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Teaching evolution in a new curriculum: Life Sciences teachers' concerns and needs.

Ngxola, Nonyameko

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CHAPTER 2
The theoretical framework for the study

2.1 OVERVIEW OF THE CHAPTER

This chapter provides details of the theoretical framework used to guide this study. Firstly, it defines the term "theoretical framework" and its significance in research. Secondly, difficulties faced by researchers when choosing appropriate theoretical frameworks are looked into. Thirdly, the "stages of concern" theory is described and its implications for those supporting teachers in times of curriculum innovation are discussed. Finally, aspects relating to subject matter knowledge are considered.

2.2 THEORETICAL FRAMEWORKS AND THEIR IMPORTANCE IN RESEARCH

It is difficult to get an exact definition for a theoretical framework (Abd-El-Khalick and Akerson, 2007). Caliendo and Kyle (1996, 225) cite Kerlinger's definition of theory as *"a set of interrelated constructs (concepts), definitions, and propositions that present a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting the phenomena".* That is, theories deal with concepts which are interwoven with others and the relationships between them. When used by researchers as a knowledge base for research, they are often referred to as theoretical frameworks or conceptual frameworks.

There are a number of reasons why theoretical frameworks are important in research. Firstly, according to Borgatti (1996), a theoretical framework provides guidance for researchers to choose a relevant research design to formulate appropriate research questions, to choose appropriate strategies to use when collecting data and analyzing data, and finally, to make interpretations based on the data analysis.

Secondly, Herek (1995) points out that a theoretical framework enables researchers to strengthen their research by identifying gaps or assessing whether unnecessary emphasis is being placed on a particular type of variable. He also points out that it connects researchers to existing knowledge which forms a basis for their hypotheses, and helps researchers to address questions of why and how.

Caliendo and Kyle (1996) point out that a theoretical framework distinguishes research from journalism. Theoretical frameworks provide theories on which researchers can base their research.

Researchers working in different paradigms use theoretical frameworks for different purposes. According to Glesne and Peshkin (1992) positivists use theoretical frameworks to make predictions and to explain phenomena. Interpretivists, by contrast, use theoretical frameworks to interpret a situation or to make sense of the world.

2.3 CHOOSING AN APPROPRIATE THEORETICAL FRAMEWORK FOR RESEARCH IN EDUCATION

Science education is a multi-dimensional and very complex discipline which sometimes makes it difficult for researchers to find a suitable theoretical framework that will guide their study. Abd-El-Khalick and Akerson (2007) say that most published theoretical frameworks fall on a continuum. At one pole of the continuum are disconnected ideas from several relevant theories and at the other pole are frameworks made up of single interrelated webs of constructs that link different theories. Rather than finding a single appropriate framework, researchers are likely to encounter a range of different and contrasting theories that are interlinked in the problems they are investigating (Abd-El-Khalick and Akerson, 2007). They suggest that in such situations researchers have two alternatives. Firstly they can use theoretical lenses, opted for when no one single comprehensive framework is available. Abd-El-Khalick and Akerson (2007, 188) point out that theoretical lenses *"legitimate studying a phenomenon".* Alternatively they look at an existing theoretical framework in detail, explore its limitations and make some additions so that it suits the study.

In my study I was fortunate to find one existing theory which I could use to guide the research design. It is the "stages of concern" theory based on work by Fuller (1969). However, because teachers' knowledge of evolution was a source of concern I also looked into the literature on subject matter knowledge. This is discussed in section 2.5.

2.4 STAGES OF CONCERN THEORY

Theory about stages of concern (Fuller, 1969; Hall and Loucks, 1978) provides the essential framework which guided the overall design of my study, the development of appropriate questions and instruments, and the interpretation of results.

Hall, George and Rutherford (1979, 5) describe the term "concern" as *"the composite representation of feelings, preoccupation, thought, and consideration given to a particular issue or task".* They go on to say *"depending on our personal make-up, knowledge, and experiences, each person perceives and mentally contends with a given issue differently; thus there are different kinds of concerns".*

2.4.1 Fuller's introduction of the theory

Fuller (1969) conducted research with student teachers who were in her teacher preparatory programme. She embarked on intensive research after she noticed in her own teaching that many of her student teachers regarded her course as "irrelevant" even though it was dealing with very relevant matters. She suggested that this was because they did not see things as relevant to the needs they were concerned about at the early stages of their training. This could apply in my study where in-service training that was offered by the Department of Education to *Life Sciences* teachers to prepare them to teach the new topic of evolution was judged by the teachers to be irrelevant (Makgoba, 1999). This was echoed by teachers in my cluster who were worried that the in-service training offered was not addressing their needs: it only focused on policy matters and not on content and strategies relevant for teaching evolution.

