Chapter two

LITERATURE REVIEW

2.1 Introduction

In this chapter, I discuss the relevant literature for understanding and exploring the research questions on clusters as discussed in chapter one. To recap, my study seeks to provide insights into the following research questions:

- What are the kinds of teacher clusters that operate in Mpumalanga and what is the nature of their formation?
- How do the clusters help science teachers to challenge and change their content knowledge (CK) in science?
- What is the nature of the resulting content knowledge (CK) and PCK and how is it used by teachers to shift their classroom practices in science?

In carrying out this literature review, I wanted first and foremost to find out what research has been done in the field of networking/clustering of teachers. This is primarily because, clusters have in the last few years, been regarded as one promising approach to teacher development (Lampert, 1988; Lieberman and Grolnick, 1996, Adams, 2000, Southwood, 2002). I was also interested to find out especially what research has been done in Africa and other developing countries on clusters.

In the second instance, my literature review was informed by the fact that this research study is situated in a broader context of an exploration of issues of teacher development, knowledge and what it takes for teachers to change their practices. Changing the teachers' classroom practices in science and mathematics involves, among others, changing the teachers' expertise in content knowledge and pedagogical content knowledge to allow for changes in the classroom practice (Spillane, 2000). This is a very difficult and challenging task in which many programs that are geared to teacher development have come short. In this chapter, I will then review the traditional and innovative approaches to teacher development that have been used to try and foster teacher change in science education. The focus on teacher clusters

/networks is also informed by the reality that such networks have been posited as an alternative approach to teacher development.

Furthermore, this, chapter focuses on a discussion of the literature that explores the nature of teachers' knowledge that is needed to change classroom practice. The first section of this chapter seeks to unpack in detail the concept of teacher knowledge as it forms the backbone of teaching and learning; and later issues of teacher development that are centred on this concept. The choice of this literature on teachers' knowledge for this study provided a useful conceptual framework that helped to frame the data collection and analysis of the various themes that emerged from this study.

In order to make sense of all this information, the chapter is divided into three sections that are directly related to my research questions:

- teachers' knowledge;
- teacher development approaches; and
- teacher clusters .

2.2 The meaning of knowledge as viewed by various researchers

Knowledge is a very complex concept that means different things to different people. Rathborne (1971) and Barth (1972) (as cited in Candy, 1991) argued that knowledge is idiosyncratically formed, individually conceived, fundamentally individualistic and that theoretically, no two people's knowledge can be the same, unless their experience is identical. For Candy (1991), while individually conceived knowledge is important, it becomes useful and effective if it socially shared and constructed in a community of people.

 Teachers' knowledge of practice is often socially constructed. The social construction of teachers' knowledge of practice is usually influenced by the environment, ethos and the culture of the school. As teachers we do not learn isolated facts and theories independently of the practices in which they arise. These practices may be work processes, experiments, arguments about theories or principles and the like. Teaching and learning is contextual. While the teachers are engaged in the same processes of teaching and learning, their experiences that form part of their knowledge

base are therefore different. And while as individuals their different life experiences in the teaching profession are valuable, but they become more valuable when they are shared, critically examined and used to construct general knowledge of and about practice. This constitutes what Shulman (1987) talks about as pedagogical content knowledge (PCK). "Pedagogical content knowledge is a special amalgam of content and pedagogy that is uniquely the province of teachers" (Shulman, 1987:8). Effective science teaching combines many elements to engage students in learning. In order to achieve this expertise of effective teaching, teachers must therefore know more than science content and more than just some teaching strategies.

2.2.1 Content Knowledge (CK) and Pedagogical Content Knowledge (PCK)

To teach science effectively, teachers require relevant insights into science as explored by the experts and scholars (Guskey, 1986; Fullan, 2001), and this is where the gap of teacher development has been identified. These knowledge insights are based on content knowledge (CK) and the Pedagogical Content Knowledge (PCK). It is my view that, traditional approaches to teacher development that separate the teachers' classroom experience and the content knowledge have discouraged teachers from active participation in enhancing their CK and PCK.

A number of researchers on teacher knowledge have also explored the notion of different types of teacher knowledge. In his search for the expert pedagogue, Berliner (1988) made it clear that teaching in the classroom is based on a genuine scholarship practice. This genuine scholarship practice is based on knowledge. The word, "knowledge" has been defined differently by different researchers in education (Cochran-Smith and Lytle, 1999; Connelly and Clandinin, 2000). Their definitions of knowledge and distinctions between the definitions have impacted on what researchers have looked for and valued in attempts to articulate links between practice and knowledge. However many of these attempts to articulate links between practice and knowledge have proved to be extremely difficult.

