisted in organising data into manageable units which the computer programme converted into numerical data such as descriptive statistics which served as a tool for presentation of data in summaries in the form of tables and graphs. The data collected on the items in the first section of the questionnaire were the first to be analysed: gender socio-economic status of the working place, years of experience in the teaching of mathematics in intermediate classes, duration in instructional leadership position as an HMD.

The analysis of data solicited in the second section of the questionnaire focused on patterns of thought, perceptions and views of HMDs regarding new approaches to teaching mathematics; as proposed by CAPS for Mathematics. Data analysis sought to

identify perceptions and patterns of thought held by HMDs regarding the strategies and learning styles that were preferred in the teaching, learning and assessment of mathematical knowledge and skills.

Analysis of data from the third section of the questionnaire searched for indicators of how HMDs engaged teachers in collaborative activities in the department for: (i) developing teaching and learning policies, (ii) deciding on teaching and learning strategies and assessment procedures proposed in the espoused mathematics curriculum for intermediate phase. Analysis of data from the Likert scale ascertained patterns of thought presented in the frequency distribution tables. Responses to each rating were classified under each of the five categories indicated on the scale: Agree, Strongly Agree, Disagree, Strongly Disagree and Undecided.

Data collected from teachers of mathematics through the questionnaire were analysed by means of the Statistical Package for the Social Sciences. The descriptive statistics yielded from closed-ended questions were used to characterise perceptions and views of teachers: regarding the nature of instructional leadership of HMDs in the teaching of mathematics and professional development for effective implementation of new approaches to teaching of mathematical knowledge and skills to intermediate phase learners. The extent to which mathematics teachers felt they enjoyed the freedom to apply other strategies, which they considered relevant to mathematical knowledge and competencies in their learning environments, was identified from responses to the closed-ended questions of the questionnaire. The synchrony of views and perceptions was presented in the frequency distribution tables and graphs.

4.6.2 Analysis of data collected by means of a qualitative tool: Interviews

Kumar (2011:78) claims that: “for the analysis of qualitative data, a researcher needs to go through the process called content analysis”. He explains that content analysis entails analysing participants’ responses to each question and identification of main themes. The process of data analysis began soon after all participants were interviewed. The first step was to develop transcripts. The data were classified and categorised under the identified themes. Convergent views and divergent perceptions were presented and discussed under the guidance of Valsiner’s Zones theory and Blanton’s descriptions of the Zone of Promotion Action.

4.7 Summary

This chapter outlined the methodology and research design deployed in this project. Descriptive research was explained and accounted for as a procedure and design for data collection. Sampling strategies adopted for explanatory research are set out. Ethical clearance, access to schools and validation of the research instrument for reliability are elaborated upon. Delimitations of the study were examined; indicating the geographical parameters within which the field work was conducted.

Chapter Five: Data Analysis and Presentation of Results

5.1 Introduction

This chapter presents the analysis of data collected by means of a questionnaire and interviews. The quantitative data are organised into summaries, units and themes. The frequency distribution tables and graphs are used to present a summary of the raw data. The data collected by both questionnaires and interviews sought to answer two research questions:

- To what extent do HMDs promote the adoption of constructivist ideas on pedagogical approaches to teaching and learning of mathematics in the intermediate phase?
- How do mathematics teachers respond to the ideas on pedagogical approaches promoted by HMDs for the teaching and learning of mathematics in the intermediate phase class?

Data were analysed to identify themes associated with the aim of this study:

Critically interrogate the perspectives of the developments in the teaching and learning of Mathematics in intermediate classrooms in the context of curriculum change, known as CAPS.

The analysis of data focused upon issues and themes that addressed the three objectives of the research:

To identify different perspectives on pedagogical approaches for teaching of mathematical concepts and skills in classrooms under the leadership of HMDs

To determine the perceptions of HMDs and teachers in their socio-cultural contexts for the promotion of collegial understanding of the strategies of teaching and learning of mathematics according to CAPS.

To devise a model for instructional leadership that could be suitable for effective implementation of new approaches in the teaching and learning of mathematics.

5.2 Analysis of quantitative data collected by means of a questionnaire

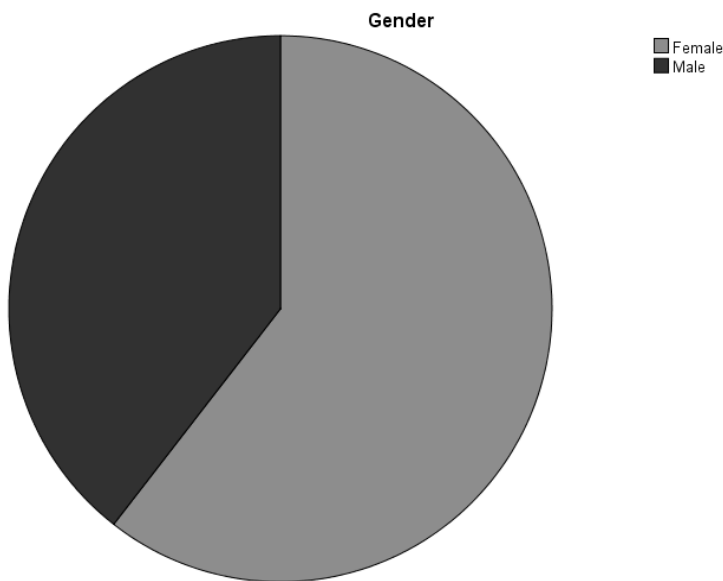
5.2.1 Perspectives of Heads of Mathematics Departments

5.2.1.1 Participants' biographical Data

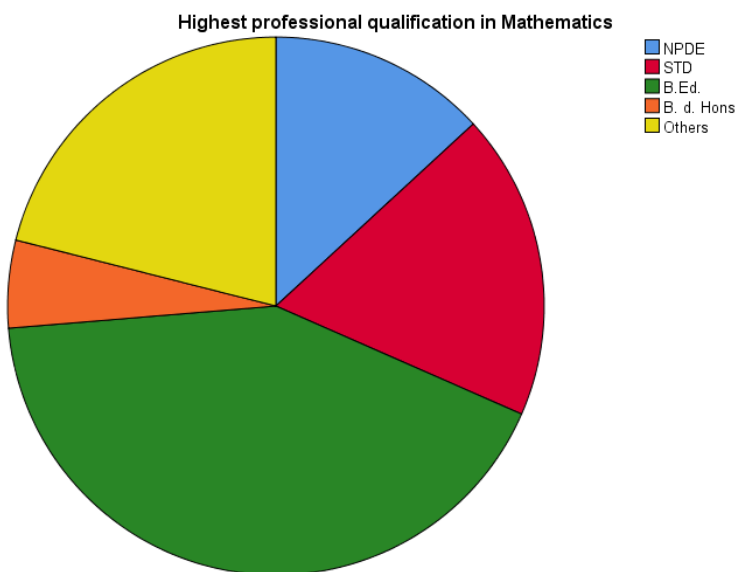
Participants were requested to provide information about their gender, and years of experience in teaching mathematics. HMDs were asked to state the years of experience they had in instructional leadership, and the socio-economic status of their workplace. The biographical data provided a context for the interview questions; which were intended to probe for substantive information regarding views and perception identified from the data in the questionnaire. The purpose of the issue of gender in the questionnaire was to indicate the instructional leadership roles for female and male teachers. Information provided by participants about gender enabled the researcher to distinguish between perceptions and views along gender divides. There is a false belief that males are more mathematically intelligent than their female counterparts (Dickerson *et al.*, 2015:22 and Fryer & Levitt, 2010). The issue of

attitudes and compliance with instructions from leadership was determined by contrasting responses of male and female teachers.

5.2.1 .1Graph presenting the sample in terms of gender and socio-economic status

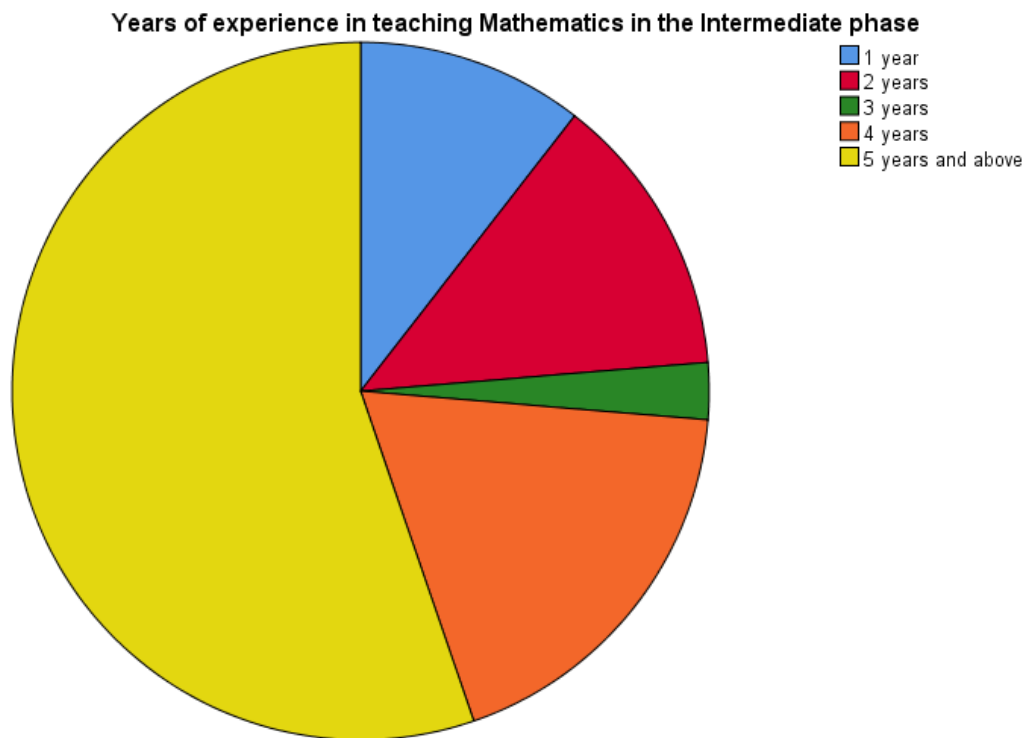


5.2.1.2. Pie graph presenting a summary of data on the highest professional qualifications of HMDs in Mathematics



5.2.1.3. Pie graph presenting the socio-economic background and location of schools in the sample

5.2.1.4 Pie graph presenting the HMDs' years of experience in teaching mathematics in the Intermediate phase



5.2.1.4 Pie graph presenting HMDs' years of experience in teaching mathematics in the Intermediate phase

The data presented in the following Frequency distribution tables were elicited by closed-ended questions from participants. The question sought to explore views and perceptions of proposed changes in the mathematics curriculum for intermediate learners. HMDs are expected to provide clarity about what changes entail and to understand the implications of the changes in teaching and learning. The team leader

should be kept abreast of changes in the subject content and pedagogical knowledge required implementing changes in the department. Interpretation of results should indicate that HMDs are creating an environment conducive to learners and teachers; one that facilitates effective teaching and learning in the subject.

HMDs were requested to use the Likert scale to rate the effectiveness of approaches to staff professional development and collegial engagements with teachers in the department. Each participant ticked off categories to show the effectiveness or ineffectiveness of particular approaches. The approaches presented in the questionnaire were identified from the conceptual framework generated in chapter two of this study. The categories on the Likert scale were Strongly Disagree and Undecided, Agree, Strongly Agree;

Statistical data summary of reflections of the HMDs on their mentoring and supporting mathematics teachers to understand the value of aims and specific mathematics skills when organising teaching and learning content

categories	Frequency	Percent	Valid Percent
Strongly Disagree	12	31.6	31.6
Undecided	2	5.3	5.3
Agree	20	52.6	52.6
Strongly Agree	4	10.5	10.5
Total	38	100.0	100.0

Figure 5.2.2.1: Frequency Distribution Table presenting views of HMDs on the readiness of mathematics teachers to adopt the aims of mathematics teaching and learning into their planning of lessons and learning activities (n=38)

Statistical summary of data from the responses of the heads of department to the statement about the attitude and commitment of mathematics to implement innovative strategies and techniques of teaching and learning in their practice

categories	Frequency	Percent	Valid Percent
Disagree	3	7.9	7.9
Strongly Disagree	13	34.2	34.2
Undecided	2	5.3	5.3
Agree	16	42.1	42.1
Strongly Agree	4	10.5	10.5
Total	38	100.0	100.0

Figure5.2.2.2: Frequency Distribution Table presenting the HMDs' interpretation of the attitudes, and reactions of the teachers of mathematics in intermediate phase to teaching strategies and learning styles (problem solving, self –discovery learning, inquiry-based and cooperative learning)(n=38)

Statistical summary of the views of HMDs about involving teachers in activities to develop mathematics learning programmes and assessment plan for grade 5-6 learners (intermediate phase)

Categories	Frequency	Percent	Valid Percent
Disagree	1	2.6	2.6
Strongly Disagree	12	31.6	31.6
Undecided	7	18.4	18.4
Agree	13	34.2	34.2
Strongly Agree	5	13.2	13.2
Total	38	100.0	100.0

5.2.2.3 Frequency Distribution Table representing data about the readiness of mathematics teachers to take part in activities proposed by HMDs concerning development of learning programme and assessment plan for teaching and learning in intermediate phase. (n=38)

Statistical data summarising the reflections of the HMDs on the integration of formative diagnostic and baseline assessments to the daily mathematics learning activities

categories	Frequency	Percent	Valid Percent
Strongly Disagree	14	36.8	36.8
Undecided	1	2.6	2.6
Agree	19	50.0	50.0
Strongly Agree	4	10.5	10.5
Total	38	100.0	100.0

5.2.2..4: Frequency distribution table presenting the HMDs understanding of the values of integrating formative assessment to mathematics learning activities (n=38).

Statistical summary of perceptions the importance of selection of inclusive teaching strategies for differentiated learning and remedial teaching in their mathematics department

categories	Frequency	Percent	Valid Percent	Cumulative Percent
Disagree	2	5.3	5.3	5.3
Strongly Disagree	6	15.8	15.8	21.1
Undecided	16	42.1	42.1	63.2
Agree	14	36.8	36.8	100.0
Strongly Agree	0	0	0	
Total	38	100.0	100.0	

Figure: 5.2.2.5 frequency Distribution Table representing the views of HMDs on the competence of teachers to design Mathematics lessons for differentiated learning

Statistical summary of HMDs reflections on their mentoring and coaching teachers to develop competences in aligning teaching styles with individual learners learning styles in mathematics classes

categories	Frequency	Percent	Valid Percent
Strongly Disagree	14	36.8	36.8
Undecided	1	2.6	2.6
Agree	19	50.0	50.0
Strongly Agree	4	10.5	10.5
Total	38	100.0	100.0

Figure 5.2.2.6 frequency distribution table representing the perceptions of HMDs concerning mathematics teachers' adaptation of: diagnostic and formative assessment for addressing diverse learning styles in the mathematics content programming. (n=38)

Statistical summary of data on HMDs' preference of teaching and learning strategies for innovative teaching and learning of mathematics conceptual knowledge and skills

listed items	frequency	percent	valid percent
Group discussions	12	31.5	31.5
Self-Discovery	4	10.5	10.5
Group projects	9	23.7	23.7
Inquiry –based learning	13	34.2	
Total			

Figure 5.2.2.7: frequency distribution table representing the choice of teaching and learning strategies for effective teaching and learning of mathematical knowledge and skills to the intermediate phase. (n=38)

Statistical data summarising the responses of the HMDs to the options of activities they prefer for capacitating mathematics teachers with techniques and strategies introduced in the mathematics curriculum innovation (CAPS)

Listed items	Frequency	Percent	Valid Percent	Cumulative Percent
Staff meetings	15	39.5	39.5	39.5
Training workshops	17	44.7	44.7	84.2
Planning sessions	6	15.8	15.8	100.0
Total	38	100.0	100.0	

Table 5.2.2.8: A frequency distribution table representing a summary of data on interventions preferred by HMDs to capacitate mathematics teachers who seek assistance with pedagogical strategies as stipulated in CAPS (n=38)

Statistical data showing HMDs observations of the teaching strategies that influences practices of mathematics teaching and learning in their departments

listed items	Frequency	Percent	Valid Percent
Problem solving	6	31.6	31.6
Telling methods	4	10.5	10.5
Group work	7	18.4	18.4
Role play	1	2.6	2.6
Drill methods	12	15.8	15.8
Question and answer methods	6	15.8	15.8
Demonstration	2	5.3	5.3
Total	38	100.0	100.0

5.2.2.9: frequency distribution table displaying a summary of data what HMDs perceived to be strategies influencing teaching and learning of mathematical knowledge and skills; in the context of the intermediate phase curriculum and assessment policy for Mathematics. n=38)

Summaries of data focused on role of head of mathematics department with regards to the engaging mathematics teachers in departmental staff development activities

Categories	Frequency	Percent	Valid Percent
Disagree	1	2.6	2.6
Strongly Disagree	2	5.3	5.3
Undecided	4	10.5	10.5
Agree	13	34.2	34.2
Strongly Agree	18	47.4	47.4
Total	38	100.0	100.0

Figure 5.2.2.10: Frequency Distribution Table representing data about the readiness of mathematics teachers to take part in intervention activities proposed by HMDs concerning remedial teaching of learners with learning difficulties (n=38)

Statistical data summarising the HMDs' views about readiness and willingness of mathematics teachers to shift their mindset of learning mathematical concepts and mental skills through memorisation and repetition

categories	Frequency	Percent	Valid Percent
Disagree	3	7.9	7.9
Strongly Disagree	8	21.1	21.1
Undecided	5	13.2	13.2
Agree	15	39.5	39.5
Strongly Agree	7	18.4	18.4
Total	38	100.0	100.0

Figure 5.2.2.11 Frequency Distribution Table presenting HMDs' perception of teachers of the adherence of o traditional techniques such as drill and reciting in mathematics teaching and learning (n=38)

Statistical summary of the HMDs approaches to promote collaborative and collegiality among staff members in the department who sought assistance to understand curriculum innovations and application of the teaching techniques in practice