In an effort to understand why student teachers in her teacher preparatory programme did not seem to benefit from education courses offered to them, Fuller conducted a study with three groups of beginning teachers during the first few weeks and the last weeks of the semester. She analyzed their responses and found that their concerns were more 'self-centred' at the beginning of the semester and shifted more to 'pupil-centred' concerns towards the end of the semester. The results were supported by the written concerns statements she got from twenty-nine teachers she surveyed in her second study. She originally proposed a two-stage model (Fuller, 1969) which made a distinction between 'early concerns' (self-centered concerns) and 'late concerns' (pupil-centred concerns).

Fuller (1969, 214) described 'early concerns' as *"perceived problems of student teachers or beginning in-service teachers"* that relate to personal adequacy of controlling the class, interaction with parents, principals and supervising teachers and knowledge of the subject matter. She went on to describe 'late concerns' as "*perceived problems or worries of experienced teachers"* which often focus on the success of pupils (Fuller, 1969, 216). She noted that student teachers with little or no experience showed a higher level of self concerns, while experienced teachers were more concerned about how well pupils perform in classroom, rather than concerns about themselves. As a result she speculated that the student teachers in her course would developmentally move through these stages of concern in time as their experience in the profession grew.

With more understanding of teachers' concerns, and as she got more data, Fuller revised her two-stage model to a three-stage developmental model which I have represented diagrammatically in Figure 1.