Shulman's (1986, 1987) approach to teachers' knowledge has led to a shift in our understanding of the knowledge for teaching and learning science in the classroom. In his conceptual scheme, Shulman identified components of what constitute a teachers' professional knowledge. This conceptual shift has enabled researchers to focus much

research on, among others, the specific topics and how they are taught in the classroom. This is the notion of pedagogical content knowledge (PCK). According to Shulman (1987) pedagogical content knowledge is understood as the knowledge that links the particular science content and the teaching practice. Using Shulman's approach, this study also sought to capture the pedagogical content knowledge of (teacher) cluster leaders who are the main drivers of the MSSI clusters in Mpumalanga. The main aim was to understand and respond to the questions on:

- how teacher clusters help teachers to challenge and re shape both their CK and PCK; and
- how this knowledge is translated into practice in their respective classrooms.

2.2.2 Conceptual Framework

If constructivism takes seriously the knowledge construction by learners, then in the same vein, there must also be recognition of the knowledge construction by the teachers who are the learners during the teacher development programmes.

This study adopted a conceptual framework based on the views of Cochran Smith and Lytle's (1999) and Shulman, (1986; 1987). Cochran Smith and Lytle (1999) provided an analytic framework for theorising teacher learning on the basis of fundamental ideas about how knowledge and practice are related and how teachers learn within communities and other contexts. Their views are based on a scheme that explores firstly the knowledge that teachers have acquired through formal training before they qualify to be teachers; secondly, the knowledge they acquire during teaching experiences and lastly the combination of both which is the knowledge for professional practice. These three concepts of teacher knowledge are identified as:

- knowledge of practice
- knowledge in practice and
- knowledge for practice.

While these concepts that explore teacher learning on the basis of the relationship between knowledge and practice are important, they still fell short on articulating the issue of pedagogical content knowledge. This is what Shulman (1986; 1987) considers the missing paradigm that accounts for that strong relationship between what teachers know, and how they teach what they know. Linking the two conceptual

frameworks on knowledge, as dicussed above makes sense for examining the teachers CK, PCK and the resulting changes in classroom practice. This combination of perspectives of teachers' knowledge in my conceptual framework avoids the limitations of the past research that has only sought to understand what teachers need to know, and how they learn to teach instead of what they know and how they teach what they know (Lieberman and Miller, 1991).

Shulman (1987) originally identified seven categories of teacher knowledge required for effective practice. These are:

- general content knowledge ;
- general pedagogical knowledge;
- curriculum knowledge;
- pedagogical content knowledge;
- knowledge of the learners and their characteristics;
- knowledge of the educational contexts;
- knowledge of educational ends, purposes and values, and their philosophical and historical backgrounds.

The importance of the seven categories of teacher knowledge is the link and the relationships of these knowledge categories in teaching and learning. It becomes difficult to show and display teaching knowledge into segments.

Of critical importance to the present study, are concepts of CK and PCK. Grossman, et al (1989), using Shulman's scheme on knowledge further conceptualised the idea of PCK as identifying four types of sub-themes of knowledge, namely

- content knowledge;
- substantive knowledge;
- syntactic knowledge; and
- beliefs about the subject matter.

Their identification of the PCK lies on the premise that the teacher is an expert in the subject that he/she teaches and is able to disseminate this knowledge to the learners.

The notion of different types of knowledge needed for teaching was further explored by researchers such as, Lieberman and Miller (1991); Lampert (1988); Senge (2000), and Sawyer (2001). They all supported mostly the category of teacher knowledge in the general pedagogical knowledge as defined by Shulman, (1987). Their views relate to what teachers know about topics such as the curriculum, lesson assessment and preparations. Much of this knowledge is been acquired during the years spent in the classroom by teachers as subject teachers (Sawyer, 2001)

The theoretical constructs of knowledge of practice, knowledge in practice and knowledge for practice as discussed by Cochran Smith and Lytle (1999) also provided a very critical component of my conceptual framework for this study.