Listed items	Frequency	Percent	Valid Percent	Cumulative Percent
Departmental training workshop to share own creativity and experience as mathematics teachers	11	28.9	28.9	28.9
invite the district advisor to assist teachers	6	15.8	15.8	44.7
Encourage teachers to network with others in neighbouring schools seek clarity from colleagues	3	7.9	7.9	52.6
To consult other colleagues one another	18	47.4	47.4	
Total	38	100.0	100.0	100.0

Table 5.2.2.11: Presenting the frequency of views of the HMDs on the approaches they thought are appropriate for encouraging their colleagues in their respective department to work collaboratively to share the knowledge of the innovations introduced in the mathematics curriculum (CAPS)

Statistical summary presents HMDs perceptions of the determination demonstrated by mathematics teachers to provide remedial teaching to learners experiencing learning difficulties in mathematics classes

Rating scale	Frequency	Percent	Valid Percent
Highly satisfied	3	7.9	7.9
Satisfied	20	52.6	52.6
Neutral	1	18.4	18.4
Unsatisfactory	7	18.4	18.4
Highly unsatisfactory	7	2.6	2.6
Total	38	100.0	100.0

Table 5.2.2.12: A frequency distribution table representing a summary of data on f teachers' knowledge of how to handle learners with learning difficulties

Statistical summary of data on how HMDs' mentor and coach mathematics teacher who encounter challenges in challenges in assisting learners with learning difficulties

listed items	Frequency	Percent	Valid Percent
Organise a staff meeting and seek suggestions from other teachers of mathematics	21	55.3	55.3
Plan demonstration lessons and call teachers to observe what the teaching strategies entail in the intermediate phase teaching and learning	12	31.6	31.6
Delegate excellent teachers who understand and apply learner-centred teaching methods to assist their peers.	3	7.9	7.9
Encourage teachers to rely on the guidelines provided by the department and text-books to teach and learner books for class activities	2	5.3	5.3
Total	38	100.0	100.0

Table 5.2.2.13: Presents the frequency distribution of the data showing HMDs styles of interventions to assist teachers to implement inclusive principle to attend to learners with learning difficulties in mathematics classes

Statistical summary of the HMDs' views on the medium of instruction adopted in their department for teaching and learning mathematics in intermediate phase grade

listed items	Frequency	Percent	Valid Percent
Mother tongue	10	26.3	26.3
English	21	55.3	55.3
Code switching	6	15.8	15.8
Others	1	2.6	2.6
Total	38	100.0	100.0

Table 5.2.2.14: Presents the frequency distribution of data on HMDs preferences of medium of instruction for effective implementation of mathematics curriculum innovations in intermediate classes

Summary of data focusing on the role of HMDs in providing guidance in the selection of teaching strategies suitable for addressing diverse learning abilities in mathematics lessons.

rating scale	Frequency	Percent	Valid Percent
Highly satisfactory	4	10.5	10.5
Satisfactory	28	73.7	73.7
Neutral	4	10.5	10.5
Unsatisfactory	1	2.6	2.6
Highly unsatisfactory	1	2.6	2.6
Total	38	100.0	100.0

Figure 5.2.5.1: Frequency distribution table representing data about how HMDs rated teacher collaboration and participation in staff development activities

Summary of data on issues the HMDs perceived to be critical for effective implantation of mathematics curriculum innovation in intermediate phase classes

listed items	Frequency	Percent	Valid Percent
Training of teachers in teaching methods, strategies and styles for inclusive classroom environment	6	15.7	15.7
Mathematics teaching and learning resources	6	15.7	15.7
remedial classes for underperforming learners	8	21.1	21.1
intensive training of intermediate phase teachers of mathematics	17	44.7	44.7
frequent visits of subject advisors to support teachers	1	2.6	2.6
Total	38	100.0	100.0

Figure 5.2.4.2: frequency distribution table showing how HMDs perceived of recommended approaches to benefit mathematics teachers towards their professional development in pedagogical content knowledge and competences of mathematics subject content knowledge (n=38)

rating scale	Frequency	Percent	Valid Percent
Highly satisfied	3	7.9	7.9
Satisfied	26	68.4	68.4
Neutral	6	15.8	15.8
Unsatisfactory	3	7.9	7.9
Total	38	100.0	100.0

Table 5.2.5.6.A frequency distribution table representing statistical data about how much HMDs knew about staff development programmes and workshops

5.2.6 Analysis of Data gathered qualitatively from participant HMDs in the focus group

Transcripts generated from the audio tapes were used in analysis of the responses of participants. Under the guidance of Henning *et al.* (2004) and Mouton (2012) on the process of qualitative data analysis, the researcher: (i) coded the responses to each interview question and then (ii) classified coded responses according to the categories or themes identified from the data. The frequency of responses is presented numerically to indicate the views under each theme that represent majority and minority participants in the sample of fifteen HMDs' departments in the intermediate phase.

Table 5.2.6.1 Distribution of mathematics teachers' utterances on the instructional leadership role of HMDs from Interviews.

Case study A: rural and township schools (n=10)

Themes	Range (n-10)	Range 100%	Exemplar utterances
<p>1. Provision of professional support and guidance</p> <p><i>Role of head of department in assisting teachers to Interpret aims of teaching and learning Mathematics in intermediate phase</i></p> <p><i>Main Question: When designing your school based teaching and learning schedules what do you use as the source of reference? (Is it curriculum guidelines? Or textbooks?)</i></p> <p><i>Follow question</i> <i>Which source do you use for selecting the specific aims of Mathematics Curriculum?</i></p> <ul style="list-style-type: none"> • <i>demonstrated no clue of understanding the importance of aims of the mathematics curriculum</i> • <i>demonstrated understanding of the existence of the general aim but not in the context of specific aims for the CAPS mathematics guidelines for intermediate phase</i> 	<p>5</p> <p>5</p>	<p>50%</p> <p>50%</p>	<p>“The aim is the same as learning outcomes. If teacher understand the importance of learning outcomes that means they know the aim. My duty is to make sure that learners are taught and assessed”</p> <p>“the teachers are experienced now , they have been attending workshops on CAPS”</p> <p>“the textbooks and learner books are very clear about what teacher should teach and learner should know and do in each term”</p> <p>“I think it is important to know the general aim of the syllabus, because they are generic, but it is not something that we and teacher worry about.”</p>
<p>2.Collegial and collaborative engagement of teachers in curriculum and planning of subject content knowledge</p> <p>Collegial and collaborative approaches in the practice of instructional leadership by HMDs to engage and involve teachers in professional development programmes for effective implementation of proposed teaching and learning strategies.</p>			

<p>Main Questions: <i>How do you manage to involve teachers of mathematics under your guidance to plan and organise content and learning support material?</i> Follow up question: <i>what is your experience in doing this?</i></p> <ul style="list-style-type: none"> • <i>Affirmed collaborations and collegial engagement</i> • <i>Indication of challenges and no concern about collegial and collaborative engagement</i> • <i>Indication of concern about collegiality and collaboration but with resistance</i> 	<p>3</p> <p>3</p> <p>4</p>	<p>30%</p> <p>30%</p> <p>40%</p>	<p>“I have noticed that mathematics teachers who were trained prior to the democracy are more committed to work than these young mathematics teachers.” “ I work harmoniously with my staff. We have a culture of sharing information in the meeting about challenges and difficulties we have in classes.”</p> <p>“no matter what you tell these teacher does not make any difference because they do what they are accustomed to.”</p> <p>“Some teachers are open to learn new things but some are very stubborn....and, so what can you say? The unions are there to protect them</p>
<p>1. Teachers’ confidence to make input in the selection of strategies of teaching and learning</p> <ul style="list-style-type: none"> • Encouraging teachers to apply their creativity and innovative strategies which advance learners performance in demonstrating mathematical conceptual knowledge and application <p><i>Main Question: What teaching methods or strategies do teachers commonly prefer to use in their teaching of mathematics?</i> <i>Follow up question: In your view are the strategies in accordance with the principles recommended in the CAPS curriculum guidelines?</i></p> <ul style="list-style-type: none"> • <i>Affirmed teachers’ confidence and active engagement in decision making about suitable teaching and learning strategies the selection of teaching and the HOD flexibility about teachers’ choice of teaching strategies.</i> 	<p>4</p>	<p>40%</p>	<p>(Hesitantly...) Yes I would say but not generally, meaning that some especially those who attend workshops and upgrading courses organised by CASME are the ones who apply new teaching methods and share knowledge with the members of the department” “ In the main teachers of mathematics recommend what is working for them and the learners in</p>

<ul style="list-style-type: none"> • <i>Rejecting flexibility and enforcement of uniformity in the teaching strategies.</i> 	6	60%	<p>the classroom, so I do not bother myself much about their choices as long as learners performance improve I am not worried about new or old teaching methods</p> <p>Selecting the teaching strategies differ from teacher to teacher. In fact teachers are expose to all teaching strategies during their training so, I am science and technology teacher I can choose methods of teaching for people who are qualified in the subject.</p>
<p>2. Freedom of teachers to share their own views regarding learners who experience learning difficulties in mathematics, for example; Accessibility of the heads of department Commitment of HMDs to providing satisfactory attention to teachers’ opinions and suggestions to benefit learners’ acquisition and development of skills</p> <p>Main Question: How do teachers report learners with learning barriers in their mathematics classes to you as the HOD?</p> <p>What do they expect you to do?</p> <ul style="list-style-type: none"> • <i>affirmation of accessibility of HOD and their commitment to support teachers to deal with diverse learners’ abilities</i> • <i>Indication of not commitment but relying on teachers to apply their discretion</i> • <i>Indication of intention from HMD but with</i> 	3	30%	<p>“during our department meeting we all share our experiences and difficulties about learners who are failing to cope with mathematics content. Of course, they expect me to call parents and advise them about alternative institution where the child can be taken to. I remind them about the inclusive policy in education.</p> <p>I am open to every teacher to report children problems and I normally advise them to apply every skills and expertise they have to help the children. As an HOD I do not have solution to every child’s problem”</p> <p>To solve some problem of learners’ poor performance has nothing to do with the curriculum and heads of</p>
	5	50%	
	2	20%	

<p><i>challenges of encouraging teachers to implement remedial teaching</i></p>			<p>department, but the time and parental involvement is the problem. Children need time to practice and practice until they understand the mathematical problems and methods of solving them. I do address parents about this challenge, but the thing is, they say, they are working; children stay with grandparents and helpers.</p>
<p>3. Collaborative effort by HMDs and teachers to conduct various forms of assessment to identify, diagnose learners' barriers to the learning of mathematics concepts, skills and practices</p> <ul style="list-style-type: none"> ○ Adequacy of mechanisms used by Heads of Department to share information with teachers ○ resilience of the HMDs in attending to teachers concerns about classroom practices ○ willingness of the HMDs to take initiative to demonstrate teaching strategies, assessment procedure for teachers, leading by example on matters regarding organisation and planning of teaching and learning activities <p>Main Question: which mechanism or procedure do you encourage teachers in your department to use for the purpose of identifying learners barriers to learning mathematical knowledge and skills.</p> <ul style="list-style-type: none"> ● <i>affirmation of HMDs' commitment to engage teachers in the all forms of assessment to identify learners who experience difficulties with conceptual knowledge and application of numerical skills</i> ● <i>Unclear about HMD commitment to initiate collaborative effort to conduct diagnostic assessments and planning of activities to assist learners with learning difficulties.</i> 	<p>4</p> <p>2</p>	<p>40%</p> <p>20%</p>	<p>“</p> <p>We in our schools mostly in rural areas we do not have resources except counters, charts and learner books.” The HOD consults the staff about material such as charts and textbooks that we need to top up. We start by giving the simple work or activities and if they fail to do them we organise small group and support them</p> <p>Even though we know learners problems in mathematics learning, the head of departments cannot solve the issue of overcrowded classrooms. The subject advisors do not give us support to assist these learners.</p>

<ul style="list-style-type: none"> Confusing of diagnostic assessment with daily class activities based on textbooks and learners' book. 	4	40%	<p>"The main issue to me is the lack of parental involvement. Teacher cannot do anything if learners do not do daily homework to test their knowledge. Teacher cannot under the circumstance of large classes attend to each learner. Teacher do share problem with me but there is nothing one can do to solve some challenges"</p>
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Figure 5.2.6.1: a frequency distribution table presenting the themes and the range of responses with convergent and divergent perceptions.

Case Study B: Participants from the township schools(n=5)

Themes	Range (n-5)	Range 100%	Exemplar utterances
<p>1. Provision of professional support and guidance</p> <ul style="list-style-type: none"> Role of head of department in assisting teachers to Interpret aims of teaching and learning Mathematics in intermediate phase <p><i>Main Question: When designing school based teaching and learning schedules what do you use as the source of reference? (Is it curriculum guidelines? Or textbooks?)</i></p> <p><i>Follow question</i> <i>Which source do you use for selecting the specific aims of Mathematics Curriculum?</i></p> <ul style="list-style-type: none"> demonstrated no clue of understanding the importance of aims of the mathematics curriculum 	2	40%	<p>" the aim of teaching mathematics is what teacher should know because they are qualified in the teaching of the subject. I think what the HOD</p>

<ul style="list-style-type: none"> <i>demonstrated understanding of the existence of the general aim but not in the context of specific aims for the CAPS mathematics for intermediate phase</i> 	3	60%	<p>should do is supervise their lesson plans and teaching.</p> <p>“when teacher prepare their daily lesson they are aware of the aim of teaching that knowledge to learners. The department material helps us to understand what should be taught in each term. That helps us a lot”</p> <p>Sometimes teachers do not even bother about the aim written on the documents, I do not know whether to them it is important.. they simple teach from the textbook. ... Ok.. I told teacher to copy the specific aims for each from the department because they are readily provided in the CAPS document</p>
<p>2.Collegial and collaborative engagement of teachers in curriculum and planning of subject content knowledge</p> <p>Collegial and collaborative approaches of HMDs to engage and involve teachers in professional development programmes for effective implementation of proposed teaching and learning strategies</p> <p>Main Questions: <i>How do you manage to involve teachers of mathematics under your guidance to plan and organise content and learning support material?</i></p> <p>Follow up question: <i>what is your experience in doing this?</i></p> <ul style="list-style-type: none"> <i>Affirmed collaborations and collegial engagement</i> <i>Indication of challenges with concern about collegial</i> 	2	40%	<p>“ meetings are for announcements and discussing general issues about many things. Sure, to be specific, learners who struggling with certain topics, failure of students to do homework. Yes, we do discuss strategies of teaching.. Parental support to learners is our main problem. Of course we agreed that learners cannot do activities or solve problem without the teachers demonstration, explaining and give examples before learners do it on their own and the teacher</p>

<p><i>and collaborative engagement</i></p> <ul style="list-style-type: none"> • <i>Indication of challenges and no concern about collegial and collaborative engagement</i> 	1	20%	<p>assesses</p> <p>“I have noticed that mathematics teachers who were trained prior to the democracy are more committed to work than these young mathematics teachers.”</p> <p>“there are experienced teachers who are resistant to any new methods. We are told about this learner-centred teaching strategies in training workshops but to demonstrate this to teachers is not changing them from what they know and having been doing over the years</p> <p>“Some teachers are open to learn new things but some are very stubborn....and, so what can you say? Teacher in townships are unionised so you cannot force them to do what they are used to. They are working hard though to assist children in these overcrowded classrooms.</p>
<p>3. Teachers’ confidence to offer input in the selection of strategies of teaching and learning</p> <ul style="list-style-type: none"> ○ Encouraging teachers to apply their creativity and innovative strategies which advance learners performance in demonstrating mathematical conceptual knowledge and application <p><i>Main Question: What teaching methods or strategies do teachers commonly prefer to use in their teaching of mathematics?</i></p> <p><i>Follow up question: In your view are the strategies in accordance with the principles recommended in the CAPS curriculum guidelines?</i></p> <ul style="list-style-type: none"> • <i>Affirmed teachers’ confidence and active engagement in decision making about suitable teaching and learning strategies the selection of teaching and the HOD flexibility about teachers’ choice of teaching strategies.</i> 	2	40%	<p>“At circuit yes, The advantage we have is that businesses around our town are supportive and the science centre of the neighbouring university do assist our teachers in the Mathematics and Science.</p>

			<p>working and the arrangement are in place to deliver children to their homes”</p> <p>“ in our school all Heads of Department have to write quarterly reports on learner performance. This makes me to be with teachers quit often to discuss learner performance, assessment and to moderate learners’ marks “</p>
<p>5. Collaborative effort by HMDs and teachers to conduct various forms of assessment to identify, diagnose learners’ barriers to the learning of mathematics concepts, skills and practices</p> <ul style="list-style-type: none"> ○ Adequacy of mechanisms used by Heads of department to share information with teachers. accessibility of facilities and resource material ○ resilience of the HMDs in attending to teachers concerns about classroom practices ○ willingness of the HMDs to take initiative to demonstrate teaching strategies, assessment procedure for teachers, leading by example on matters regarding organisation and planning of teaching and learning activities <p>Main Question: <i>which mechanism or procedure do you encourage teachers in your department to use for the purpose of identifying learners barriers to learning mathematical knowledge and skills.</i></p> <ul style="list-style-type: none"> ● <i>affirmation of resilience of HMD to engage teachers in the all forms of assessment to identify learners who experience difficulties with conceptual knowledge and application of numerical skills</i> ● <i>Unclear about HMD resilience to initiate collaborative effort to conduct diagnostic assessments and planning of activities to assist learners with learning difficulties.</i> 	<p>2</p> <p>1</p>	<p>40%</p> <p>20%</p>	<p>“ It is true that mathematics teacher work hard to assist learners who experience gaps in the knowledge of mathematics from previous grades , for instance Foundation Phase.</p> <p>Learners who have been taught in their mother tongue (IsiZulu) take time to adjust to English medium of instruction. In foundation Phase concepts such as: multiplication is known to learners as Ukuphindaphinda”</p>