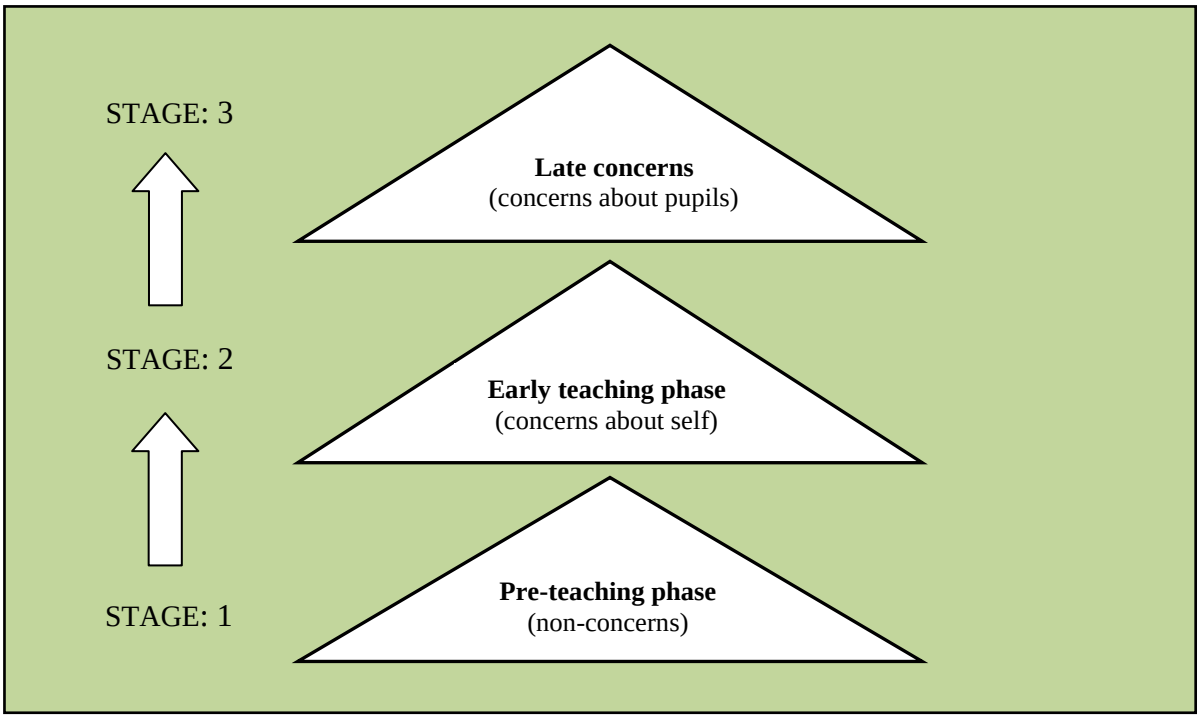


Figure 1: Representation of Fuller's stages of concern

The first stage focused on concerns of student teachers prior to teaching (her *'non-concern'* stage). Fuller described the first stage as a pre-teaching phase, which "*seemed to be a period of non-concern with the specifics of teaching"* (Fuller, 1969, 219). She pointed out that concerns expressed at this stage were based on rumour, or on student teachers' perceptions of teaching based on their experiences as pupils or as tertiary students. The second stage focused on concerns with self (her *'concern with self'* stage). The self-concern stage indicates that when pre-service teachers or in-service teachers begin, they are more concerned about their survival in the classroom, for example, their adequacy with subject matter and classroom management. Fuller (1969, 221) points out that *"when concerns are 'mature', i.e. characteristic of experienced superior teachers, concerns seem to focus on pupil gain and self evaluation as opposed to personal gain and evaluations by others".* This describes her third stage (*'concern with pupils'* stage) which represents a shift from self-oriented concerns to working towards pupils' achievement.

Fundamental to Fuller's stages of concern is the perception that pre-service and in-service teachers concerns shift in an orderly manner that occurs in a linear predictable pattern (i.e. from *'non-concern'* stage to *'concern with pupil'* stage) as they gain experience, as represented in Figure 1. This perception implies that addressing concerns in early stages is essential if teachers are to proceed to the next level of concerns. Therefore, pre-service and in-service training offered to teachers should be designed in a way that it links with their developing concerns.

2.4.2 Expanded stages of concern theory

Building on work by Fuller (1969), Hall and Loucks (1978) examined Fullers' three-stage theory of concerns in teachers as they implemented an innovation. The use of Fuller's theory in their research led to a definable set of key stages of concern as teachers are involved in implementing an innovation, and as teachers move developmentally through the stages of concern. The key stages of concern Hall and Loucks identified retained Fullers' original ideas of *'non-concern'*, *'concerns with self'*, and *'concerns with pupils'* (or impact concerns). However, Hall and Loucks' self and the impact concerns were expanded by identifying distinctive stages within each category. Self-concerns were divided into two stages (*informational* and *personal* stages) and impact concerns were divided into three stages (*consequence, collaboration and refocusing* stages). Seven detailed categories of concerns of teachers about innovation were confirmed by their research (Hall and Loucks, 1978). Table 4 on the next page introduces the seven-stage concerns theory, with explanations.

Hall and Hord (2006) summarize the expanded stages of concern model and its application to teachers' concerns during times of curriculum innovation. They point out that when teachers are faced with change even experienced teachers become novices. This could be because teachers experiencing change will still have moments of self-doubt about whether they can be successful with the new ways of doing things, and whether they are willing to be part of the innovation (Hall and Hord, 2006). This could be the case with *Life Science* teachers in South Africa who are required to teach the new topic of evolution and also to change their classroom practices.

Hall and Hord (2006) point out that at the beginning of an innovation process, when teachers first become aware of an innovation and have to adopt it, their greatest concerns tend to be grouped in

stage 1 (informational) and stage 2 (personal). I anticipate that this would also be true of the *Life Sciences* teachers concerning the teaching of evolution in the first year or two. A clue to these concerns might be the use of 'I' and 'me' when they express their needs. For example, teachers typically make comments such as *"well, at this point* [beginning of innovation process] *I don't know much about it, other than that we have been told that we will be adopting it"* (Hall and Hord, 2006, 139). Such concerns would be categorized as 'informational' as the teacher knows little about innovation, but showed an interest to know more about innovation itself. A teacher might go on to say *"I just hope that I don't have to stop doing what I have been doing and start all over again"* (Hall and Hord, 2006, 139). This concern would be categorized as 'personal', as the teacher is concerned about what she or he has to give up when adopting innovation.