 Fig.1 Schematic presentation of my Conceptual Framework

Knowledge (Science)

Knowledge of Practice (Pre-service)   +   Knowledge in practice (In-service)
Professional Development
= knowledge for practice

  Content knowledge (CK)   +   Pedagogical Knowledge (PCK)
Professional Development
= improved teaching practice

{ Cochran Smith-Lytle ,(1999} and Shulman, (1987) }
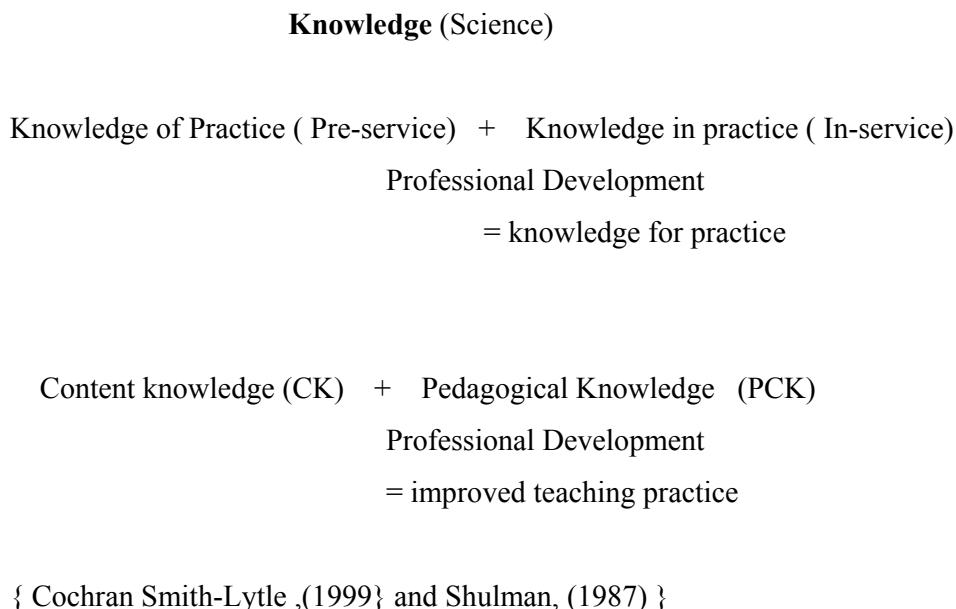
2.2.3 Knowledge of practice
This knowledge is acquired by the teacher during the teacher training program, for initial teacher training (Cochran Smith and Lytle, 1999). During pre-service training, learning subject content knowledge is always accompanied by learning of teaching methods. The teachers' competence in using both the content and the teaching methods is challenged once the teacher is engaged in a real classroom situation. At

this stage, the teachers' knowledge is usually cluttered with theories and assumptions of what should happen in the classroom, however, these are the only tools that the teacher has to use in the classroom.

There has been always a concern as to the relevance and effectiveness of the content knowledge that is offered to subject teachers in pre-service programmes (Ovens, 2000).When students graduate as teachers, they use this knowledge as knowledge in practice as they practise and encounter new challenges in the classrooms (Little, 1993). Gess-Newsome et.al. (1999) claims that most science majors leave college with poor understanding of science subject matter, methods of teaching and the contextual elements of schools. They have been exposed to and ingested a great deal of science content, but not digested and assimilated it in a manner useful to teaching. This content knowledge is usually exposed and challenged by the real classroom encounters. As they meet these challenges, they are often required to reflect on them with other teachers. The knowledge that teachers share and reflect on during in-service training is viewed as, knowledge in practice (Cochran smith and Lytle, 1999).

2.2.4 Knowledge in Practice

When the process of teacher development continuous as an on job- training, teachers bring with them a vast number of experiences that influences their previous knowledge which was acquired during pre-service training. This knowledge relates to what teachers know about topics and the context of the curriculum which they have used as practitioners in their own classrooms. Many factors will influence this content knowledge and the pedagogical content knowledge. Some of these factors might be related to the number of learners in the classroom. For example, in the presentation of science lesson in a class of 60 learners, experiences will be different from the class with 20 learners. Teachers teaching in these classrooms will definitely use different teaching strategies to reach these learners. The availability of teaching and learning resources and the teaching experiences of teachers influence the presentation of science lessons in the classroom (Rogan, 2000; Jansen, 2000).

The skills and challenges that the teacher faces in the classroom would build and enrich his or her knowledge in practice. Johnson, Monk and Swain, (2001) offer examples of how school factors shape classroom practice. In their opinion, teachers' classroom behaviour is best understood by observing from the selection of pedagogical content knowledge that is successful in the classroom environment in which the teacher works.