<ul style="list-style-type: none"> ○ <i>Confusing of diagnostic assessment with daily class activities based on textbooks and learners' book</i> 	2	40%	<p>and divide as ukuhlukanisa, subtraction as ukususa.. This are the issues that we deal with in our meeting and lessons development at the beginning of each term.</p> <p>The main challenge we are facing like all township and may be rural schools is the shortage of qualified teacher of intermediate phase and I overcrowded classes.... The combinations of learners with different abilities is another challenges for teachers</p>
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Case Study C: Participants from the township schools(n=6)			
Themes	Range (n-6)	Range	Exemplar utterances
<p><i>1. Provision of professional support and guidance</i></p> <ul style="list-style-type: none"> ○ Role of head of department in assisting teachers to Interpret aims of teaching and learning Mathematics in intermediate phase ○ <p><i>Main Question: When designing you school based teaching and learning schedules what do you use as the source of reference? (Is it curriculum guidelines? Or textbooks?)</i></p> <p><i>Follow question</i> <i>Which source do you use for selecting the specific aims of Mathematics Curriculum?</i></p> <ul style="list-style-type: none"> ● <i>demonstrated no clue of understanding the importance of aims of the mathematics curriculum</i> ● <i>demonstrated understanding of the existence of the general aim but not in the context of specific aims for the CAPS mathematics for intermediate phase</i> 	<p>4</p> <p>2</p>	<p>66.6%</p> <p>33.3%</p>	<p>“the teachers are experienced now , they have been attending workshops on CAPS”</p> <p>“the textbooks and learner books are very clear about what teacher should teach and learner should know and do in each term”</p> <p>“The aim is the same as learning outcomes. If teacher understand the importance of learning outcomes that means they know the aim. My duty is to make sure that learners are taught and assessed”</p> <p>“I think it is important to know the general aim of the syllabus, because they are generic, but it is not something that we and teacher worry about.”</p>

<p>2. Collegial and collaborative engagement of teachers in curriculum and planning of subject content knowledge</p> <ul style="list-style-type: none"> Collegial and collaborative approaches of the HMDs to engage and involve teachers in professional development programmes for effective implementation of proposed teaching and learning strategies. <p>Main Questions: <i>How do you manage to involve teachers of mathematics under your guidance to plan and organise content and learning support material?</i> Follow up question: <i>what is your experience in doing this?</i></p> <ul style="list-style-type: none"> <i>Affirmed collaborations and collegial engagement</i> <i>Indication of challenges and no concern about collegial and collaborative engagement</i> <i>Indication of concern about collegiality and collaboration but with resistance</i> 	<p>4</p> <p>1</p> <p>1</p>	<p>66.6%</p> <p>16.6%</p> <p>16.6%</p>	<p>“ I work harmoniously with my staff. We have a culture of sharing information in the meeting about challenges and difficulties we have in classes.”</p> <p>“I have noticed that mathematics teachers who were trained prior to the democracy are more committed to work than these young mathematics teachers.”</p> <p>“no matter what you tell these teacher does not make any difference because they do what they are accustomed to.”</p> <p>“Some teachers are open to learn new things but some are very stubborn....and, so what can you say? The unions are there to protect them</p>
<p>3. Teachers’ confidence to make in put in the selection of strategies of teaching and learning</p> <ul style="list-style-type: none"> Appraisal and reward for good practice Encouraging teachers to apply their creativity and innovative strategies which advance learners performance in demonstrating mathematical conceptual knowledge and application <p>Main Question: <i>What teaching methods or strategies do teachers commonly prefer to use in their teaching of mathematics?</i> Follow up question: <i>In you view are the strategies in accordance with the principles recommended in the CAPS curriculum guidelines?</i></p> <ul style="list-style-type: none"> <i>Affirmed teachers’ confidence and active engagement in decision making about suitable teaching and learning strategies the selection of teaching and the HMD flexibility about teachers’</i> 	<p>3</p>	<p>50%</p>	<p>“Well, the circuit subject committee had asked HOD’s to identify good teachers of mathematics in their schools. There are yearly awards given to those teachers. So I do encourage them to work hard for those awards”</p> <p>“Yes, the non-governmental organisations such CASME had encourage mathematics teacher to take part in training workshops. Those teacher are the ones who apply new teaching methods and share knowledge with the members of the department”</p>

			<p>them.</p> <p>I do address parents about this challenge, but the thing is, they say, they are working; children stay with grandparents and helpers.</p>
<p>5. Collaborative effort by HMDs and teachers to conduct various forms of assessment to identify, diagnose learners' barriers to the learning of mathematics concepts, skills and practices</p> <ul style="list-style-type: none"> ○ Adequacy of mechanisms used by Heads of department to share information with teachers ○ accessibility of facilities and resource material ○ Resilience of the HMDs in attending to teachers concerns about classroom practices ○ willingness of the HODs to take initiative to demonstrate teaching strategies, assessment procedure for teachers, leading by example on matters regarding organisation and planning of teaching and learning activities <p>Main Question: <i>which mechanism or procedure do you encourage teachers in your department to use for the purpose of identifying learners barriers to learning mathematical knowledge and skills.</i></p> <ul style="list-style-type: none"> ● <i>affirmation of resilience of HMD to engage teachers in the all forms of assessment to identify learners who experience difficulties with conceptual knowledge and application of numerical skills</i> ● <i>Unclear about HMD resilience to initiate collaborative effort to conduct diagnostic assessments and planning of activities to assist learners with learning difficulties.</i> ○ <i>Confusing of diagnostic assessment with daily class activities based on textbooks and learners' book</i> 			
	2	33.3%	"We in our schools mostly in rural areas we do not have resources except counters, charts and learner books."
	2	33.3%	"Even though we know learners' problems in mathematics learning, the issue of overcrowded classrooms cannot be solved by the head of departments"
	2	33.3%	"The main issue to me is the lack of parental involvement. Teacher cannot do anything if learners do not do daily homework to test their knowledge. Teacher cannot

			under the circumstance of large classes attend to each learner. Teacher do share problem with me but there is nothing one can do to solve some challenges”
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Figure 5.2.6.1: a frequency distribution table presenting the themes and the range of responses with convergent perceptions. (n=6)

5.3 Teacher of Mathematics’ perspective of the instructional role of the heads of department

The analysis of the raw data gathered from teacher by means of questionnaire was summarised into the descriptive statistics and is presented in the frequency distribution tables. The participants used the Likert scale to respond to the closed-ended questions and statement.

The bar chart presents the summary of data on the representative of gender in the sample of mathematics teacher in the sample.

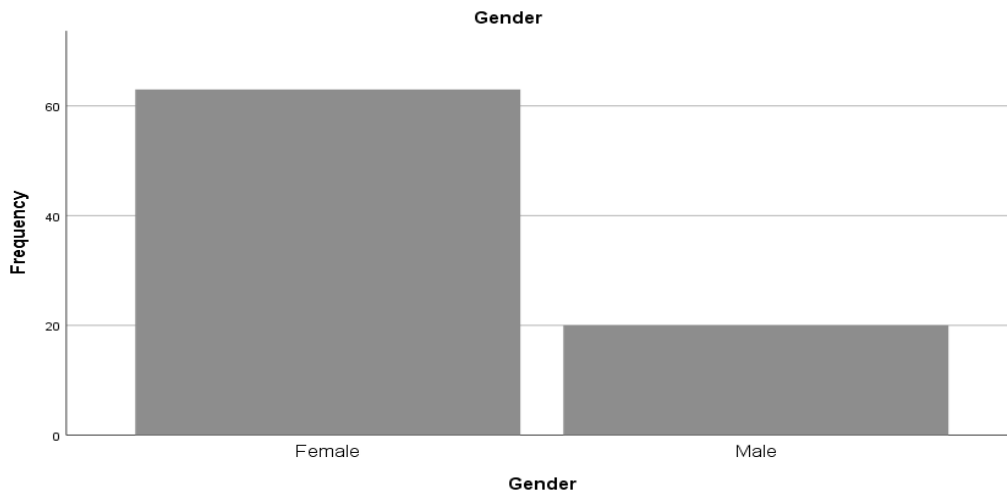


Figure 5.3.1: a bar chart displaying the gender representativeness in the sample of eighty-three mathematics teachers.

The bar chart presents the summary of information provided by participants on the highest professional qualification in Mathematics.

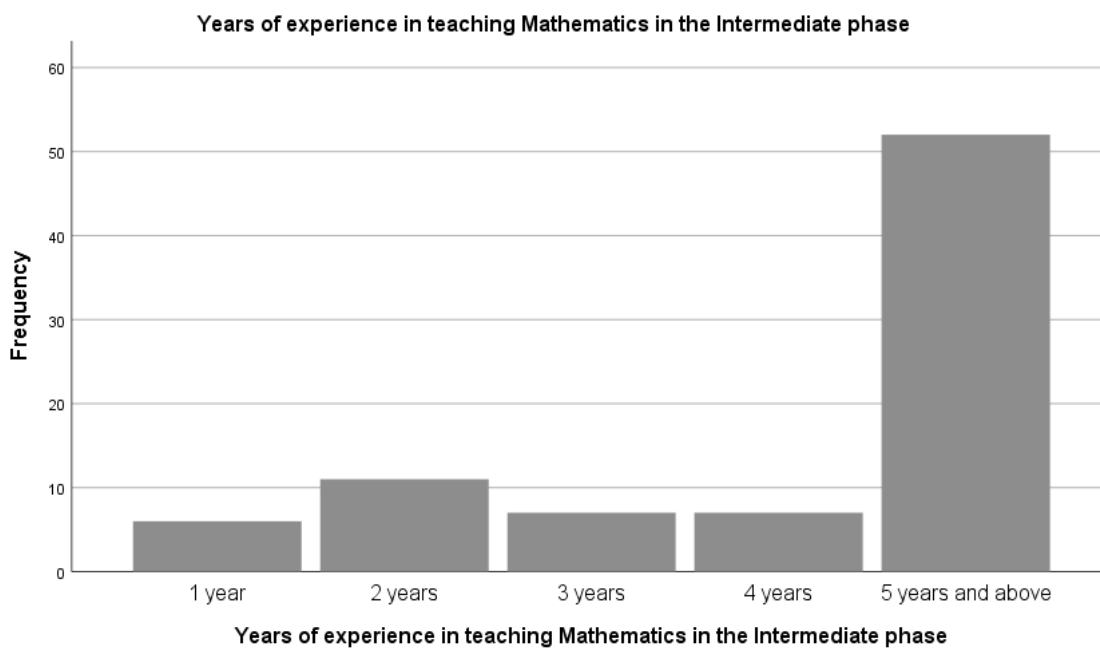


Figure 5.3.2 a bar chart indicating the years of experience of the mathematics teacher in the sample

Bar charts representing data on teachers' of Mathematics perceptions of the role of the heads' of department in organising professional development activities in their schools. According to the (ELRC 2001: c36) head of department have to support teachers on matters related to classroom practice,(n=83)

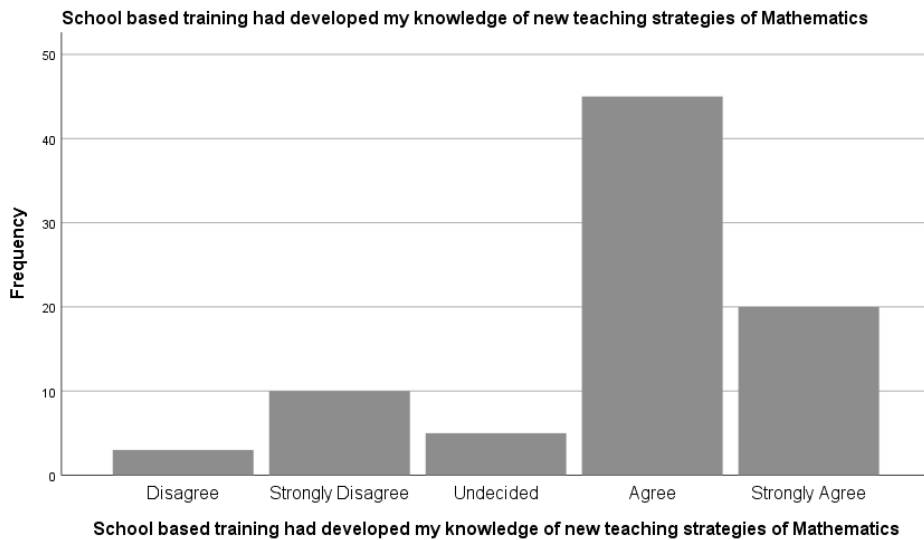


Figure 5.3.3A Bar chart representing the teachers' perceptions on the accessibility of heads of mathematics department regarding learner-centred teaching and learning strategies recommended in the mathematics curriculum guidelines (CAPS: 8) (n=83)

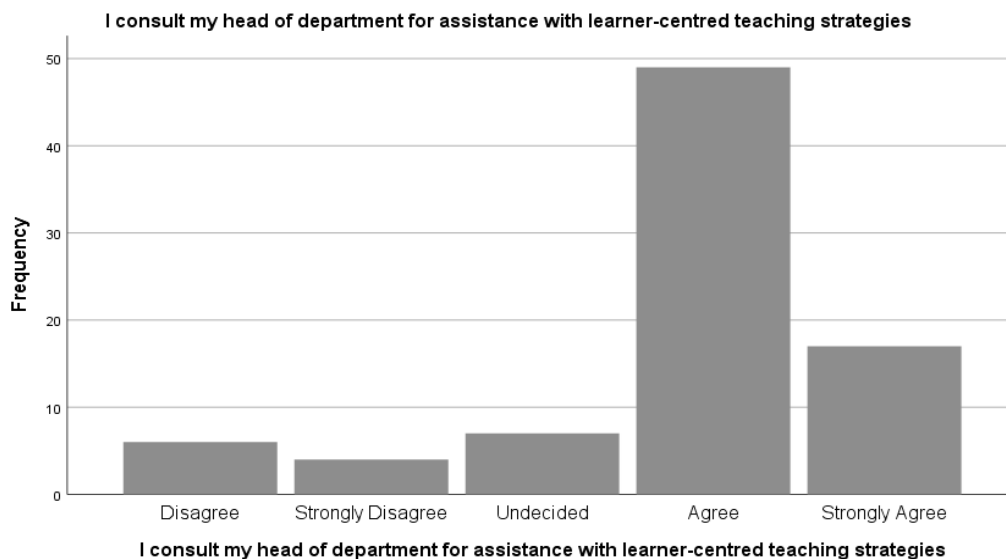


Figure 5.3.4: A bar chart presenting the summary of data on teacher of mathematics views about the role of the heads of mathematics department in providing support, mentoring and guidance to ensure that learners with learning difficulties in mathematics receive adequate assistance to improve their performance.(n=83)

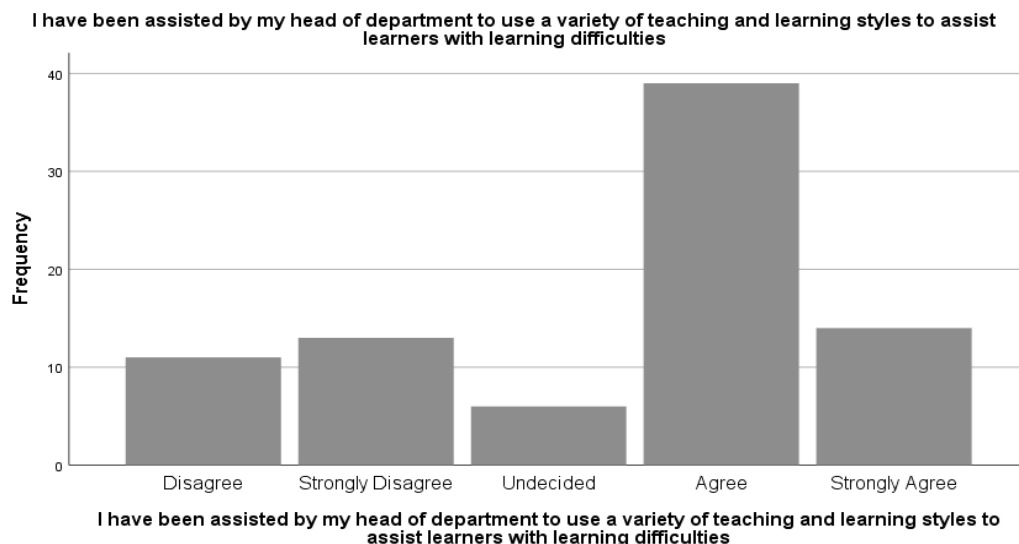


Figure 5.3.5A bar chart representing a summary of data about how teachers perceived of the value of guidance and support proffered by HMDs in teaching mathematics content knowledge to intermediate phase learners(n=83)

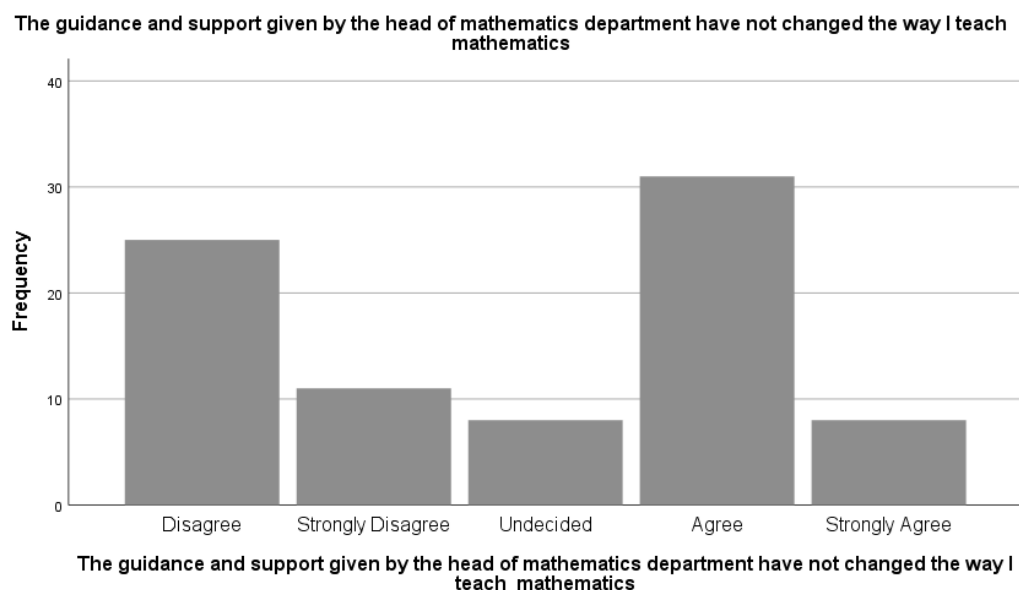


Figure 5.3.6A bar chart representing a summary of data on teachers' reflections on the value of the role of HMDs to persuade and supervise the implementation of curriculum innovations in mathematics classroom practice



Figure 5.3.7A bar chart representing a summary of data on teachers' evaluation of the competence of HMDs to select suitable teaching strategies for teaching mathematics knowledge and skills to intermediate learners(n=83).