Table 4: The expanded stages of concern theory of Hall and Loucks (1978)

Stages of concern			Explanations and typical expressions of concern
Unrelated concerns	0	awareness	Teachers' concerns do not relate to the innovation.
Self concerns	1	informational	Teachers show interest or express a need to learn more.
	2	personal	Concerns are expressed in an egocentric way, e.g. worrying about how they will cope with the innovation.
Task concerns	3	management	Concerns focus on the processes and tasks of using the innovation and the appropriate use of information and resources.
Impact concerns	4	consequence	Concerns relate to relevance, or impact of the innovation on pupils.
	5	collaboration	Teachers focus on working with others regarding the innovation.
	6	refocusing	Teachers focus on alternative, more appropriate methods.

Hall and Hord (2006) state that when self concerns are intense it is time for those supporting teachers in times of curriculum innovation to determine why these concerns are intense, and to come up with specific intervention strategies that will address those initial informational concerns, before going on to focus on pupils' learning. In-service training offered should focus on making teachers comfortable with the innovation, which may be achieved by giving descriptive information about the innovation, giving information about the significance of the innovation, and by describing how the innovation will affect teachers. This is because at that stage teachers are less concerned about consequences of change for the pupils (Hall and Hord, 2006). The authors warn that a once-off in-service workshop with all the details at once may not resolve self-concerns. They therefore recommend that teachers be given small pieces of information that are repeated across time.

According to Hall and Hord stage 3 concerns (management) emerge during the first year or years of implementing an innovation. Loucks-Horley (1996) points out that management concerns emerge when topics which teachers teach for the first time bring surprises and when teachers need to carry out new approaches they are expected to use in class. Management concerns focus on mastery of the tasks, and typical comments made at this stage are *"using this material is taking all of my time. You can't imagine all the pieces and steps that are entailed in just doing one step"* (Hall and Hord, 2006, 138). They explain that such comments are an indication that the teachers are struggling on how-to-do-it skills. Sweeny (2003) points out that when management concerns are intense the 'power of

mentoring' becomes critical for implementers of an innovation so that they continue to grow. Sweeny warns that if relevant support is not provided at the stage 3 concerns level, implementation problems may overwhelm the users of an innovation. As a result coping strategies which are often poor practice will be adopted (Sweeny, 2003). Sweeny (2003) and Hall and Hord (2006) indicate that management concerns are, in fact, not resolved quickly. For that reason intervention strategies should include a variety of activities which are modelled during training, and support given should be ongoing until teachers master the skills.

Hall and Hord (2006) state that as teachers become more experienced with an innovation, and as their early stage concerns are alleviated, they tend to move to impact concerns. Impact concerns are multifaceted and represent concerns for *"guiding, challenging, and meeting the diverse needs of students"* (Schipull, 1990 cited by Watzke, 2007, 107). Hall and Hord point out that when teachers are having consequence concerns (stage 4) they concentrate more on consequences of change for the pupils, and how they (the teachers) should tailor their ways of doing things and teaching subject matter so that their students succeed. They go on to say collaboration concerns (stage 5) focus on teachers assisting and coaching one another regarding the use of an innovation so as to increase student's achievement. Teachers experiencing collaboration concerns assist one another by also sharing lesson plans and ideas that have worked in their classrooms. During the refocusing stage (stage 6) teachers weigh the costs and benefits of the innovation and may decide to use alternatives that work even better (Hall and Hord, 2006). The authors argue that in times of innovation these later stages are more important in helping teachers make the required changes in the classroom.

Although both models show that pre-service and in-service teachers concerns shift in an orderly manner that occurs in a linear predictable pattern as teachers gain experience, later researchers recognize that a person does not necessarily have concerns clustered in just one stage at a time. That is, teachers may have a variety of concerns from different stages of concerns at the same time. However, at any given time, concerns from one stage may have more importance than those from other stages (Hall and Hord, 2006). Figure 2 (on the next page) is a representation from Hall and Hord (2006), showing graphically that at any point in time teachers with different levels of experience have different concerns, but may have concerns at more than one level.