2.2.5 Knowledge for Practice

When training workshops are organised for practicing teachers (INSET), teachers are exposed to "new knowledge" and skills of teaching in the classroom. This "new knowledge" is often assumed to have no link with the knowledge that teachers already have. In my view, this is one of the big mistakes that teacher developers make in running their workshops and programmes. This view is supported by McNiff (1993), as she argues that working with case studies of actual practice and modifying practice in the light of evaluation, can aid the professional development of classroom practitioners rather than working with theory as if the teachers bring no experiences of their own. This sharing allows all participants to build on their *knowledge of practice* (Lampert and Ball, 1995*).* During training teachers acquire more of and become adept at the use of this knowledge. Some researchers call this "new knowledge" (Fullan, 2001) because it brings in new dynamics, shifts and changes in teacher's life. It might also bring in new encounters in the teaching and learning of science in the classroom. Bell and Gilbert (1996) in their studies on teacher development confirm the value of sharing the experiences as a way of filling in the gap of knowledge in practice. Whilst their study on teacher development confirms the value of sharing experiences by the teachers, it was thin on the discussion of the ways and strategies in which this can be done effectively. This is the gap that this study identified and it is trying to close it by exploring the functioning and operation of teacher clusters as a basic structure for sharing by the teachers at their own communities.

Most researchers of professional development and teacher change have discussed the gap that is usually created by teacher development programmes in failing to link CK and PCK when working with teachers (Hargreaves and Fullan, 1992; Schlerechty, 2000; Rogan and Grayson, 2002). Some of these researchers talk of, "inside knowledge" and "outside knowledge". Inside knowledge being the knowledge that

one possesses before it is challenged and reshaped by new ideas while outside knowledge refers to the new knowledge that is brought about by reshaped ideas (Fullan, 2000; Sawyer, 2001).

In summary, it is important to note that as science teachers are developing scientists of the future, they themselves should be exposed to the construction of *scientific knowledge* as individuals and as peers in a community of teachers (Gottesman, 2002). This is still a gap as little or no opportunities are provided for teachers to explore their scientific content knowledge.

2.2.6 Knowledge Construction

Central to the concept of constructivism is the idea that people are "self-constructing and that they can reconstrue their circumstances through the application of their personal worldview" (Candy, 1991:279). Learning is an active process in which the learner interprets and uses sensory input and constructs meaning out of it. The crucial action of constructing meaning is mental and it happens in the mind. Teachers have created and constructed their own meaning of specific concepts and the theories which can only be seen and observed through actions and hands on experiences. These interpretations might be misleading as expressed through actions and experiences in the classroom. Professional development programmes that provide opportunities for teachers to tap on these concepts have a better chance to allow the teacher to formulate a better meaning and understanding of the new knowledge that will fit into a recognisable pattern. We all learn by making mistakes. We can learn from getting things right and reflecting on but more often than not, we learn from mistakes we make as teachers. All experiences are potentially educative (Dewey, 1939).

Teachers are adults and their learning occurs in a social context. Most learning needs derive from membership of social group, e.g. members of a working environment (Lampert and Ball, 1995, Southwood, 2002). A great deal of learning takes place in group settings rather than in isolation; even those who begin their learning alone often seek out other learners against whom to measure their progress and with whom to share their experiences. Teachers who sometimes struggle to perform tasks often succeed when they are helped by mentors or HOD's. This is usually not very practical

in a South African context because of the duty loads that CI's and HOD's have and the availability of such opportunities in schools. This concept of mentoring borrows from socio- cultural theories by emphasizing the social nature of learning through joint activity as viewed by Vygotsky (1978) cited in Gluck and Draisma (1997). Vygotsky's main contribution to learning theory is the concept termed the '*zone of proximal development'*. He referred to this term as *a gap* that exists for an individual between what he or she can do alone and what he or she can achieve with help from someone who knows. Some teachers have larger zones of proximal development than others especially in subjects like science and mathematics which are abstract in nature. An experienced or competent teacher provides assistance to the struggling or less competent so that the latter develops greater potential of teaching. The perspective presented here, whereby individuals through their own mental activity, experience with the environment and social interactions progressively build up and restructure their schemes of the world around them.