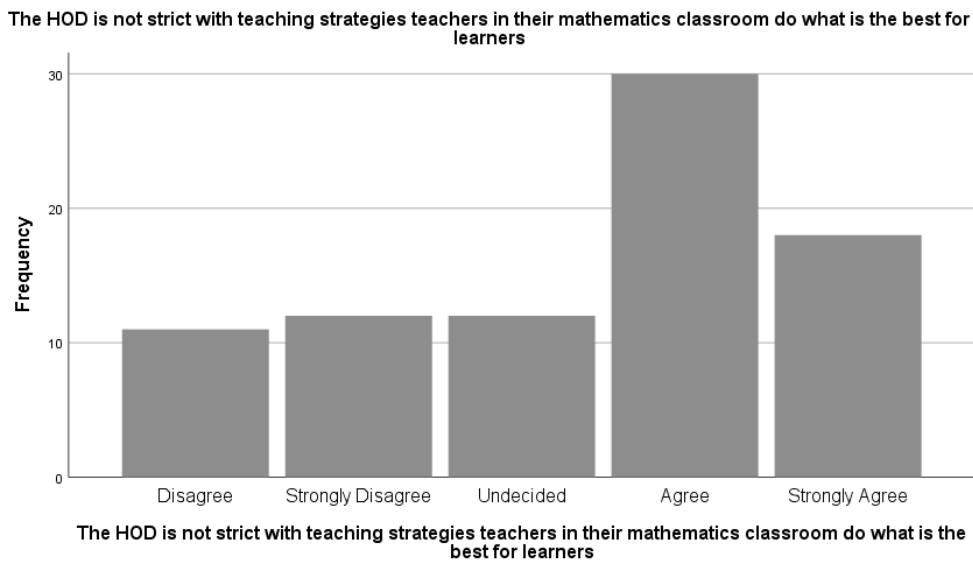


Figure 5.3.8A bar chart representing a summary of data about teachers' views on the competence of HMDs to create an environment for creative teaching and for innovative teaching in mathematics classes.

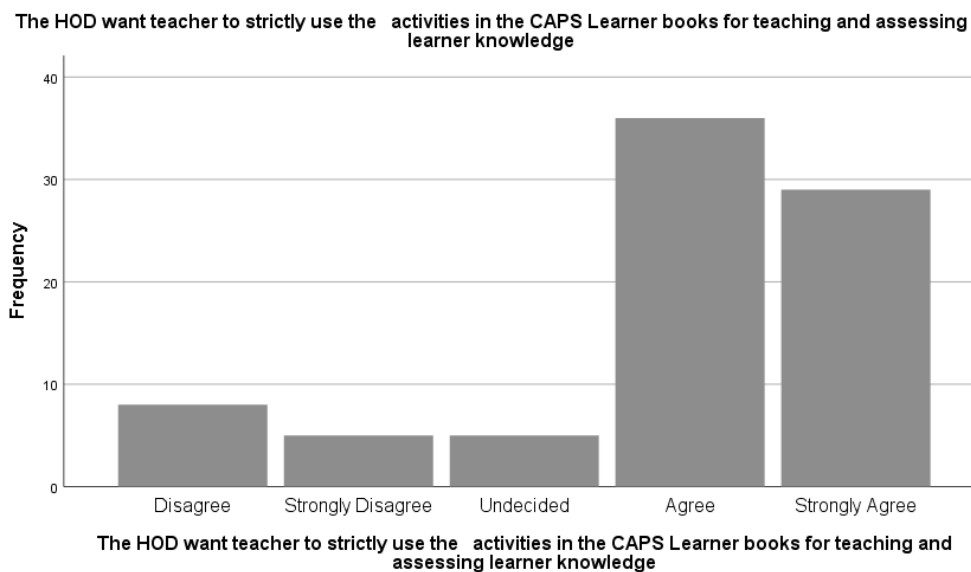


Figure 5.3.9A bar graph representing a summary of data about how teachers perceived of the instructional leadership style of HMDs and their ability to acknowledge teachers' competence in pedagogical content knowledge.(n=83)

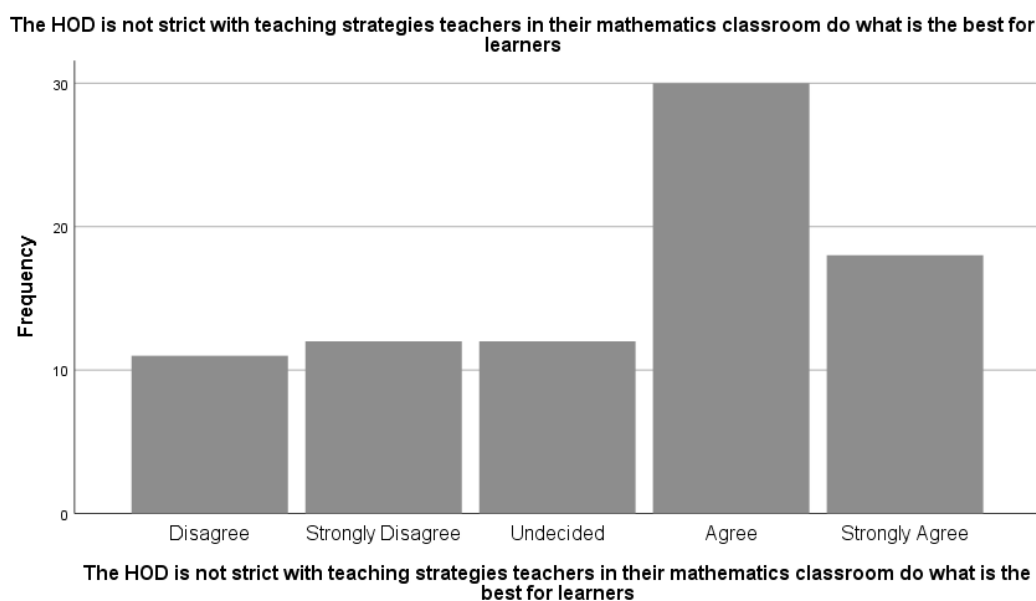
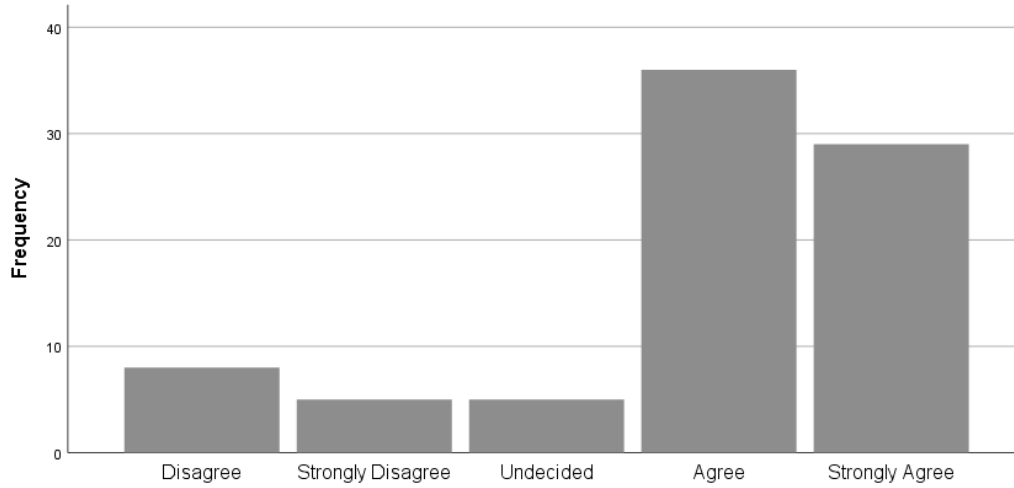


Figure 5.3.10A bar chart representing a summary of data about teachers' assessment of the proclivity of HMDs to prescribe books and book-based learning and assessment activities

The HOD want teacher to strictly use the activities in the CAPS Learner books for teaching and assessing learner knowledge



The HOD want teacher to strictly use the activities in the CAPS Learner books for teaching and assessing learner knowledge

5.4. Analysis of Data gathered qualitatively from participant teachers of Mathematics in the intermediate phase-in the focus group

5.4.1. Case Study A: Participants: Mathematics Teachers from rural areas

Table below representing the frequency in the data elicited from mathematics teachers on their perspective of the effectiveness of the instructional role played by HMDs in rural schools. The categories indicate the themes identified from the ELRC, 2006:c36.

categories	Range (n-15)	Range %	Exemplar utterances from teacher of mathematics
<p>1. Provision of professional support and guidance</p> <ul style="list-style-type: none"> ▪ Role of head of department in assisting teachers to Interpret aims of teaching and learning Mathematics in intermediate phase <p>Question: Have you considered the specific aim of Mathematics in the CAPS curriculum guideline of any importance in you development and planning teaching and learning activities? How does your HMD ensure that you implement it in your practice?</p> <ul style="list-style-type: none"> ▪ <i>affirmation</i> ▪ <i>Rejection with uncertainty</i> ▪ <i>Complete rejection</i> 	<p>3</p> <p>6</p> <p>6</p>	<p>20%</p> <p>40%</p> <p>40%</p>	<p>“ heads of the department are busy with office work and they are supposed to teach like us”</p> <p>“The aim is the same as learning outcomes. If teacher understand the importance of learning outcomes that means they know the aim. My duty is to make sure that learners are taught and assessed”</p> <p>“I think it is important to know the general aim of the syllabus, because they are generic, but it is not something that we and teacher worry about.”</p>
<p>2.Collegial and collaborative engagement of teachers in curriculum and planning of subject content knowledge</p> <ul style="list-style-type: none"> ▪ Collegial and collaborative approaches of the HMDs to engage and involve teachers in professional development programmes for effective 			

<p>implementation of proposed teaching and learning strategies.</p> <p>Question: <i>How is the planning and development of teaching, learning and assessment coordinated and supervised by your head of department?</i></p> <ul style="list-style-type: none"> ▪ <i>affirmation</i> ▪ <i>Rejection with not clear explanations</i> ▪ <i>Complete rejection</i> • <i>Confirmation but with excuses</i> 	<p>3</p> <p>6</p> <p>3</p> <p>3</p>	<p>20%</p> <p>40%</p> <p>20%</p> <p>20%</p>	<p>“... the head of department tries her level best but the challenges are the shortage of budget to by us learning support material. Although our HOD is a science person she does listen to us when we report challenges.</p> <p>“Mathematics teachers in this school are privileged because we have Wi Fi, so we download materials like worksheets for our learner. So we do not rely on the HOD because they are also teaching their classes technology and natural science”</p> <p>“Our head of departments do guide new teachers and give experience duties to assist one another”</p> <p>“ We, teachers are open to learning new things but the problem is time because HOD have classes to teach</p>
<p>3 Teachers’ confidence to make in put in the selection of strategies of teaching and learning</p> <ul style="list-style-type: none"> • Appraisal and reward for good practice • Encouraging teachers to apply their creativity and innovative strategies which advance learners performance in demonstrating mathematical conceptual knowledge and application <p>Question: <i>Is it acceptable in your department to apply any teaching strategies besides those approved by the heads of department?</i></p> <ul style="list-style-type: none"> ▪ <i>affirmation</i> 	<p>6</p>	<p>(40%)</p>	<p>“Yes, actually we theorise a lot about the strategies. From my many years of experience I have produce good mathematics learners, using the same methods such as; drill methods for</p>

<ul style="list-style-type: none"> ▪ <i>Rejection with uncertainty</i> ▪ <i>Complete rejection</i> 	<p>4</p> <p>5</p>	<p>(27%)</p> <p>(33%)</p>	<p>teaching multiplication for instance. Learners should memorised the table, mental mathematics”</p> <p>“ I was fortunate to participate in the non-governmental organisations called CASME to understand other strategies of teaching mathematics. The HOD does encourage us to attend district training workshops.</p> <p>It is difficult to use one method for all learners to learn mathematics concepts and application. Some learners find difficulties to work sums and products of multiplication from their heads. For instead the breaking down of number, some learners have to see the teacher demonstrating the breaking of the numbers using objects, diagrams before they could practice it on their own. “</p>
<p>4. Freedom of teachers to share their own views regarding learners who experience learning difficulties in mathematics</p> <ul style="list-style-type: none"> ▪ Accessibility of the heads of department ▪ Commitment of HMDs to providing satisfactory attention to teachers opinions and suggestions to benefit learners acquisition and development of skills <p><i>Question: Are your suggestions regarding learners with learning barriers in mathematics acceptable or rejected by you HOD?</i></p> <p><i>Have you experienced any problem with your HMD when sharing your views and opinions regarding teaching strategies in your department?</i></p> <ul style="list-style-type: none"> ▪ Confirmation ▪ Confirmation with reservation ▪ Rejection with uncertainty ▪ Complete rejection 	<p>3</p> <p>5</p> <p>4</p> <p>3</p>	<p>20%</p> <p>33%</p> <p>27%</p> <p>20%</p>	<p>“ We do not rely much on the head of department for assistance but sometimes we share views among ourselves. Some of us are good in ICT. They know Apps that are good to explain teaching some concepts and skills. For instance’ ‘factorising’ and long division”</p> <p>“during our department meeting we all share our experiences and difficulties about learners who are failing to cope with mathematics”</p> <p>I do report cases of children who fail to cope with the grade five’s work to the HOD.</p> <p>His advices sometimes help but not to all learners. He is not opposed to my own ways of solving the problem. In fact our HOD is flexible because he understands the challenges of teaching in rural areas</p> <p>... The issue of parents and homework, some learners especially those from parents who are not numerical literate are the ones who are struggling.</p>

<ul style="list-style-type: none"> ▪ <i>Complete rejection</i> 	2	<p>learners with hopeless performance in subjects like mathematics to proceed to the next grade or phase. In my understanding we are teaching grade five and six Mathematics to children who cannot perform grade 2 and 3 work. So... that is our problem. The solution is to get expertise and time to re-teach and remedial classes and extra teachers.</p> <p>Yes it true that the main issue to is the lack of parental involvement. I cannot do anything if learners do not do daily homework to test their knowledge. In my opinion it is impossible for us working under these conditions of large classes, limited resources to attend to each learner. Even the HOD in my opinion cannot do anything if children do not have support from home”</p>
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5.2.3 Case study B: Participants (mathematics teachers) from township schools

Table representing the frequency in the data elicited from mathematics teachers on their perspective of the effectiveness of the instructional role played by HMDs in so-called township schools. The categories indicate the themes identified from the (ELRC, 2006:c36)

categories	Range (n-15)	Range %	Exemplar utterances from teacher of mathematics
<p>1. Provision of professional support and guidance</p> <ul style="list-style-type: none"> ▪ Role of head of department in assisting teachers to Interpret aims of teaching and learning Mathematics in intermediate phase <p>Question: <i>Have you considered the specific aim of Mathematics in the CAPS curriculum guideline of any importance in you development and planning teaching and learning activities? How does your HOD ensure that you</i></p>			

<ul style="list-style-type: none"> ▪ <i>Rejection with uncertainty</i> ▪ <i>Complete rejection</i> 	<p>4</p> <p>5</p>	<p>(27%)</p> <p>(33%)</p>	<p>for years</p> <p>I for instance have taught mathematics in this phase for many years of experience I have produce good mathematics learners, using the same methods such as; drilling methods for teaching multiplication, for instance learners should master the table through memorising the table, mental mathematics” ...the HOD does not interfere with any ones’ teaching methods</p> <p>“Unfortunately we have different beliefs about best methods of teaching methods. From what we learned from training colleges and varsities about teaching mathematics to primary learners. Yes the different beliefs and practice are common. In my case I do not believe that mental exercises are not good for example many of the teachers do emphasise memorising, drilling, dramatisation and role playing whether the HOD says what I will not change from these methods.”</p> <p>“It is difficult to use a specific strategy or method for all learners to learn mathematics concepts and application. Some learners find difficulties to work sums and products of multiplication from their heads. For instead the breaking down of number, some learners have to see the teacher demonstrating the breaking of the numbers using objects, diagrams before they could practice it on their own. “ our HODs does not bother telling us about this because it will never work”</p>
<p>4.Freedom of teachers to share their own views regarding learners who experience learning difficulties in mathematics</p> <ul style="list-style-type: none"> ▪ Accessibility of the heads of department ▪ Commitment of HMDs to providing satisfactory attention to teachers opinions 			

<p>and suggestions to benefit learners acquisition and development of skills</p> <p><i>Question: Are your suggestions regarding learners with learning barriers in mathematics acceptable or rejected by you HOD?</i></p> <p><i>Have you experienced any problem with your HMD when sharing your views and opinions regarding teaching strategies in your department?</i></p> <ul style="list-style-type: none"> ▪ <i>affirmation</i> ▪ <i>affirmation with reservation</i> ▪ <i>Rejection with uncertainty</i> ▪ <i>Complete rejection</i> 	<p>5</p> <p>3</p> <p>3</p> <p>4</p>	<p>33%</p> <p>20%</p> <p>20%</p> <p>27%</p>	<p>“ We do not rely much on the head of department for assistance but sometimes we share views among ourselves... “During our department meeting we all share our experiences and difficulties about learners who are failing to cope with mathematics”</p> <p>Some of us are good in ICT. They know Apps that are good to explain teaching some concepts and skills. For instance ‘factorising’ and long division”... If he, the HOD, is interested he accepts those exemplars.</p> <p>I do report cases of children who fail to cope with the grade five’s work to the HOD. His advices sometimes help but sometimes not to all learners. He is not opposed to my own ways of solving the problem.</p> <p>The HOD in our school calls meetings to share new circulars from the department and to present test time tables. I do not think there is anything she can do with failures in mathematics because some of these children failed mathematics in the previous grades.</p>
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<ul style="list-style-type: none"> ▪ <i>Rejection with uncertainty</i> 	4	(27%)	<p>only tell us to attend to them and nothing have changed.”</p> <p><i>(With groaning)</i>....Do not have extra-classes for learner who have barriers and as teacher and HOD we are not properly skilled to assist children who are of very low mathematical intelligence</p>
<ul style="list-style-type: none"> ▪ <i>Complete rejection</i> 	2	13%	<p>“The department should think again about learner progression from phase to phase. The issue of allowing learners with hopeless performance in subjects like mathematics to proceed to the next grade or phase is beyond the HODs powers. <i>(How does the HOD deal with this matter?)</i>...</p> <p><i>(With fury and frustration)</i> please do not get me wrong I do not blame HOD for this but in my understanding we are teaching grade five and six Mathematics to children who cannot perform grade 2 and 3 work. So... that is our problem. The solution is to get expertise and time to re-teach and remedial classes and extra teachers. Head of the department is not doing anything because it is the department of education who cause this mess for us teachers.</p> <p><i>(further elaboration)</i>...“It true that the main issue to is the lack of parental involvement. I cannot do anything if learners do not do daily homework to test their knowledge. In my opinion it is impossible for us working under these conditions of large classes, limited resources to attend to each learner. Even the HOD in my opinion cannot do anything if children do not have support from home”</p>