The graph shows that at the early stages of an innovation non-users concerns are usually unrelated concerns (stage 0), with some informational concerns (stage 1), and perhaps self concerns (stage 2). They have fewer concerns at higher levels. Hall *et al*., (1979) point out that at this time non-users have few management concerns (stage 3) and are not concerned about how an innovation will impact on students (stages 4 to 6). The low intensity refocusing concerns (stage 6) suggest that the non-users do not even know about an innovation and do not even have ideas of how to improve the use of an innovation (Hall *et al.,* 1979).

During the first year or years of an innovation inexperienced user's management concerns (stage 3) are the highest and consequence concerns (stage 4) concerns are slightly lower than management concerns. An inexperienced user is a first-year user of an innovation (Hall and Hord, 2006). Hall *et al.* (1979, 40) suggest that when management concerns are intense the inexperienced user is *"indicating high concern about time, logistics, or other managerial problems related to the innovation".*

In contrast to inexperienced users, experienced users of an innovation (i.e. master teachers) have most high level concerns (consequence concerns and collaboration concerns), indicating more concern about how use of innovation is affecting their students (Hall and Hord, 2006). The average level of stage3 concerns suggests that the experienced user feels comfortable with using an innovation, and the few informational (stage 1) and personal concerns (stage 2) suggest that experienced users of an innovation are highly knowledgeable about an innovation and personally comfortable with using it (Hall *et al.*, 1979).