This process of knowledge construction by teachers is still problematic in South Africa as schools are isolated from each other. Also, the nature of teacher development programmes have not yet provided learning environment for teachers to construct knew knowledge by sharing their classroom experiences (Kahn, 1995). This study seeks to examine examples of how these opportunities can be provided for teachers to construct CK and PCK, in teacher development programs, by making use of their daily experiences in the classrooms. Everyday teaching provides the new learning experience that enhances the development of PCK which might be explored and be used collaboratively for the improvement of science teaching in schools.

2.2.6.1 Knowledge construction through reflection
The notion of a teacher as a reflective practitioner was popularised through the work of Schon (1983; 1987). Schon (1987) argues that, guided reflection assists the process of conceptual change, and the intuitive knowledge upon which teaching practice rests. There is however, little record of how such reflections can be achieved and made more accessible (McMahon, 2000).

Teachers need to reflect both individually and collectively on the learning and its consequences in the classroom (Southwood, 2002). Reflecting collectively will have

an advantage of allowing teachers to put their experiences and associated feelings into words with peers with the aim of confirming or strengthening their beliefs about teaching and learning of science in the classrooms (ibid). Reflecting on their own life histories also provide an important resource for teacher knowledge. Jita and Vandeyar, (2003), clearly indicate that the identity that the teachers have with respect to their subject reflects the way in which they were taught as early as in elementary schools. Furthermore, these scholars argue that changing classroom practice eventually depends on the teachers' ability to construct a counter identity around their subject area e.g. mathematics, and to incorporate new (reform) vocabulary within their own systems of thought and practice.

Denis (2000) gives a warning that, without a change in how teachers perceive themselves, they will go through the motions of learning but they will not retain the material in the long term. This argument is important, in my view, to take into consideration the CK and the PCK that individual teacher bring to developmental sessions and construct the new meaning by making use of it. If the teachers' contributions are not discussed and clarified on how they differ or are similar with what is being done, the teachers will continue to hang on to their original ideas and practices.

Boyd and Fales (1983) view reflective learning as a process of internally examining and exploring an issue of concern. This issue of concern is usually triggered by an experience. The experience usually creates and clarifies meaning, which results in a changed conceptual perspective. In most cases, the person that reflects on an experience (reflector) usually thinks of a familiar experience, compares it to the new experience and makes a decision on the relevance of that new experience. Reflection on one's knowledge should be based on learning experiences which take place, as far as possible, in everyday situations and be embedded in familiar activities as eluded by researchers such as Brown, (1989). As Popper, cited in Fensham (1988:79) observed that, "we make progress by reflecting about our errors rather than basking in our strengths." This statement simply confirms that we all learn from our mistakes through reflections.

2.2.6.2 Knowledge construction through sharing

The science curriculum reflects the theories and models, which have been constructed, and the ways in which these are checked and evaluated as coherent and useful (Driver, 1988). This process does not happen in a vacuum. Theory making and testing is a dynamic human enterprise that takes place within the socially defined community and institutions through sharing *(ibid)*. Louckes-Horsley, et.al. (1987) argue that construction of knowledge is a process and the change that includes addition, creation, modification, refinement, restructuring and rejection. Knowledge can be collectively constructed at a teachers' course (*ibid*). This new knowledge must be built onto existing knowledge. Fullan (2001) argues the issue of knowledge building by saying that, change in instructional practice involves working through problems of practice with peers and experts, observation of practice and steady accumulation over time of new practices anchored in one's own classroom setting." Knowledge building and accumulation takes time and it need to be built into teaching practice of the individual as a way of monitoring the link between the knowledge of practice and the knowledge in practice (Shulman, et al.2004).

When teachers are in situations where they can construct, share and reflect on their knowledge and skills with the aim of improving their teaching in the classroom, the process is known as teacher development (Adams, 2000; Ovens, 2000). Teacher development approaches and strategies take place in various forms and in a variety of teaching and learning contexts (Joyce and Showers, 1988). These strategies on teacher learning and the construction of knowledge impact on the way teachers are developed (Lieberman and Miller, 1991; Ball and Gilbert, 1996).

2.3 Teacher development

Having discussed my conceptual framework based on the literature on knowledge for teaching and the various conceptions on knowledge change and its potential impact on classroom practice, I now wish to examine the various kinds of teacher development approaches that have been tried in an effort to reshape science teachers' classroom practices that will ultimately lead to the present practices especially in South Africa. I want to explore the idea of teacher development as a process of growth of the individual whereby the individual's life is formed and informed by the values that she/he holds and the knowledge that she/ he develops and practice. This discussion

focuses on the approaches that have been and are still being used world-wide and specifically in South Africa for teacher development.