5.4.5 Case study C: participant mathematics teachers from urban areas

Table 5.4.3 presenting the frequency in the data elicited from mathematics teachers on the perspective of the effectiveness of the instructional role of HMDs in urban schools

categories	Range (n-15)	Range %	Exemplar utterances from teacher of mathematics
<p>1. Provision of professional support and guidance</p> <ul style="list-style-type: none"> ▪ Role of head of department in assisting teachers to Interpret aims of teaching and learning Mathematics in intermediate phase <p><i>Question: Have you considered the specific aim of Mathematics in the CAPS curriculum guideline of any importance in you development and planning teaching and learning activities? How does your HMD ensure that you implement it in your practice?</i></p> <ul style="list-style-type: none"> ▪ <i>affirmation</i> ▪ <i>Rejection with uncertainty</i> ▪ <i>Complete rejection</i> 	<p>5</p> <p>4</p> <p>6</p>	<p>33%</p> <p>(27%)</p> <p>(40%)</p>	<p>“ heads of the department do meet with us when there are new things or we need to change the way we do our work e.g. NCS to CAPS aims”</p> <p>They are busy with office work and they are supposed to teach like us. there are many, many things in these changes we are not sure about what was first and what is the last one</p> <p>“Certainly, the aim is the same as learning outcomes and that we know because we attended workshops for mathematics teachers in the circuit. The HOD wants us to teach and assess learners quarterly and submit marks when we should, the lesson plan have aims for the lesson. My duty is to make sure that learners are taught and assessed”</p>
<p>2.Collegial and collaborative engagement of teachers in curriculum and planning of subject content knowledge</p> <ul style="list-style-type: none"> ▪ Collegial and collaborative approaches of the HMDs to engage and involve teachers in professional development programmes for effective implementation of proposed teaching and learning strategies. <p><i>Question: How is the planning and development of teaching, learning and assessment coordinated and supervised by your head of department?</i></p> <ul style="list-style-type: none"> ▪ <i>affirmation</i> 	<p>7</p>	<p>47%</p>	<p>“the HOD supervise our work. At the beginning of the year we submit our scheming files for her to check if our topics for the lessons are same as</p>

<ul style="list-style-type: none"> ▪ Rejection with not clear explanations ▪ Complete rejection 	<p>3</p> <p>5</p>	<p>(20%)</p> <p>(33%)</p>	<p>those in CAPS document. Yes.. the dates for quarterly tests are provided to all of us in the department</p> <p>“...the HOD is not strict when it comes to teaching and learning material. Each one of us down load worksheet she/she wants from internet. The HOD promotes hard work and commitment in classroom teaching. Some of us use teachers’ guide to teach CAPS mathematics.</p> <p>“ We, teachers are open to learning new things but the problem is time because HOD have classes to teach his science and technology lessons. We only meet as a department to present mark schedules and preparation files</p>
<p>3 Teachers’ confidence to make in put in the selection of strategies of teaching and learning</p> <ul style="list-style-type: none"> • Encouraging teachers to apply their creativity and innovative strategies which advance learners performance in demonstrating mathematical conceptual knowledge and application <p><i>Question: Is it acceptable in your department to apply any teaching strategies besides those approved by the heads of department?</i></p> <ul style="list-style-type: none"> ▪ <i>affirmation</i> ▪ <i>Rejection with uncertainty</i> 	<p>6</p> <p>4</p>	<p>(40%)</p> <p>(27%)</p>	<p>“Sure! .. a great deal we do advise her that this learner –centred teaching strategies that are preached to us may be they work well in sophisticated communities not with the learners who do not have even a calculator. (<i>further elaboration</i>). We are still using what is available to us that benefit our kids to learn. As you see on my walls have charts with a multiplication table and diagrams of fractions. That is what the HOD supports so, I will say we do share similar understanding of what should be done</p> <p><i>(Confidently responded) ...“Yes, actually we theorise a lot about the strategies. From my many years of experience I have produce good</i></p>

<ul style="list-style-type: none"> ▪ <i>Complete rejection</i> 	5	(33%)	<p>mathematics learners, using the same methods such as; drill methods for teaching multiplication for instance. Learners should memorised the table, mental mathematics” The HOD have not said anything about it, he trust us in the work we do</p> <p><i>(With resentment)</i>. HODs are not solution givers to us. We only get instructions to do this and not to do this in this way....that is all they know. Our problem are our problem. We do not blame them because the subject advisors are demanding things from the HODs which they themselves fail to do (How do you this?)</p> <p><i>Confidently...</i>understand this, from OBE, to NCS and now CAPS, teachers had been accused for not doing enough –for instance, when learners fail to demonstrate literacy skills, numerical skills to who is the blame directed not HODs but teachers.</p>
<p>4.Freedom of teachers to share their own views regarding learners who experience learning difficulties in mathematics</p> <ul style="list-style-type: none"> ▪ Accessibility of the heads of department ▪ Commitment of HMDs to providing satisfactory attention to teachers opinions and suggestions to benefit learners acquisition and development of skills <p><i>Question: Are your suggestions regarding learners with learning barriers in mathematics acceptable or rejected by your HMD?</i></p> <p><i>Have you experienced any problem with your HMD when sharing your views and opinions regarding teaching strategies in your department?</i></p> <ul style="list-style-type: none"> ▪ <i>affirmation</i> 	3	20%	<p>“ Heads of department, like most of us are not specialist in this thing called inclusive education. Therefore each one of us deals with the problem in his or her own way, nonetheless we do share and assist one another as colleagues about better ways to assist certain types of learners (<i>Specifically, which method for what type?</i>)... Ok, there are learners who learn better when you demonstrate first by using various examples they are familiar with, for instance, fractions before they understand the diagram and</p>

<ul style="list-style-type: none"> ▪ <i>affirmation with reservation</i> ▪ <i>Rejection with uncertainty</i> ▪ <i>Complete rejection</i> 	<p>4</p> <p>5</p> <p>3</p>	<p>27%</p> <p>33%</p> <p>20%</p>	<p>mathematical symbols you cut either a paper sheet with them. For multiplication some learn better when you ask them to count the same group of items repeatedly from 2 times, 3 times, 4 times and write answers.</p> <p>“during our department meeting we all share our experiences and difficulties about learners who are failing to cope with mathematics” But it the HOD who share her own expertise, so we find solution to our problem on our own</p> <p>I do report cases of children who fail to cope with the grade five’s work to the HOD. His advices sometimes help but not to all learners. He is not opposed to my own ways of solving the problem.</p> <p>I rely on my colleagues for support with this problem because the HOD cannot do anything about the children who are not doing homework (<i>Taking time to ponder</i>). The issue of parents and homework, some learners especially those from parents who are not numerical literate are the ones who are struggling.</p>
<p>5. Collaborative effort by HMDs and teachers to conduct various forms of assessment to identify, diagnose learners’ barriers to the learning of mathematics concepts, skills and practices</p> <ul style="list-style-type: none"> ▪ Adequacy of mechanisms used by Heads of department to share information with teachers ▪ accessibility of facilities and resource material ▪ resilience of the HMDs in attending to teachers’ concerns about classroom practices ▪ willingness of the HMDs to take initiative to demonstrate teaching strategies, assessment procedure for teachers, leading by example on matters regarding organisation and planning of teaching and learning activities <p>Question: <i>Do you have an assessment policy in your department? What role does your HMD play in designing</i></p>			

<p><i>assessment activities to identify learners with knowledge gaps, learning difficulties in you assessment activities in your department?</i></p> <ul style="list-style-type: none"> ▪ <i>affirmation</i> ▪ <i>affirmation with reservation</i> ▪ <i>Rejection with certainty</i> 	<p>3</p> <p>5</p> <p>3</p>	<p>20%</p> <p>33%</p> <p>20%</p>	<p><i>(With certainty)</i>... The HOD has made us understand that he is an ordinary teacher, who happened to get the promotion to head the department. There are things that we teachers, need to rely on our experiences and knowledge about the classroom. However he encourages all of us to identify learners who experience problem with previous class work and try to fill the gaps in their knowledge and skills. He also supply us with material he happens to come across which he sees deemed necessary to assist us. We are appreciate that as teachers</p> <p><i>(With no complete confidence)</i>... Reasonable to say that HOD is more concerned about circulars from the circuit and district offices of the department of education. I cannot say that we have specific test to assess learners but we are informed by learners' performance in their monthly test and classroom activities about their levels of coping with the grade's work. I teach maths from grade four to six. <i>(Do you allow learners with knowledge gaps to proceed to the next grade? Or you do that with the approval of the HOD?)</i> If the learner has repeated the grade in a phase, the principle say that they should be condoned to the next grade, the HOD is compelled to do approve without argument.</p> <p>In my experience, I have not discussed anything about diagnostic test or seen the HOD demonstrating ways of identifying learners with learning barriers in mathematics. Mathematics is my subject and the HOD is more of a science person so, it could difficult to demonstrate strategies of teaching mathematics better that I do to assist learners in my class. He has never taught Mathematics and even at college he majored in Science and Technology, this is what he shares</p>
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<ul style="list-style-type: none"> ○ <i>Complete rejection</i> 	4	27%	<p>with me when we discuss issues related to teaching and learning of Mathematics.</p> <p>Knowing about learners with learning problem does not mean anything if there are no necessary resources in the school. Assessment is conducted every day through classroom activities. Our school does not have huge enrolment but to teach all level wherein there are learners are not coping. The HOD all what he knows is to blame me for not doing my work properly</p>
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5.5 Summary

In this chapter, the data collected by means of questionnaires from HMDs in rural, urban and so-called township schools were presented. The second set of data was obtained from teachers of mathematics in the same constituencies. The raw data, which were converted into descriptive statistics, are represented in the summaries contained in various frequency distribution tables and in figures, pie charts and bar charts. The categorisation of data was based on the focus of the questions, statements and the items listed on the closed-ended questions in the questionnaire. Qualitative data elicited from participants by means of in-depth interviews are presented under categorised themes. The summarised qualitative data provide the frequency of responses to the each of the questions set to individuals who participated in the sample. The qualitative data elicited from the HMDs in each focus group in the three case studies were analysed and classified under each category of themes identified from the guidelines on the instructional leadership duties and roles of HMDs in schools ELRC (2006: C36) and Mathematics Curriculum and Assessment Policy

guidelines (CAPS) (DBE, 2011). The following figures were developed to represent data related to HMD biographical data:

Figure 5.2.1.1: pie chart representing data on the representativeness of the participants in terms of gender; Figure 5.2.1.2: pie chart represents the participants' professional and academic qualifications; figure 5.2.1.3: represents the representativeness of the participants in accordance with their constituencies; rural, urban and so-called township schools.

Figure 5.2.1.4 is a pie chart representing a summary of data on the years of experience of HMDs in teaching Mathematics in the intermediate phase.

The set of descriptive statistical data from the closed –ended questions in the questionnaire is presented in the frequency distribution tables arranged in the following sequence in pages

Table 5.2.1.1 to table5.2.1.6 are the summaries of data on the HMDs' (n=38) views under the theme: *Engagement of teachers in planning and organising teaching and learning content in the intermediate phase.*

Table 5.2.3.1 to table 5.2.3.3 present summaries of the data on strategies adopted by HMDs in the sample to engage mathematics teachers in staff development activities (n=38) the theme used to organise the data is: *Approaches to staff development.*

Tables 5.2.4.1 to table 5.2.4.4 present summaries of data under the theme: *provision of guidance to teachers to select teaching strategies suitable for differentiated abilities in the learning of mathematics concepts and operations*

Table 5.2.5.1 to 5.2.5.7 present summaries of data under theme: *Styles of instructional leadership to promote cooperation, collaboration and collegiality in the department*

The data collected by means of qualitative and qualitative methods from teachers are summarised in the bar charts, which form part of this chapter. The summaries of data and the identified themes represented in this chapter are discussed in the next chapter. The interpretation of data and presentation of findings are based on the analysis presented in this chapter.

Chapter six: Interpretation of data; presentation and discussion of findings

6.1 Introduction

This chapter presents a summary of the findings; based upon results as presented in Chapter Five. Interpretations of the findings led to an identification of issues that provided answers to the research questions set for this investigation. The interpretation, discussions and synthesis of findings helped to define the attributes of HMDs in their instructional role; to ensure that teachers are adequately equipped to understand, implement and structure into lesson plans, the progressive ideas that underpin the espoused mathematics curriculum for intermediate phase classes under CAPS. A defining criterion for determining the effectiveness of HMDs was their competence to engage teachers in the designing and development of school-based learning programmes that focus upon essential mathematical skills. HMDs are tasked to implement teaching strategies that enable learners to apply mathematical knowledge in various real-life contexts. HMDs are expected to supervise and provide support to teachers' teaching and learning activities, support learning material: and ensure that assessment is conducted to determine: adequate levels of conceptual knowledge which include develop number concepts and mathematical vocabulary as well as adequate level skills and competences in the application of mathematical knowledge. This entails cognitive skills: communication, thinking, logic, reasoning investigating, analysing, representing posing and problem solving and interpretation of information (ELRC, 2003: 36) and DOE, 1998 and 2000).

6.2.1 Finding 1: Divergence in the views of the HMDs in terms of supervising school-based mathematics curriculum development

Case study A: 50% of participants in the sample of HMDs in a rural environment demonstrated to have no understanding of the aims of the CAPS mathematics curriculum. The data were elicited by means of a questionnaire:

“The aim is the same as learning outcomes. If teachers understand the importance of learning outcomes that means they know the aim. My duty is to make sure that learners are taught and assessed”:

“The teachers are experienced now; they have been attending workshops on CAPS”.

These comments demonstrated an understanding of the general aim but not a grounded knowledge of the specific aims for the CAPS mathematics for the intermediate phase.

50% of the textbooks and learner books are clear about what teachers should teach and learners should know and do in each term:

“I think it is important to know the general aim of the syllabus, because they are generic, but it is not something that we and teachers worry about.”

Case study B: *HMDs in the township schools demonstrated to have no clue of understanding the importance of aims of the mathematics curriculum⁶ (n=10).*

“The aim of teaching mathematics is what teachers should know because they are qualified in the teaching of the subject. I think what the HMD should do is supervise their lesson plans and teaching.

Data demonstrated understanding of the existence of the general aim but not the specific aims for the CAPS mathematics for intermediate phase 4.

“When teachers prepare their daily lessons, they are aware that the aim of teaching is to construct knowledge with learners. The department material helps us to understand what should be taught in each term. That helps us a lot. Sometimes teachers do not even bother about the aim written on the documents, I do not know whether to them it is important. They simply teach from the textbook. ... Ok... I told teachers to copy the specific aims for each from the department because they are readily provided in the CAPS document.”

Case study C: *Teachers demonstrated little understanding of the importance of the mathematics curriculum⁸ (80%)*

“The teachers are experienced now; they have been attending workshops on CAPS”:

“... the textbooks and learner books are very clear about what teachers should teach and learners should know and do in each term”.

These comments demonstrated an understanding of the existence of the general aim but not in the context of specific aims for the CAPS mathematics for intermediate phase^{20%} “.

The aim is the same as learning outcomes. If teachers understand the importance of learning outcomes that means they know the aim. My duty is to make sure that learners are taught and assessed”: “I think it is important to know the general aim of the syllabus, because they are generic, but it is not something that we and teachers worry about.”

6.2.2 Finding 2: Convergence in Mathematics teachers' perspective with regards to the role played by HMDs in providing support related to the implementation of the aim and differentiated learning styles.

Case study A: affirmation (40%).

“Heads of the department are busy with office work and they are supposed to teach.”

Rejection with uncertainty (27%)

“The aim is the same as learning outcomes. If teachers understand the importance of learning outcomes, that means they know the aim. My duty is to make sure that learners are taught and assessed”.

Complete rejection 20%. “I think it is important to know the general aim of the syllabus, because they are generic, but it is not something that we and teachers worry about.”

Case study B: affirmation 53%.

“I think it is important to know the general aim of the syllabus, because they are generic, but it is not something that we teachers worry about.”

Rejection with uncertainty 4

“The aim of the Mathematics lesson comes from the teacher who teaches the subject. Do you think HOD should tell us what the aim of each lesson should be? As long as we have books and teachers' guide supplied by the school to me is enough”

Complete rejection 3:

“I do not think we should worry the HOD about this. You must understand that in intermediate phase there is one HOD for Science and Mathematics, so our HOD is a Science and Technology person not much in Mathematics. At least she listens to us.”

Case study C: affirmation 53%

“Heads of the department do meet with us when there are new things or we need to change the way we do our work e.g. NCS to CAPS aims”

Rejection with uncertainty

“They are busy with office work and they are supposed to teach like us. There are many, many things in these changes we are not sure about what was first and what is the last one”

Complete rejection.