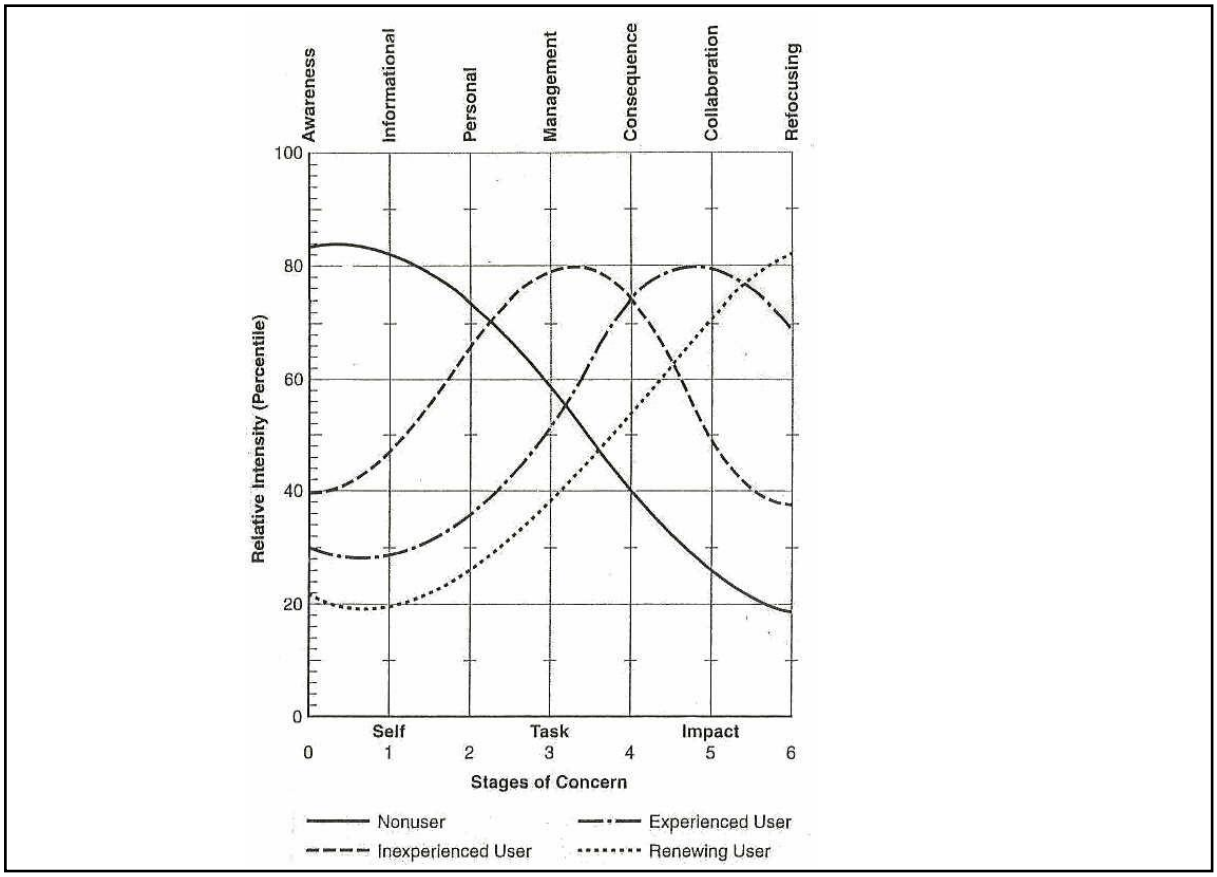


Figure 2: Changing concerns of teachers with different levels of experience, as an innovation progresses (Hall and Hord, 2006: 143)

2.4.3 Implications of the stages of concern theory

The stages of concern theory has three important implications for in-service providers. Firstly, the theory emphases the importance of listening to the concerns expressed by teachers as they engage in an innovation adoption process, and addressing them by offering in-service training that will match the teachers' needs (Hall and Loucks, 1978). Both models acknowledge that attending to where teachers are and addressing the questions they are asking when they are asking them is critical to fast-track the innovation adoption process and prevent adoption of coping strategies which are poor practice. Secondly, the theory emphasizes the importance of paying more attention to the implementation of an innovation for several years (Loucks-Horsely, 1996). Hall and Hord (2006) suggest that it takes at least three years to resolve early concerns, and later concerns might emerge as

soon as early concerns are resolved. Hall and Hord (2006) go on to say it is important to have realistic expectations about the time it will take to see progress and to make sure that all affected by change understand the change well. These authors caution that failure to address key aspects of the change process can either add years to, or even prevent, successful implementation. Finally, systematic monitoring of teacher concerns by those supporting teachers in times of curriculum innovation is necessary so as to facilitate movement from self concerns towards task and impact-related concerns (Cheung and Davis, 2000).

2.5 SUBJECT MATTER KNOWLEDGE

My experiences with other teachers in my cluster have shown that teachers generally lack content knowledge and when evolution was introduced teachers were very concerned because their knowledge of evolution was very weak. Teachers had not covered evolution in their studies and had not received recent in-services training to equip them with such knowledge. Furthermore, many papers I reviewed showed that teachers in other countries lacked content knowledge (e.g. Rutledge and Mitchell, 2002; Wuerth, 2004; and Wiles and Branch, 2008). South African teachers' lack of content knowledge about evolution has been confirmed by the research of Stears (2006).

To understand more about the importance of subject matter knowledge I reviewed papers related to content knowledge not necessarily specific to evolution. I did not find a specific single theoretical framework, so I looked at papers that touched on ideas of subject matter knowledge, and report on them below.

2.5.1 The importance of teachers' subject matter knowledge

Understanding what is to be taught (i.e. the organization of concepts and principles of specific topics) is a central requirement for teachers, yet the assessment of competency of student teachers, especially in America, de-emphasized this aspect (Shulman, 1986 and 1987). Shulman is so well known for his work on pedagogical content knowledge (PCK) that people tend to forget that it was his concern about teachers' subject competence which motivated the research of his research group.

In the 1986 paper Shulman identifies *subject matter knowledge* (which relates to a deep knowledge of the structure of the topic to be taught) as one of three categories of knowledge under the domain content knowledge, which refers to "*the amount and organization of knowledge per se in the mind of teachers*" (Shulman, 1986, 9). The other two categories which he considered the base knowledge for teaching are *pedagogical content knowledge*, and *curricular knowledge*. The second category, *pedagogical content knowledge* has become of central interest to researchers and teacher educators (Hill, Schilling and Ball, 2004). Shulman (1987, 8) believes that the category PCK identifies "*the distinctive bodies of teaching"* and defines it as the "*particular form of content knowledge that embodies the aspect of content most germane to its teachability*" (Shulman, 1986, p. 9). He includes knowledge of typical prior ideas students have about the topic in question, an understanding of what makes learning a topic difficult or easy for students, and knowledge of the best ways to teach the content (Shulman, 1986). His third category, *curricular knowledge*, involves awareness of how topics are arranged both within a school year and over longer periods of time, and ways of using curriculum resources, such as

textbooks, to organize a programme of study for students. In his 1986 paper Shulman makes an error in the section heading as he goes on to discuss the three categories of content knowledge, mistakenly calling subject matter knowledge "content knowledge".