2.3.1 Traditional approaches to teacher development

Numerous studies have already established that many of the approaches used to develop teachers have shown minimal results in influencing and changing the teachers' classroom practice (Cuban, 1993; Jansen, 1999; Fullan, 2001; Gottesman, 2002). Most of these approaches to teacher development relied mostly on the top-down approach. The top down approach to teacher development is based on the assumption that the development of teachers should be closely linked to the overall planning processes of the school management. In most cases it is driven by an expert who claims to know the needs of the individuals and could provide training (Ovens, 2000). In some cases there would be uniform details and requirements applied to all teachers in a province or in an area to be serviced by the workshop. Decisions and plans are often centred on an 'expert' that offered the training. Such traditional approaches to teacher development continue to be used in many countries, including South Africa (Jansen, 2000; Rogan, 2000).

Many such professional development sessions are characterized by a gap between the content knowledge that the experts offer with the knowledge and experiences that the teachers bring along to the workshops. In order to understand and to begin to see possibilities beyond such traditional approaches to teacher development, it is important to identify and investigate those situations where teachers and academics come together to form communities of learners in South Africa (Southwood, 2002).

The challenge that concerns teacher developers is to find an approach that helps teachers change their beliefs, knowledge and practices in the classroom. According to Louckes-Horsley et.al. (1987), such approaches should engage teachers in those processes that improve job-related knowledge, skills or attitudes. De Feiter (2002) makes a similar point in arguing that teacher education and development programmes should be linked to what happens in the classroom. Unfortunately, a great deal of evaluation of staff development programs begins and ends with the assessment of the individual's reactions to workshops and courses (Little, 1993). In such cases there is little to learn about the acquisition of new knowledge and skills and how that learning

affects teacher's daily practice (Guskey, 2001). Evaluation of staff development usually assesses the knowledge acquired by the teachers at the workshop, but in most cases, fails to asses it in the classroom (Louckes-Hoserley, et.al 1987). The transfer of skills and knowledge that goes back into the classroom remains unexamined and will form an important component of this study.

Kelly, et.al (2002), summarises the challenges facing professional teacher development decisions and dilemmas of in-service education as the failure to define professional development beyond the cataloguing of school clock hours. Their concern is that the provision of teacher development fails to differentiate between the classroom, school and district activities. This means that teacher development programs concentrate more on management issues and new policies and neglect the content knowledge that is needed in the classroom. Without denying the importance of in-service education for all teachers in all districts, the challenge of understanding the problems associated with the processes of effecting change in the classroom continues to elude us (Joyce and Showers, 1988). This is not withstanding Fullan's caution that you sometimes need a little of both of departmental INSET and community based INSET support in order to influence implementation of changes in practice (Fullan 2001).

A very recent example of such an approach to teacher development was used in South Africa during the introduction and implementation of the new curriculum known as Curriculum 2005. This approach was based on a cascade model conducted by the "experts" moving from one province to another. They first trained a group of selected Department of Education officials from the various provinces who were expected to train the local Subject Advisers. The Subject Advisors, in turn, selected and trained one teacher from each school with the mandate to go back to schools and train others. This "chain" was too long to reach the classroom and the context of this training further neglected content knowledge and focused on the skills (Rogan, 1999; Jansen, 2000; Kahn, 1999). A similar approach was still being used when the Revised National Curriculum Statements (RNCS) was introduced to teachers more recently South Africa therefore still needs to come up with approaches that provide opportunities to understand the personal and professional development needs of

teachers, investigate those situations where teachers come together to form communities of learners (Southwood, 2002).

In this study I have classified the approaches on teacher development into two broad categories, namely, traditional approaches and new innovative approaches to teacher development. I now turn to a discussion of the new, innovative approaches. Such approaches are those that as Ovens (2000) observes: promote close observation of the teacher's own classroom; harness teacher's ability to deepen their awareness of their own professional needs; promote individual and collaborative reflection about shared learning from their experiences; and promote the critical use of others' published ideas.