“Certainly, the aim is the same as learning outcomes and that we know because we attended workshops for mathematics teachers in the circuit”. The HOD wants us to teach and assess learners quarterly and submit marks when we should, the lesson plan has aims for the lesson. My duty is to make sure that learners are taught and assessed”

6.3 Interpretation of data and analysis of the findings

Findings 1: Inadequate interpretation of the philosophical paradigm for curriculum guidelines and limited understanding of fundamental principles

The role of the HMDs in the teaching, learning and assessment in the Mathematics department is to provide guidance and support to teachers with proper understanding of the importance of the aim of Mathematics curriculum in the intermediate phase of teaching and learning. According to Carl (2010) and Fullan (2001 and 2006) the school-based curriculum developers have to demonstrate competence in interpreting the aims and the principles underlying the espoused curriculum and be able to encapsulate these two essential pillars of curriculum in their learning programmes. According to the scholars in curriculum research, the aim of the curriculum is inherent in the philosophical paradigm, which dictates the learning outcomes, pedagogical approaches and assessment procedures (Ornstein & Hunkins, 2014; Carl, 2010 and Kelly, 2010).

The data elicited by means of questionnaires indicated that 63 % of the participants across the three case studies considered the aim to be of great importance in the planning and development of teaching and learning activities. 32% of the participants in the sample did not agree; meaning that they did not consider the aim to be of importance and 5% were not sure about the necessity of the aim in the planning of the teaching and learning activities. Similarly, the qualitative data highlighted divergence in the opinions of the participants in the focus group sample; the 50% of representatives from the rural schools, 60% from township schools and 80% from suburbs schools confirmed that the aim of the Mathematics curriculum and learning outcomes refer to the same thing.

The Educational Labour Relations Council (ELRC) (2003: 6) emphasises the importance of the role of HMDs in school-based curriculum development as it states: the heads of department should work collaboratively with teachers to design teaching

and learning policies in the phase and to guide teachers in prepare and organise learning programmes for the subject.

Implication:

This finding points to inadequate conceptualisation of the two concepts “*learning outcome*” and “*specific curriculum aim*” by HMDs. The Lack of essential knowledge among HMDs about performing their instructional leadership role effectively could imply that teachers who rely on these instructional leaders for guidance and support for understanding the paradigm shift in the teaching and learning of Mathematics could have limited conceptual and procedural knowledge of the professional practice required to implement innovations

Section 2 of CAPS DBE (2011:8) elaborates upon what the specific aims for grade four, five and six entail. The following are the key issues for curriculum implementers:

To develop a critical awareness of how mathematical relations are used in social, environment, cultural and economic relations;

to develop confidence and competence to deal with any mathematical situation without being hindered by fear of Mathematics,

to develop a spirit of curiosity and a love for Mathematics; recognition that Mathematics is a creative part of human activity; deep conceptual understanding in order to make sense of Mathematics and acquisition of specific knowledge and necessary for:

the application of Mathematics to physical, social and mathematical problems and the study of related subject matter as well.

The specific aims of teaching and learning of the Mathematics curriculum from the DBE (2011) perspective provided HODs with the premise or point of departure for

their schools-based curriculum development. According to Carl (2010:41) school-based curriculum development is the implementation phase which entails high teacher participation and proper orientation of teachers into issues of: planning content, learning and teaching support material and selection of relevant pedagogical strategies.

Designers and developers at national level point to the main issues in the planning and organisation of subject content knowledge. The specific aims of the Mathematics curriculum provide school-based curriculum developers with the direction for implementing philosophical and theoretical inclinations regarding preparation of teaching, learning and assessment activities. Inadequate interpretation of the aim of CAPS mathematics curriculum by HMDs compromised outcomes of the new curriculum.

Fullan (2006) emphasises that instructional leaders should, in consultation with teachers, identify teaching and learning support materials and teaching strategies for delivering the curriculum efficiently and effectively in classroom practice. Limited knowledge and inadequate interpretation of the curriculum policy guidelines were found to be threats facing the implementation of changes in the Mathematics curriculum; supporting the concerns highlighted by Seobi and Wood (2016) that HODs as instructional leaders struggled to interpret the transcripts of what they should do. According to DBE (2011) Mathematics teachers under the instructional leadership of the HMDs should align learning activities with adequate context, concepts, cognitive skills and applied abilities within the frameworks of the intermediate phase Mathematics curriculum specific aims. Teaching and learning should serve the aim of the curriculum. HMDs in their position of instructional leadership are called upon to supervise designing daily, weekly and quarterly

teaching, learning and assessment activities. This alignment should be approved and supervised by the HODs as overseers of curriculum implementation in classroom.

Finding 2: Uncertainty about capacity building programmes organised by HMDs

The ELRC (2003:36) states that HMDs should organise staff development programmes: the purpose is to provide teachers with on-going professional support and guidance. Fullan (2006) emphasises the importance of partnership and collegiality in the context of curriculum transformation. HMDs are expected to work collaboratively with teachers under their leadership to develop policies and programme to implement curriculum innovations. Carl (2010) indicates that the style of instructional leadership for effective collaborative engagement should avoid antagonism and resistance: consultative approaches and communication should be underpinned by democratic values such as acknowledgement, recognition and respect for one another. Zuber-Skerrit (2011) states that an instructional leadership style that embraces democratic values should ensure; equal opportunities, self-belonging and self-realisation in all collaborative and collegial engagements that sought to empower individuals in an organisation.

The data analysed by means of descriptive analysis indicated that participant HMDs confirmed that they organise continuous professional development of teachers: 81% (n=38) of the sample (see table: 5.2.3.1). Participants who did not confirm comprised 8%; and the undecided group comprised 11% of the sample. However, the contrast prevailed in data collected and analysed through qualitative means across the case three case studies presented in table: 5.2.6.1. Case studies participants A, B and C (70%) (n=30) confirmed that continuous professional development activities were in place for the purpose of Integrated Quality Management Systems (IQMS). Teachers'

perspectives in this regard indicated that 25% (n=83) of the sample confirm the effective operation of staff development activities in the schools; whereas 65% rejected the existence and the running of staff development activities, for instance, workshops and seminars. 10% of the participants in the sample were uncertain and could not distinguish between staff meetings and staff development programmes or activities.

Implications: There were contradictions between what HMDs claimed they did and what teachers observed HMDs not doing. HMDs often claimed that they organised school-based staff development activities. But teachers of Mathematics in the focus groups rejected the organisation of any such staff development programmes. In the context of this study, this contradiction between HMDs and teachers may be interpreted to suggest that both teachers and HMDs are uncertain about what continuous professional development entails or that they lied and were unwilling to launch such initiatives. This uncertainty or duplicity could imply an uncooperative spirit among HMDs to play their role as instructional leaders; to capacitate and engage teachers in critical issues pertaining to their daily classroom practice. This finding confirms a claim made by Seobi and Woods (2016:1) that HMDs have limited capacity ‘to foster the trusting relationship necessary for effective mentoring, coaching and teamwork essential for the provision of quality instructional support’. For the teaching and learning of Mathematics in intermediate phase, this finding could imply that teaching and learning in Mathematics classes will continue to be problematic as learners’ performance in mathematical conceptual, application skills and numerical literacy continues to decline. These worrying findings about the weaknesses among HMDs were confirmed by this research project.

Finding 3: Satisfactory support and guidance provided to Mathematics teachers with respect to differentiated learning styles and learning difficulties

Differentiated learning styles and individualised teaching are principles underlying the curriculum transformation in South Africa. The Curriculum guidelines of the DBE (2011) emphasise integration of teaching, learning and assessment. This principle should be embraced in the planning and scheduling of teaching, learning and assessment in a Mathematics department. According to DoE (2005) the assessment process should be purpose driven; assessment should be carefully planned and aligned with learning outcomes.

The principle of continuous assessment provides guidelines on how assessment should be conducted for various purposes: such as to determine the levels of readiness of learners for acquiring complex conceptual knowledge and cognitive skills, baseline assessment is recommended to identify what gaps or misconceptions learners may have in their prior knowledge. Baseline assessment is recommended by the designers of CAPS to characterise individual learners' learning styles and areas of difficulties in learning. The information gathered from this assessment informs the development of learning activities, teaching strategies and planning of learning support material. The importance of diagnostic assessment is proposed in the Mathematics curriculum guidelines BDE (2011) to be used in identifying barriers to acquisition of numerical literacy and mathematical conceptual knowledge as well as cognitive skills. Killen (2007) and Carl (2010) emphasise that assessment should be developmental and formative: since assessment is an integral part of teaching and learning.

Continuous assessment principles in the teaching and learning schedules for each grade in the intermediate phase are the responsibility of instructional leaders and HMDs. According to ELRC (2003) HMDs are required to supervise and monitor the

implementation of assessment policy in their schools. To do so, HMDs need to mentor and coach teachers on designing assessment activities that target suitable information about learners' abilities, skills and readiness to proceed from simple to complex Mathematical knowledge.

Interpretation of statistical data presented in tables 5.2. 3.2 have to do with the interventions of HMDs to address the issue of learning difficulties experienced by learners in mathematics classes. According to statistical data, 79% (n=38) of participant HMDs across the case studies claimed that learners with learning barriers received adequate support and serious attention within their departments. 21% in the sample admitted they were not competent to address learning barriers in the acquisition of mathematical knowledge and skills.

Quantitative data presented in bar chart form as figure: 5.3.5 show that participating HMDs do provide support to overcome learning barriers to mathematical knowledge experienced by learners in classrooms under their respective directions. Qualitative data highlight the threats that face effective implementation of remedial activities; listed in Table: 5.3.11. Confirmatory utterances included phrases such as: "*overcrowded classes*"; "*insufficient learning support material*", and "*lack of parental support and time constraints*".

Implications: This finding implies that participants in the sample groups of the study, both HMDs and teachers, understand the value of intervention activities to support learners and improve their performance in the learning of Mathematical knowledge and skills. The practical application of the ideas is threatened by insufficient physical resources and environmental issues; such as lack of parental support; in terms of homework which grants learners further practice of mathematical problem-solving

skills and mental calculations. 21% of the sample could be a small portion, but in this study the declaration of incompetence in providing guidance and support to teachers is perceived in this study to be critical. Participants under this category are instructional leaders who are not exceptional or exempt from the duties and responsibilities of HMDs.

The concerns expressed by participating HMDs as threats to the implementation of the remedial activities imply that, in spite of the stated determination of HMDs to provide extra support to learners with learning difficulties in mathematics learning in real terms nothing of significance transpired. The commitment and understanding of the value of the interventions is considered in this study to be a marginal indication of satisfactory instructional leadership practice (ZPD) (+zpa). Explaining abstract concepts via actual objects is an important principle of the Gestalt theory of learning Woolfolk (2014). Understanding this principle is important for HMDs and teachers: lessons must relate to the language, objects and parameters of the learners' natural environment; be it rich, poor, rural or urban. The context of learning activities for learning mathematics, according to Killen (2015), should enable learners to assign meaning to the physical and mental representation of the real world. Another important factor for the improvement of teaching mathematics conceptual knowledge understands that meaningful learning and learning for understanding is a process. The principle of scaffolding in Lev Vygotsky's social learning theory, points to the gradual development of cognition; at the foundation level is the sensory learning-perception and internalization of images. According to (Woolfolk, 2014: 238), Gestalt psychologists assert that, the features are organized into patterns, and the formation of patterns is facilitated by *a priori* knowledge, that is the knowledge that existed before formal instruction: word, pictures or images. The examples of figures that have

patterns in mathematics are commonly diagrams and concerned with aspects such as proximity, similarities and alignment between objects. For instance, in algebraic expression and geometrical patterns indicating proximity, the image of the clustered lines in a pattern of three enables learners to understand proximity and identify similarities. The emphasis upon visualization and diagrammatic learning styles in mathematics learning activities Mudaly (2013) and Giaquinto (2005) could indicate good practice.

Finding 4: Uncertainty about continuous professional development and support to implement recommended pedagogical strategies for Mathematical knowledge and specific skills

- Learner-centred strategies versus teacher-centred teaching strategies

Analysis of data highlighted similarities in the opinions and beliefs of HMDs and mathematics teachers about effective strategies for teaching and learning in the subject at the intermediate phase. Data presented in tables 1, 2,3 and 4 point to the degree to which HMDs and teachers in the sample group affirmed their adherence to teacher-centred teaching strategies.

Synthesis

- Divergence between philosophical and theoretical principles underpinning Mathematics curriculum change and HMDs practice of instructional leadership in schools.

Analysis of statistical data presented in tables 1,2,3,4 and 5 and qualitative analysis summarised in table 5.4.1, and 5.2.6.1 indicate that the instructional leadership roles of HMDs were often congruent with the abstractionist and absolutist schools. This finding points to the promotion of rote learning. 26percentage of HMDs in the sample

affirmed that drill methods are effective in the acquisition of mathematical concepts and application skills. HODs often showed a *laissez-faire* attitude to the selection of teaching and learning strategies; as confirmed in the data presented in tables 1,2,3 and 4 which indicate the non-compliance of HMDs in terms of CAPS requirements set out for HMDs. Such non-compliance, recalcitrance and even subversion in some cases manifest inadequate and limited support, and guidance to teachers to understand and to apply pragmatic strategies to the teaching and learning of Mathematics.

Implications: This finding indicates that HMDs in the sample were not adequately committed to lifelong learning, continuous professional development through engaging in research and reading about new developments and advancements in subject pedagogical knowledge.

Discussion: Synthesis of data and the findings show that the practice, philosophies of teaching and thinking of most of the HMDs and teachers surveyed in this project are starkly antipathetic to progressive scholars and researchers in Mathematics Education. Mudaly (2015), Spandaw (2009) and Galbraith (2007) propose alternative approaches that are inclined to Freirean priorities. Mudaly (2013) and Gaiquinto (2005) affirms that effective learning of mathematical concepts and skills requires active learner engagement through diagrammatic and visualisation presentations in class; to conceptualise mathematical knowledge and to construct their own understanding of reality.

Spandaw (2009) and Galbraith *et al.* (2007) emphasise modelling and application. This proposal resonates with the perspective of the designers of the national mathematics curriculum statement in terms of specific aims and skills. Golding (2002) and Galbraith *et al.* (2007) advocate contextualised teaching and learning of

mathematical conceptual knowledge, which this entails the solving of problems cited from the learners' real-world situation rather than based upon the abstract realm. Modelling teaching and learning strategies are elaborated upon in Killen (2015) and Blum *et al.* (2007) to involve; role-playing, inquiry-based case studies, problem-based learning and cooperative learning styles.

The synthesis of the findings confirms the claim in the work of Seobi and Woods (2016) that HMDs require support on issues of curriculum development and implementation; in order to execute their instructional leadership roles effectively. The adherence of HMDs and teachers to drill methods, memorization of multiplication tables and textbook-based learning of units in measurement suggest that HMDs surveyed in the sample groups did not provide teachers of mathematics with the necessary understanding of learner-centred teaching strategies. HMDs were by and large unable to interpret curriculum guidelines for mathematics in DBE (2011: 8-9) which states categorically that: learners should develop a critical awareness of how mathematical relations are used in social, environmental and cultural and economic relations; acquisition of mathematical skills and specific knowledge is necessary for application of mathematics to physical, social and economic problems.

This synthesis confirms that the data and the findings support the argument highlighted in the works of Vithal & Skovsmose 1997, Vithal, 2003 and Volmink, 2009 and other researchers that the teaching and learning of Mathematics is dominated by philosophical views and beliefs that are rooted in idealist and realist understanding of aims typical of pedagogy pre-1994. The utterances of HMDs in table (5.2.4.3) and mathematics teachers who participated in the sample groups substantiate outdated techniques for teaching mathematics were commonly employed at the schools in this

investigation: such as drill methods, reciting multiplication tables and rigid formulas based on textbooks for learning units in measurements.

- Congruence about how teachers perceived of strategies used by HMDs for effective implementation of CAPS curriculum guidelines

Data presented in figure 5.2.4.2 and tables 5.4.1, 5.4.2 and 5.4.3 affirm a certain agreement between the philosophical beliefs and theoretical principles that informed the instructional practices in the implementation of curriculum innovations in the intermediate phase. The Mathematics teachers' pedagogical approaches were commonly based upon the principle of the Gradual Release of Responsibility Model advocated by Spires & Stone (1989) and Pearson & Gallagher (1983). The qualitative statistical data and substantiating utterances presented in tables 5.2.6.1 and 5.2.6.2 indicate that HMDs approved of teaching strategies which are teacher-centred rather than learner-centred. Teachers and HODs in the sample groups believed that the teacher should play a maximum role in the transfer of learning concepts and application of numerical and mathematical knowledge. According to the Gradual Release of Responsibility model, modelling is about the exposition of conceptual knowledge and knowledge of application and that this zone is dominated by teachers; with minimum involvement of learners. Killen (2015) reiterates that teaching strategies that encapsulate the principles of GRR promote direct instruction, for example demonstration, telling methods, question, and answer.

Implications:

It was observed in this investigation that there was a certain indifference, resistance and even animosity in instructional leadership style among several HMDs. This

indifference is perceived in this study to be the source of non-conformity in the selection of teaching and learning strategies. Most HMDs surveyed in this project reverted, consciously or unconsciously, to the authoritarian, top-down models of pedagogy preferred by behaviourist educators of the pre-1994 era that promote maximum participation of the teacher in the acquisition of mathematical conceptual knowledge and specific skills proposed in the curriculum guidelines. The critical role of HMDs according to ELRC (2003) is to orientate teachers into the innovations introduced in the CAPS guidelines, and to monitor and mentor teachers in the adaptation of new teaching and learning strategies in their daily classroom practice. The fact that so many MHDs surveyed in this project did not respect the terms and ethos of CAPS could compromise and retard the transformation of Mathematics curriculum in the intermediate phase; contributing to a decline in learners' ability to demonstrate expected numerical skills, conceptual knowledge and cognitive competences.

Bonawitz *et al.* (2011) condemn the frequent use of direct instruction for creating the impression among learners that teachers alone are the fountains of knowledge; learners become too dependent upon teachers for solutions and answers. Constructivists prefer independence as a pedagogic mode: learners need to work out how to solve problems themselves, search for information and seek alternative means to prove the correctness of their thoughts and logic.

HMDs participating in this research project did not know that, by allowing teachers to adhere to direct instruction teaching strategies favoured in SA pre-1994, they allow a one-way communication which deprives the learners of opportunities to develop confidence and enthusiasm in learning independent mathematical knowledge and skills. Killen (2007) contends that knowledge acquisition for the effective

development of the entire learner in terms of cognitive domain, affective domain and psychomotor domain should encourage maximum participation or involvement of the learner in the learning activities. Killen (2015:97) emphasises that the attainment of the outcomes of the learning activities is determined by the opportunities and time given to learners to construct their own understanding of the context, content and concepts, and the skills and competences required for mastering these areas in the subject.