2.3.2 New and Innovative Approaches to teacher development

Innovative approaches to teacher development are regarded so far as the better ways of improving classroom practices, where content knowledge and pedagogical content knowledge takes the form of reflection on action (Wilson Berne, 1999; Southwood, 2002). As a consequence of lack of effective classroom practices, problems and related theoretical debates, especially in South Africa, many new approaches to professional development, have begun to emerge (Southwood, 2002). These innovative approaches are mostly targeting science and maths teachers (Grayson, 2001; Kahn, 1988) South African literature reviews that the majority of teachers are ill or under qualified to teach science, especially at the senior high schools (Kahn, 1995; Taylor and Vinjevold, 1999, Jansen, 2000; Lubisi, 2000). The majority of these teachers are heavily dependent on textbooks for content and use rote learning as a teaching methodology in most cases (Kahn, M. & Rollnick, M. 1991). The baseline survey conducted by JICA (JICA1999) showed that Mpumalanga teachers lack content knowledge in science and mathematics subjects to teach effectively in the classroom. Grayson et al. (2001) also mentions the negative attitudes that South African teachers have towards the teaching of science and how this impacts on the teaching and learning of science in the classroom. Reflecting on the South African context where teachers lack content and pedagogical content knowledge, because of ill training and ineffective INSET programs that address classroom issues (Lubisi, 2000; Jita, 2004), innovative and effective teacher development approaches are needed to fill the gap. The type of intervention that is ideal would be different from

the Western countries where teachers are well qualified to teach the subject, but meet in teacher networks for sake of improving, expanding or 'polishing' their knowledge and skills of teaching   (Lieberman& Wood (2002).

Taking the context in which the teachers operate and their characteristics as outlined above, it makes sense to implement teacher development approaches that are innovative. At the heart of the new approaches is the move towards teacher clusters as a form of teacher development (Southwood 2002). Teacher clusters are a "form of professional community that provides a context within which members can come together and understand their practices"(Secada and Adajian, 1997; 193). Lieberman and Grolnick (1988) have highlighted the fact that, although there is no single definition of clusters or networks, the 17 clusters that they studied, engaged in similar activities. Amongst the activities that they examined the following were rated as the most common characteristics of network/ clusters: Sharing content knowledge, reflecting on their teaching experiences, giving feedback, collaboration and negotiation among others.

While, I reviewed the descriptions of the networks provided by Western researchers, I assume that teacher networks in South Africa will not provide an adequate substitute for Western examples, since the context is different and the focus might be different. For example, teachers in the Western countries might be focussing on teaching the subject better while the teacher in South Africa might be focussing on understanding concepts and terminology that were never taught during his or her training but faced with the task of teaching them. In a way, the teacher cluster provides an opportunity for this teacher to learn new concepts and new terminology that helps to bridge the gap in content knowledge. This is the knowledge that the teacher would have learnt during Pre- Service Training.

Collaboration and sharing of knowledge among peers help teachers to reflect on their practices as equals through meaningful social interaction. Prawat (1992) uses the term 'negotiation' to describe this social interaction because it involves learning and unlearning new information. When teachers share their classroom experiences they learn from each other and unlearn their old experiences by accepting new knowledge so that it becomes meaningful. Further to the acquisition and exchange of knowledge,

Gottesman (2002) observes that when teachers work together as a community, they develop skills of mentoring each other as peers and learn to plan collaboratively as peers. Wineberg and Grossman (2000) confirm the value of collaboration by observing that peer-coaching, combined with the acquisition of new teaching skills, is an expedient, positive and supportive way for teachers to implement new strategies in the classroom.

The new innovative cluster approach to teacher development therefore seems to enhance the kind of learning that has a potential of providing opportunities for teachers to engage in learning which promotes the collaboration, construction and sharing of CK and PCK in a meaningful way (Guskey, 1986).

The cluster approach is currently being used in most provinces in South Africa in one form or another. In some cases it is embedded in the community structures of teachers, in others it is part of the Department of Education structures (Gray, 1999; Southwood, 2002; De Feiter, 2002). The approach is still fairly new in South Africa, although it has been in used in the United Kingdom and in the United States of America since the seventies (Parker, 1971). It has recently become popular in other countries as well: Swaziland (through the SMART project); Botswana through a Netherlands funded project (UB INSET, 1976) and in Namibia (De Feiter, 2002). Views from researchers on the successes and the failures of such teacher clusters are at this stage few and far between, a gap which this study seeks to fill by documenting examples on the structure and functioning of teacher clusters for science teachers in the Mpumalanga province of South Africa.

2.3.3. Cluster Approach

My review of the literature suggests that clusters differ from one another, especially with respect to their formation, mode of operation and their consequences or effects on teachers' knowledge and classroom practices. A review of Guskey (1986), for example, identified four types of clusters, on the basis of their formation and operation. Guskey (1986) named the three clusters as follows:

- Formal hierarchical top-down cluster;
- Formal expert/funder driven cluster; and

- Informal community driven cluster.

The differences between the hierarchical top down cluster is that in most cases the cluster is led by a senior person within the departmental structures and in most cases it fails to engage teachers to issues that are addressing CK and PCK. In most cases it focuses on policy and administrative issues. The expert or funder driven cluster is often driven by an expert who is an outsider. The experts usually impose to the teachers and fail to consider the CK and PCK that teachers bring to the teacher development programs. In some cases, if the teacher development program is funded by an outsider with his/her own objectives, it imposes its strategies and practices on the teachers.

The informal community driven cluster on the other hand, is mainly a bottom up structure that is initiated by teachers in order to improve their CK and PCK. In most cases, this cluster is driven by teachers themselves, and the context of meeting is collaborative and reflecting on their classroom practices.

Similarly, Lieberman and Grolnick (1996) identified 6 different types of clusters. The latter scheme, developed 10 years after the Guskey's scheme was more comprehensive due to the fact that it further identified three types of clusters.

- Informal subject based cluster
- Informal radical issue driven cluster; and
- Informal collaborative subject based cluster.

The subject-based cluster focused on the specific subject within the schools that are close to each other. This cluster is usually linked to school improvement policies. It differs completely from the collaborative subject based cluster in that it is school based and it is guided by the school policies and subject policies. The collaborative is very informal and the participation is very informal and voluntary. The radical clusters are more concerned with all the issues of education that affect teachers. They concentrate on issues that are generic and that are not specifically focussing on the complexities of content knowledge and how it is taught in the classroom.

Table 1   **Cluster definitions and characteristics**

Type	Characteristics	Status	Participation
Community	Embedded in the community Structures	Informal	Voluntary
Collaborative	Concern interest group	Informal	Voluntary
Reform radicals	Radical and open-ended issues e.g. teachers 'rights, teachers' salaries, challenging new policies and structures in education	Informal	Voluntary
Hierarchical	Top-down inside expert	Formal	Compulsory
Expert-driven	Out-side expert	Both formal and informal	Voluntary

2.4 Summary

Continuous learning on the job has great potential to influence teacher's practices in the classroom. The word change dominates this study and as a result it became important to review briefly the literature on change of teachers' classroom practices. According to Roget's Thesaurus (Kirkpatrick, 1987), one meaning of the word "change" is, the difference at different times". Others associated with change, are alteration, reformation, improvement and transformation. All these words attempt to explain the acts or processes that lead to change. This study endeavours to understand this change process in teachers by examining what they do to improve and transform their teaching practices in clusters. The issues of CK and PCK become the key tools of transforming and changing classroom practices. Fullan (2001) noted that the future of educational change lies in the learning process of the individuals or in change processes in organisations where both see the active construction of meaning, as participants. The process of change involves developing a mindset and action set that is constantly cultivated and refined. Here the role of in-service education and training (INSET) becomes vital. Change in instructional practice involves working through problems with peers or experts, observation of teaching practice, and steady

accumulation of new practices overtime anchored in one's own classroom setting (Fullan, 2001). The emphasis here is placed on learning in the setting where you work e.g. learning while teaching in a classroom. This type of learning has the greatest reward because it is more specific, customised to the situation, and social involves a group (Fullan, 2001:126).

This study examines the opportunities that innovative teacher development programmes provided for teachers to engage in the analytic process of uncovering and challenging their CK and PCK through as peers. In order to understand these teacher changes and teacher development, this chapter focused on a literature review and how it influenced the design of this study. The areas covered in it are views on teacher development, teacher knowledge, theories and models of initiating and implementing innovation and change. The literature helped to focus the research design in respect of teacher change in science education by providing theories on the process of teacher change and the context that enhanced learning. These theories took into consideration the nature of science and its philosophy as it impact on teaching and learning.

The next chapter describes the research design used for exploring my research questions in detail. It further discusses the experiences and challenges of data collection in this study. The research design took the form of qualitative approaches in order to collect in-depth descriptions on the formation and functioning of teacher clusters. This approach was used with an attempt to understand the nature of opportunities provided for teachers' development and personal growth.