The findings point to the incapacity of HMDs to provide adequate instructional leadership on matters related to:

Developing school- based mathematics work schedules which reflect the consideration of the school environmental factors in terms of availability of teaching and learning support material, learners' diverse learning needs and the alignment of learning activities with the purposes of assessment activities;

Neglect to orientate teachers into learner-centred teaching strategies for the purpose of maximising learner-active participation in the process of acquiring mathematical conceptual knowledge such as: self-discovery learning, inquiry-learning and problem-solving;

Non-compliance to contextual learning of mathematical concepts and skills set out in CAPS points to inadequate instructional leadership practices;

Inadequate commitment and zeal demonstrated by HMDs in the sample to provide mentoring and coaching teachers in adapting alternative methods of teaching to benefit learners' acquisition of complex mathematical concepts;

- Inability of HMDs to provide for learners with learning difficulties.

The findings presented in this study resonate with some researchers' concern that outdated behaviourist modes of instruction inherited from segregationist, obedience education pre-1994 are returning to favour and being perpetuated in many classrooms in the South African context (Kriek and Grayson, 2009); contrary to the democratic vision of inclusive educational criteria mooted by CAPS. Politically, this relapse into behaviourist, teacher-centred, textbook-based education undermines the spirit of ubuntu; collegiality and egalitarianism aspired to by national leadership.

Finding 5: Confusion regarding the medium of instruction for teaching and learning conceptual knowledge in mathematics

Data highlighted divergence in the perceptions of the HMDs and those of the teachers on the issue of language of teaching and learning of mathematical concepts. The HMDs who indicated that teachers use English as Language of learning and teaching (LoLT) were in the majority (55%) compared to those who preferred mother tongues. The lack of uniformity about the medium of teaching and learning is viewed in this study to be the issue of concern. Further, the choice of the medium of teaching and learning in the department is part of curriculum policy in the department, and this is the responsibility of the HMDs to monitor and supervised lesson planning and to ensure that the subject language policy is applied in the teaching and learning of mathematics concepts. The intermediate phase learners are in the transition from Foundation phase to senior phase, therefore the issue of the medium have to be aligned with further learning in the subject (DHET, 2011).

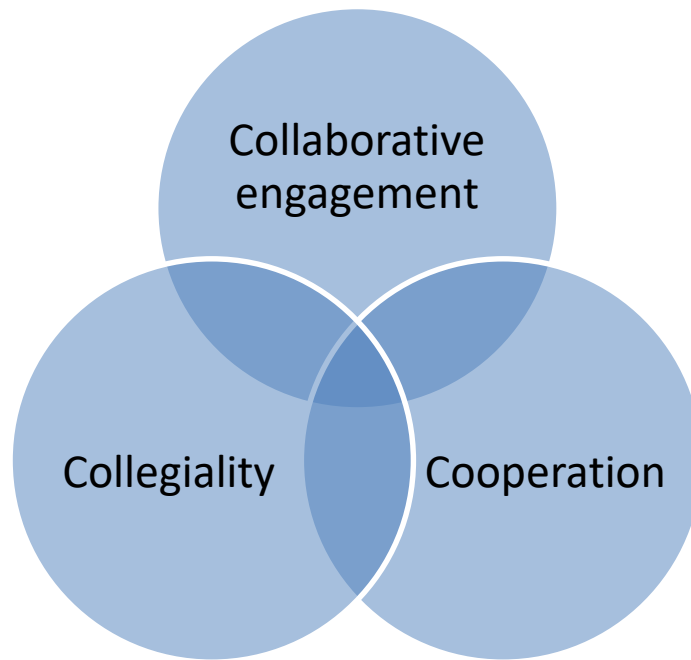
The issues of the language and socio-cultural learning is emphasised in Vygotsy's theory. The principle of effective learning of conceptual knowledge in the subject or phenomenon is determined by the socio-cultural environment and language. The

synthesis of the finding about the medium of instruction could have implication in the development of learners' conceptual knowledge in mathematics. Vygotsky theory recommends that application of conceptual knowledge depend of the mastery of language (Woolfok, 2010). It is on this ground that this study considers the non-compliance of the HMDs' instructional leadership with the innovations of the national mathematics curriculum developers. According to Curriculum and Assessment Policy, DoE (2011) teaching and learning of mathematics curriculum at intermediate phase grades should enable learners to acquire a repertoire of mathematical concepts and the knowledge of applications of concepts in various socio-cultural context.

Interpretation of data and findings within Valsiner's zones theory:

Analysis of data elicited by means of close-ended questionnaires from Mathematics teachers intended to identify strengths and weakness in the practices of instructional leadership roles of HMDs. Socio-cultural learning theory and Valsiner's zones theory were the lenses used to understand the working relations between mathematics teachers and their supervisors and mentors; in the context of curriculum transformation in schools. Senge's five disciplines were incorporated into this analysis in order to determine how HMDs conceptualise of their instructional leadership roles in the processes of implementing curriculum change.

- Findings in relation to the *zone of Proximal development (ZPD) in instructional leadership*



These three pillars are the determinants of the environment conducive to knowledge sharing and socio-cultural learning. The promotion of *collegiality* among staff members by the HMDs shows the good practice of instructional leadership. Fullan (2006) emphasises that effective curriculum implementation requires teachers and instructional leaders to share a common vision of what ought to be achieved in improving teaching and learning; to ensure that learners achieve maximum performance in the subject. Ornstein and Hunkins (2014) state that collegiality and partnership among the staff members in school reduces chances of resistance to change.

The ELRC (2003: 6) stipulates that HMDs should promote collegiality in their departments in matters concerning; decision-making about teaching, learning and assessment policies. The statistical data in table: 5.2.5.3 indicate that in a sample of (=38) there were 26 participating HMDs (76%) who affirmed that were compliant with the departmental policies on teaching, learning and assessment. This finding

point to the positive practice of the instructional leadership role; confirmed by mathematics teachers in the sample (=83) in the data summarised in the bar chart presented as figure: 5.3.8.

Researchers in curriculum implementation (Carl, 2010, Fullan, 2006, Grundy, 1990 and Null, 2009) recommend cooperation as a component socio-cultural learning. According to Carl (2010) instructional leaders have to demonstrate competence in winning everyone involved in the curriculum development and implementation in school through motivation, encouragement and support. Fullan (2006) recommends partnership between teachers and instructional leaders: respect, recognition and openness. The instructional leaders in this sense do not pose as authorities over teachers as instructors but rather compassionate coaches and mentors with good listening and communication skills. Statistical data in table: 5.2.5.1 indicate that, of the HMDs in the sample (=38), the majority of 32 (84%) participants affirmed that mathematics teachers cooperated in staff development activities in the department. This was confirmed by the mathematics teachers in the bar chart (figure: 5.3.3) who strongly expressed that they benefited from the school-based workshops organised in their departments.

Collaboration is recommended by researchers in curriculum implementation for creating an atmosphere of acceptance, creative thinking and teamwork and trust which is required to motivate and encourage everyone to make contributions in the process of articulating policies in a department. According to Vygotsky, social learning theory collaboration enables participants to share experiences, knowledge and expertise necessary for capacity building and cognitive development. Affirmation of the prevalence of collaboration and teamwork under the leadership of the mathematics HMDs is highlighted in the summary of statistical data in table 5.2.5.2 and table

5.2.5.1. Teachers and HMDs in his study claimed that they worked as partners and that every decision taken was debated before being accepted by all teachers in the mathematics department.

- Findings in relation to the *zone of promote action (ZPA)* in instructional leadership in the implementation of Mathematics curriculum

The category of findings that confirmed the competence of the heads of mathematics department to perform the duties and responsibilities of instructional leadership in their departments were classified under the zone of performance action (+zpa).

The key performance areas tested under this category in the empirical study were competences of HMDs to:

- Support mathematics teachers to implement the principle of differentiated learning in the mathematics classes by aligning learning activities with learners' diverse abilities;
- to develop assessment activities for continuous assessment which entails identifying mathematical content knowledge that learners find difficulty mastering; so that alternative strategies can be devised in the remedial teaching;
- to mentor and coach mathematics teachers to organise learning activities that stimulate learners understand various socio-economic contexts from which learners can draw upon for their mathematical conceptual development.

The heads of mathematics department in the sample indicated that, despite challenges, there were remedial actions taken to address barriers to mathematics learning experienced by underperforming learners. There were participants who mentioned the importance of the using physical objects when illustrating and demonstrating certain content knowledge to learners. This practice suggested and recommended by proponents of modelling, diagrammatic and visualisation of mathematics content knowledge to facilitate acquisition of conceptual and procedural knowledge in mathematics lessons (Galbraith *et al.* 2007; Spandaw, 2009, Niss *et al.*, 2007 and Mudaly, 2013).

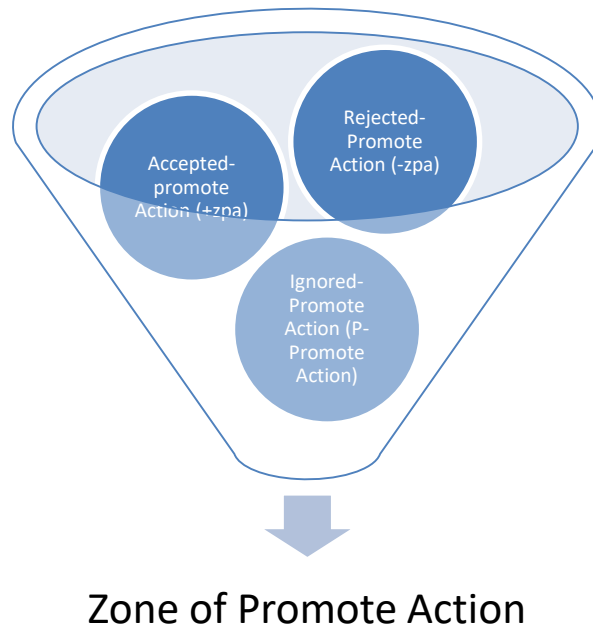
The interpretations of the finding in the context of the zones of theory indicated that knowledge and skills (problem-solving, logic and critical thinking). Killen (2015) emphasises that effective acquisition of mathematical skills requires:

- Identification of the relevant contexts
- Careful selection of visual or physical entities, which should form the source of reference in the classroom.

Mudaly (2013) suggests the visualisation and diagrammatic learning style to assist learners to develop critical thinking skills as they construct their own understanding of abstract mathematical concepts in various real-life world contexts.

Statistical data in tables 5.4.1, 5.4.2 and 5.4.3 establish certain contradictions about the competence in the practices of instructional leadership in the mathematics department represented in the sample. Teachers of mathematics' utterances point to the challenges that hinder implementation of principles of differentiated learning, addressing learners with learning barriers in mathematics classes and alignment of learning activities with assessment activities during planning of learning content.

Analysis of such contradictions in data was read in terms of the zone of promotion action [as adopted by Blanton's interpretation] which allowed the classification of action as follows:



The findings that indicate positive implementation are classified under the *Accepted-promote action (+zpa)* formula. The fact that participant HMDs and Mathematics teachers comprehended the importance of remedial activities for underperforming learners in mathematics was considered as a positive indicator for compliance with CAPS prerogatives.

The views expressed by teachers of mathematics on the issue of parental involvement pointed to an understanding of the value of parents in every learner's performance.

Evidence that important aspects of classroom practice to promote effective teaching and learning in the practices of instructional leadership by HMDs were being neglected, was classified under rejection of action (R-promotion Action) (-zpa). The statistical data in tables 5.2.4.3 and 5.2.4.4 and bar charts figures 5.2.3.3 and 5.2.3.4

indicate that HMDs rejected learner-centred approaches. There was strong evidence in this research of (i) limited support to teachers to understand the importance of maximising active participation in learning activities and (ii) little encouragement of teachers to apply their discretion in the selection of teaching and learning strategies; as presented in statistical data in tables: 5.2.4.4 and 5.2.4.3 and figures: 5.3.6; 5.3.8; 5.3.9 and the summary of qualitative data in tables 5.2.6.1, 5.2.6.2 and 5.2.6.3.

Indifference to the importance of CAPS curriculum guidelines to provide teachers with the proper paradigm for designing and developing learning activities and selection of teaching strategies, is interpreted as rejection of promotion action: teachers did not receive support and guidance to implement transformation in the teaching and learning of mathematical knowledge and skills in this phase. This non-compliance with the vision and ethos of CAPS could have adverse implications for learners in the acquisition of cognitive skills and conceptual knowledge needed to improve performance in mathematics, such flagrant indifference and inattention retards the development of learners' competences in more complex skills and knowledge in mathematics. This finding points to the incapacity of mathematics teachers to design learning activities within the frameworks of the CAPS policy guidelines highlighted in Graven and Lerman (2003); Graven (2004) and the Centre for Development Enterprise (2013). Teachers surveyed in this project generally relapsed into old modes of behaviourist pedagogy such as textbook-based learning and assessment activities; this reversion to pre-1994 modes of obedience learning was confirmed by several HMDs. These reactionary tendencies are shown in figure 5.3.10 and table 5.4.1. Such obstinate and uncritical return to outdated pedagogy is evidence of rejection of promotion action (-zpa). According to Killen (2012) and Carl (2010) it is the responsibility of teachers to develop learning activities, which integrate the

immediate community and landscape of learners to enhance learning of mathematical conceptual knowledge and skills. In a profoundly Freirean way, learners' prior knowledge can be employed to construct a vital and authentic understanding of introduced mathematical content knowledge and diverse learning abilities in learning mathematical concepts and skills (Fejes & Nicoll, 2008:43). Uncertainty about the planning of continuous assessment for purposes of identifying baselines and finding out the nature of difficulties to learning of mathematical knowledge (diagnostic) was highlighted in the data elicited by means of qualitative tools and presented in the descriptive statistics in figure 5.3.9 and tables 5.2.1.8, 5.4.1; 5.4.2; 5.4.3 and 5.2.4.1.

- Findings in relation to the *zone of free movement (ZFM)* in instructional leadership in the implementation of mathematics curriculum guidelines

The zone of free movement in the context of instructional leadership in departments of Mathematics in school is associated with the creation of a teaching environment conducive to creative thinking, sharing of innovative information about Mathematical subject pedagogical knowledge and the subject content. Teachers are exposed to educational media on internet websites such as Google, YouTube, Gmail and Chrome and in sophisticated technology such as computers and iPhones. The free movement zone suggests recognition of mathematics teachers in the department as qualified academics and professional individuals in the subject. Such teachers need to be allowed to reflect on their own experimentation of alternative strategies of teaching mathematics such as the use of technology to enhance learning of mathematical knowledge: as shown in tables 5.2.4.4; 5.2.6.1 and 5.2.6.2 and figures: 5.3.6; 5.3.7; 5.3.8 and 5.3.9 which confirm that the practices of instructional leadership of HMDs

in the sample acknowledged and recognised mathematics teachers' competence in subject pedagogical content knowledge and of the subject content knowledge.

6.3 Conclusions and Recommendations

The synthesis of data and findings presented in chapter six highlighted the role of HMDs in the implementation of CAPS priorities. The argument presented in the discussion of the problem statement in chapter one highlighted that intermediate phase schooling in South Africa is crucial in the sense that it serves as a link between elementary level of learning of mathematical conceptual and procedural knowledge and skills and senior phase level. The intermediate phase is a transitional stage through which learners are prepared for complex mathematics content knowledge and skills which provide the base for further education and learning in grades ten, eleven and twelve. It is of the utmost importance that mathematics teachers and HMDs are fully apprised of the priorities, ethos and vision of the CAPS document for mathematics: such HMDs and teachers are in a critical position to promote the sort of imaginative, inclusive, democratic and critical, independent thinking that is so desperately needed at the intermediate phase.

Issue 1: lack of uniformity among HMDs regarding their instructional roles

The findings highlighted a divergence between HMDs. This study concluded that in general HMDs in this study did not fully or adequately understand the core functions of an instructional leader in facilitating implementation of CAPS curriculum changes in classroom practice. The limited understanding is concerning. HMDs should demonstrate knowledge of the necessary procedures to conduct assessment for purposes of identifying challenges leading to underperformance of learners in all intermediate phase grades in order for them to provide mentoring and coaching to teachers.

Recommendation: This study recommends in-service training for HMDs to bring them up to speed about CAPS curriculum compliance.

Issue 2: HMDs not specialised in Mathematics subject content knowledge and subject pedagogical content knowledge.

The findings highlighted that several HMDs were not mathematics teachers by profession and by knowledge specialisation. The findings pointed out that such lack of specialist knowledge posed a threat to adaptation of changes proposed in the CAPS curriculum guidelines in teaching and learning of Mathematics in the intermediate phase.

It is recommended that HMDs who are not specialists in the Mathematics curriculum should not be encouraged to lead departments. In terms of this study such under qualified individuals were unable to support and mentor mathematics teachers; their role became more management and administration focused. The concept of instructional leadership described by Fullan (2006), Soebi and Woods and (2016) and Educational Labour Relations council does not apply in this situation.

Recommendation: This study recommends that the appointment of teachers to the Mathematics instructional leadership position should be based on their competence in the subject content knowledge (SCK) and specialised pedagogical content knowledge of the intermediate phase. This recommendation is in keeping with the professional roles of educators stated in the Educators' Employment Act of 1998 (DoE, 1998). The act emphasises that teachers should be both phase specialists and subject specialists.

Issue3: Overcrowded classrooms and transfer of learners from one grade to the next grade with weak mastery of mathematical conceptual knowledge and skills are a threat to instructional leadership practices.

This study concluded that the performance of some HMDs was hampered by certain educational policies. The principle of promotion and progression forced HMDs and teachers to condone learners who repeated a grade in a phase; regardless of the under-performance in the current grade. It was shown in this study that earners who failed to master simple mathematical conceptual knowledge and skills in the previous grades were unduly promoted to the next level where they were expected to master complex mathematical skills. The result of this habit of promotion of learners is that learners underperform more and more, and teachers appear incompetent to teach the subject.

The findings in the study highlighted that this predicament of unwarranted promotion of learners from one grade to the next was a concern for both teachers and HMDs in the samples across the three case studies.

This research showed that overcrowded mathematics classrooms compromised effective teaching of mathematics.

Recommendation: This study suggests that unwarranted promotion of learners from one grade to the next should be left to the teachers and instructional leaders to decide on the mechanisms for handling summative results and to develop remedial programmes to assist learners to master areas of difficulty in the content and skills. This recommendation supports the principle underpinning Outcomes Based Education, which states that, all learners can learn and achieve the desired learning outcomes at a different pace and in this regard; time is not the factor to determine achievement of learning outcomes. This recommendation confirms the theory of Multiple Intelligence, which advocates, that learners' abilities in learning various subject depends of the intelligence.

Issue 4: Lack of clarity on the purpose of instructional leadership among Heads of Mathematics department in intermediate phase

Findings based on the data collected by questionnaire and interviews highlighted a perception of the role of the HMDs held by the teachers of mathematics in the sample, which indicated that heads of department are middle managers and administrators in schools. Similarly, the perception generated from the findings about continuous professional support of the HMDs portrayed the instructional leadership position to be administrative in terms of dispensing circular information to teachers, collecting learners' assessment records from teachers, supervising the daily routines of the school and supply available resources required. The perceptions of mathematics teachers highlighted in the findings regarding the heads of mathematics department confirmed the concerns raised by Mokhele and Jita (2010) which pointed to the inadequate commitment of supervisors and mentors to the continuous professional development programmes at school level. The challenges facing the heads of department highlighted by the findings prove that the Integrated Quality Management Systems (IQMS) is not yielding the positive results intended in the policy framework for continuous professional development of teachers. Findings highlighted that the HMDs do not have sufficient opportunities to organise school based workshops, seminars and reflection meetings because they are not specialist in Mathematics but they have to control other subjects which are: Natural Sciences and Technology in intermediate phase. This tendency is interpreted in the context of this study as the factors that need consideration if Mathematics teaching and learning is taken serious by national mathematics curriculum developers and curriculum advisory structures. The instructional leadership role of the HMDs could not be effective in terms of Mokhele and Jita (2010: 1763), who considered continuous

professional development to be about preparing practitioners adequately, in this instance mathematics teacher for intermediate phase, to improve their instructional and innovation in their professional. Jovanova and Mitkovska (2010) also regard the instructional role of the heads of department as critical, require determination, and focus in capacitating knowledge of mathematics and training teachers with new methods, techniques and approaches required in the changing world in their practice.

Recommendation: The problem statement of this study pointed out that teaching and learning of mathematics will not improve in South Africa, as along school based continuous professional development is not given serious consideration, particularly in schools situated in the disadvantaged communities. This study was conducted in three case studies and the study showed that the majority of participants in the circuit represented rural schools. This is an indication that circuits have more rural schools under their administration than urban schools. The historical background of apartheid education dispensation and its impact on the preparation of poor quality of mathematics curriculum for teacher education and training, is the rationale for the serious attention on school based continuous professional development for teachers.

This study recommends that the developers of mathematics curriculum at national level should form a cascading structure for the dissemination and adaptations which can operate interdependently with school administration and management organogram. The school based instructional leaders as part of the professional development structure at curriculum delivery level should be accountable not to the principal but to the curriculum cascading structure. In this sense accountability should be inclusive of all key performance areas of the HMDs, as well as creation of

links between mathematics teachers and development centres; and mathematics teachers and subject professional bodies.

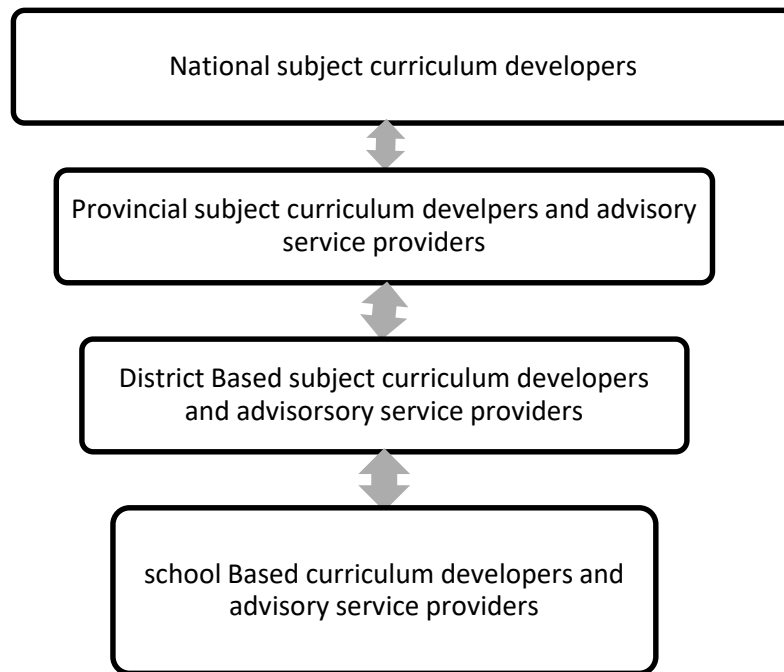


Figure 5: diagram showing the interaction in the hierarchical structure in the curriculum management and continuous professional development of mathematics teachers.

This diagram presents the hierarchical structure recommended by this study to monitor cascading and adaptation of instruction related innovation matters from national to schools.

This study further suggests that level of accountability on the adaptation process should be action research driven, and this imply that heads of mathematics department in collaboration with teachers should indicate the challenges they encounter in implementing innovation proposed by research in improving quality of teaching and learning of mathematics in early stages of schooling. This proposal is made in cognisance of the fact that the system of advisory services is currently in place, however, the ministerial report DBE (2008) pointed out that subject advisors at different levels: district and provincial or regional level are not always constantly

monitor and provide assistance to mathematics teachers. It is for this reason that this study emphasise the accountability of all professional structures involved in curriculum development, cascading and adaptation to report consistently on their operations. The question about the regress in the improvement of learner performance in Mathematics should be answered by this hierarchical structure, from bottom- up and up to bottom.

This study is of the view that through consistent support and mentoring of teachers, the quality of teaching and learning of mathematics could improve and the findings showed that there are shortcomings in the role of the HMDs to guide and support mathematics teachers. Mathematics teachers and the heads of mathematics department in the study, pointed out that curriculum management and instructional leadership role of the HMDs is hampered by their commitment to matters of school administration and management. This study recommends the delineation of the position of heads of department from school management and administration so that they could work directly with the curriculum managers at district level. The delivery of curriculum innovations and teacher continuous development programmes could be more efficient, and HMDs will not use excuses when required to account on their core duties and roles as school based curriculum managers. Delivery of curriculum according to Fullan (2011) is a process that involves planning, organisation of resources, engaging and consulting stakeholders: teachers, parents and head master in the development of the Mathematics curriculum; discussions and debates that lead to the development of school based curriculum policies, for instance, teaching and learning policy, assessment policy, remedial policy, language of teaching and learning policy and homework policy. Fullan (ibid) emphasise that teacher development programmes is an integral part of curriculum management and instructional leadership, in this aspect,

the important issue relates to the provision of orientation to teachers into the principles underpinning mathematics innovations regarding classroom practices, instructional intervention strategies, and assessment techniques as well.

Pundits in curriculum implementation and teacher empowerment Fullan (2006) and Carl (2005 and 2010) emphasise the significance of teacher empowerment when recommending that teachers should be lifelong learners in order to improve their subject content knowledge and pedagogy. The suggestion of this study adds to the views of Parker (2009) and Volmink (2009) that continuous professional development of teachers in South should capacitate teachers with academic knowledge in the subject and the pedagogical strategies

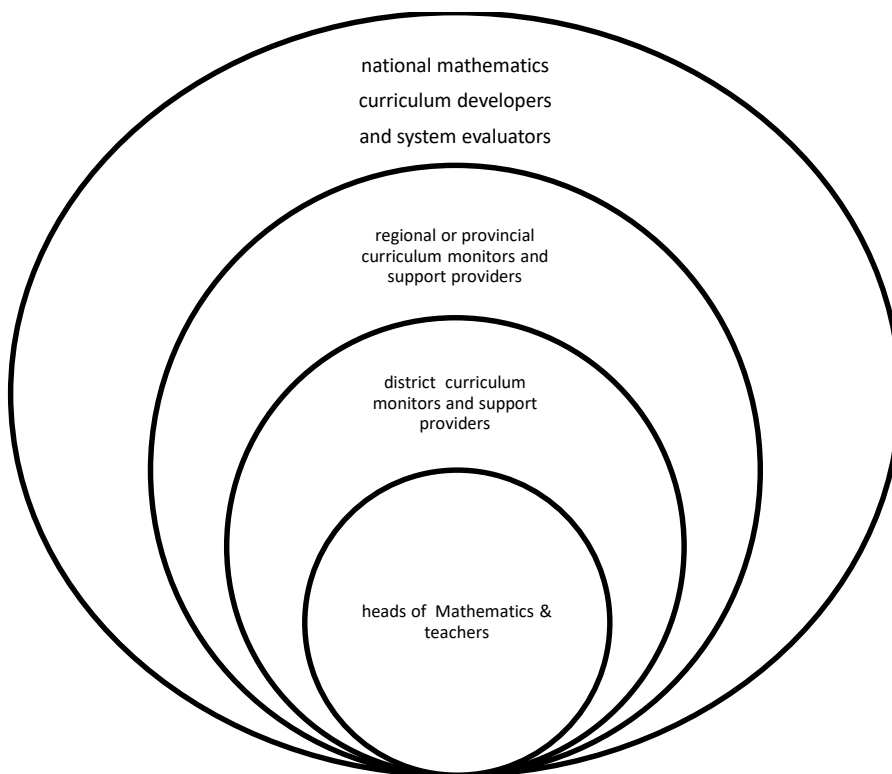


Figure 6: This diagram explains the hierarchical operation proposed for the consistent accountability in the teaching, learning and assessment of mathematics in early stages schooling.

The objectives stated in Chapter One highlighted that this study would from its findings establish the model for improving the school based instructional leadership. In this regard the study, has highlighted that the performance of HMDs in the aspect of mathematics teacher development, through collaborative engagement in curriculum development: according to Educational Labour relations Act (2003) and Norms and Standards for Educators NSE (1998) for teachers to be competent developers of learning programme, they have to be monitored, coached and supervised by the head of departments. It is this context that heads of department were expected to demonstrate their role as instructional leaders and experts in the subject and supervisors. The teachers' perspective of the heads of department interventions in instances of continuous assessment and assistance to learners with learning difficulties in learning mathematics conceptual knowledge and development of adequate cognitive skills highlighted that heads of departments in the sample were not playing effective role. The other critical issue was the teachers and heads of department interpretation of the Curriculum and Assessment Policy statement. Findings highlighted misconceptions of what heads of department and teachers understood to be the aim of the Mathematics curriculum, some teachers and heads of department could not differentiate between the learning outcomes and the aim. The statements uttered by participant from focus group referred to; the aim as a statement generated by the individual mathematics teacher from the topic of the lesson and therefore aims differ from teacher to teacher.

The lack of vision for the curriculum development and staff development programmes are interpreted within the Senge's Five Discipline of instructional leadership (Senge,2000): First discipline: *is to share a vision*. The finding about classroom practices indicated that some teachers did not take heed of the strategies suggested by

their heads of department. Similarly, heads of department endorsed the teacher view, as they said that teachers are at liberty to apply any pedagogical strategies and medium of instruction to teach mathematical concepts and skills. These findings highlight that department of mathematics represented in sample did not share a common vision about the innovative teaching and learning in mathematics classes as they required in their (2003) and DoE (1998) to: organise collaborative and collegial department meeting to discuss and develop policies. According to Senge's first discipline sharing the vision means collaboration in the development of goals by those involved in the project and the planning of activities to achieve those goals. The implication of the failure of the HMDs to share the vision of the department with teachers was evident in the lack of uniformity highlighted by the findings. The second discipline: *A mental model* was confirmed by findings, which indicated the divergence in the interpretation of Mathematics Curriculum and Assessment Policy. The beliefs, mind-sets and assumptions about teaching and learning of mathematical knowledge, which pointed to various mental models among the HDMs and teachers, manifested in the findings. Some heads of departments supported mathematics the application of behaviourist and absolutist philosophical beliefs on teaching and learning of mathematics, for instance total dependence on textbooks activities. This tendency of HMDs and teachers is provided the proof that Mathematical knowledge in early grades of schooling is taught out of the school socio-cultural context, and the repercussion of neglecting socio-cultural environment is rote learning, wherein learners memorised concepts and meaningless learning. Similarly, the adherence to textbook deprives learners in the early grades of learning mathematics the acquisition of logic and critical skills. According to Mudaly (2013), visualisation and diagrammatical approaches facilitate the learning of critical thinking skills and logic

as learners are engaged in active learning to produce their own knowledge in their own socio-cultural context.

The second discipline comprises *mental models*: beliefs, values, mind-sets and assumptions that determine the way teachers and heads of mathematics departments think and act. The shared vision and mental models complement each other, in the sense that, debates and discussion unleash divergent and convergent views, which in the end build a strong perspective, which manifests refined values, mind-sets, and beliefs about what ought to be done to implement changes in classroom practice. Carl (2010) claims that effective teaching and learning cannot be attained in an environment where there is a high degree of antagonism and lack of cooperation about what is to be taught and how it should be taught.

Interconnection of instructional leadership and continuous professional development in the school-based implementation of innovations to improve Mathematics teaching and learning

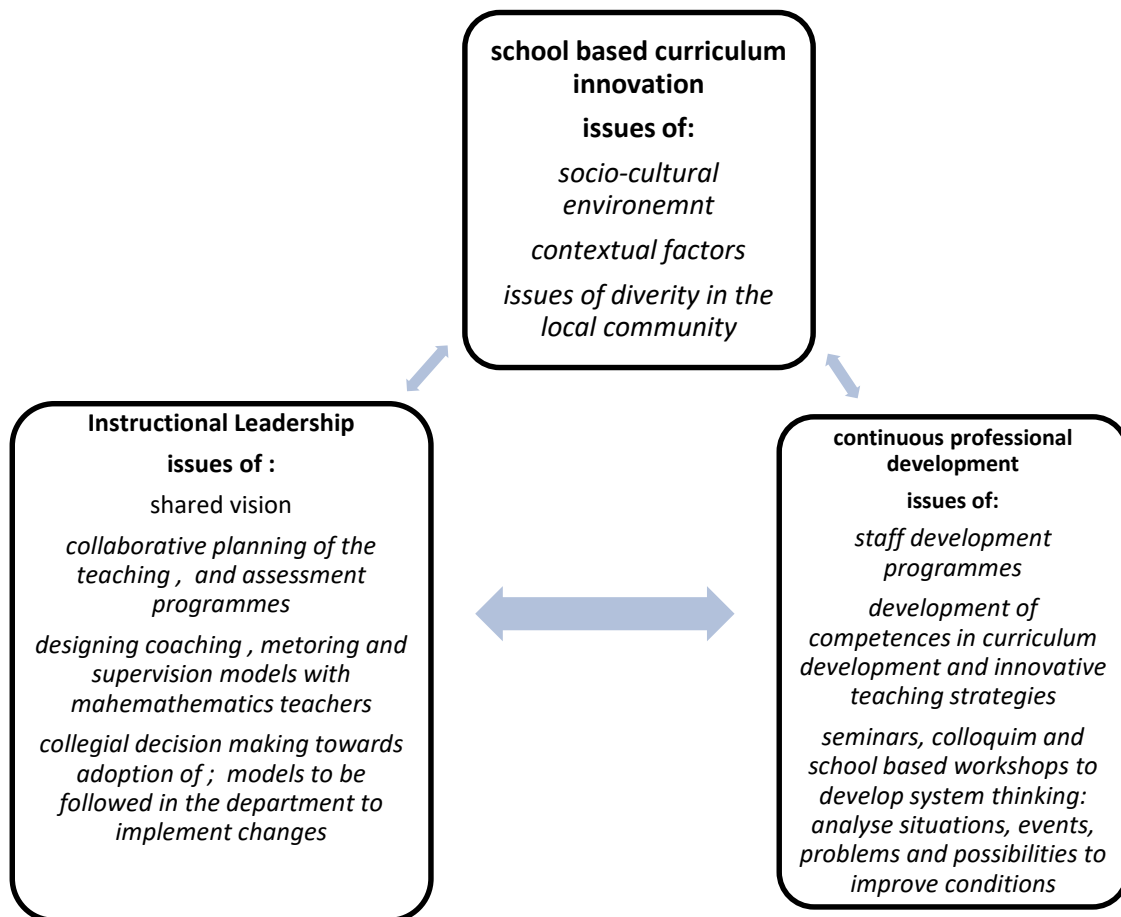


Figure 6: diagram explaining the critical issues identified from the findings within the conceptual and theoretical framework of the study.

This model together with the other two models presented in the work, focus on the areas highlighted by the findings that required attention in the role of the HMDS in order to improve school based instructional leadership for the continuous development of mathematics teachers. The role of the HMDs to capacitate teachers with the knowledge of curriculum innovations at school level is considered to be more critical in this study therefore HMDs hence this work recommend the position of the HMDs from the school management and administration. Heads of departments are regarded as curriculum managers and therefore they school be accountable to curriculum managers at district level, this model figure:

6.5 Summary

The discussions of findings and the interpretations of data highlighted the need for the collaborative intervention of the school-based instructional leaders and curriculum developers. HMDs surveyed in this study were not generally CAPS compliant. This is an issue of considerable concern and proof of a lamentable irresponsibility. This research highlighted that HODs and teachers were more textbook reliant and focusing on the curriculum guidelines. The dependence on the textbooks promotes teaching of mathematics concepts and skills out of context, which re-inscribes outmoded behaviourist pedagogies such as rote learning, rather than authentic ownership of new knowledge as preferred by the national policy in CAPS.

This study proposes the conceptual structure for providing curriculum development and implementation of innovation in the teaching, learning and assessment in mathematics

The conceptual definition of school based instructional leadership in the context of this study is, the localised subject advisory structure which operate in the school organogram to provide coaching, mentoring supervision development and nurturing in the teaching, learning and assessment of the subject.

It is recommended that HMDs be obliged to partake in programmes about their roles of instructional leadership and how best to focus upon collaborative partnerships with other stakeholders to improve curriculum delivery in classrooms.

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