Shulman (1986) did not consider subject matter knowledge as a sub-category of PCK. Many researchers (e.g. van Driel, de Jong and Verloop, 2002; and Abell, 2007) follow Shulman's original categorization, separating subject matter knowledge and PCK, but they emphasize (as does Shulman himself) that having appropriate PCK depends very strongly on the teachers' subject matter knowledge being in place. Several other researchers, however, (e.g. Cochran, De Ruiter and King, 1993) and Marks (1990), who was completing a doctorate in Shulman's research group in the 1980's, and Sanders (2008) proposed a different organization of teacher knowledge. They consider subject matter knowledge a sub-category of PCK because subject matter knowledge is essential if one is to teach a particular subject effectively.

The "*amount, organization, and accessibility of conceptual knowledge has been shown to distinguish experts from novices*" (Gess-Newsome, 1999, 55) and because teachers are considered to be the experts in the classroom, a good grasp of subject matter knowledge is important. Reasons why subject matter knowledge is essential for effective teaching emerge from research which shows what happens if teachers lack the deep understanding of subject matter knowledge which Shulman identified as so important.

- **Subject matter knowledge affects teachers' planning:** Stodolsky and Grossman (1995, 228) claim that "*subject matter is one of the primary organizers of the professional life of secondary school teachers*" influencing how teachers think, and suggests it "*undergirds departmental organization*".
- **Subject matter knowledge affects what and how teachers teach:** Stodolsky and Grossman (1995) and Ball and Bass (2000) point out that what teachers know affects not only what they teach but how they teach a topic. Without the essential base of subject matter knowledge teachers are simply unable to produce effective instruction. They either teach a topic superficially or leave a topic out, or they make mistakes, or explain it badly. Furthermore, teachers who lack subject matter knowledge tend to depend on transmission teaching (Shulman, 1986; Dennick and Joyes, 1994; Parker and Heywood, 2000; van Driel *et al*., 2002), use curriculum material injudiciously, and are less able to design meaningful homework and assignments for their students (Ball, Lubienski and Mewborn, 2001). Although based on research with only one teacher, Stein, Baxter and Leinhardt (1990) found lack of subject matter knowledge resulted in less emphasis on groundwork for future learning of the subject by the learners, and that because the teachers' subject matter knowledge was weak he could not make links between concepts, or meaningful representations. Hashweh (1987) points out that inadequate knowledge and inadequate in-service training results in teachers who may often have the same misconceptions as do their students. From informal talks I had with teachers in my cluster some indicated that their inadequate knowledge of evolutionary theory influenced their practices, with heavy reliance on textbooks and memorization of factual information. Understanding and knowing subject matter knowledge is "*essential to listening flexibly to others and hearing what they are saying or where they might be heading*" (Ball and Bass, 2000, 86).

- **Having good subject matter knowledge improves teachers' confidence:** Ball and Bass (2000) point out that knowing the subject matter helps teachers to be inventive in creating meaningful opportunities for learning that take learners' experiences, interests, and needs into account. Having good subject matter knowledge enables teachers to address with confidence diverse classroom challenges so students' opportunities to learn are not distorted (Ball, 2000).

2.5.2 Subject matter knowledge – the structure of the construct

In biology subject matter knowledge is more than just knowing the facts or concepts: it requires knowledge of both substantive structure and syntactic structure (Shulman, 1986; and Abell, 2007). Schwab (1978) explains that the structure of a discipline is important when educators are trying to plan a curriculum, because various "structures" are possible, depending on the viewpoints of the person looking at the structure, and their goals. Teachers who are focusing on transmitting knowledge will see the structure of the discipline differently to those trying to impart the skills of the discipline (Schwab, 1978). Schwab was instrumental in the production of three versions of the biology textbook during the Biological Sciences Curriculum Studies curriculum revisions in the USA in the 1960s, one taking a "molecules to man" approach, the second a "development and genetics" stance, and the third an "ecological" approach. These three approaches showed three very different ways in which teachers could organize the same subject matter, and this affected their sequence of teaching the content as well as their focus. Schwab emphasizes that it is not just a case of "knowing" the content, because various scientists will see the structure of the discipline differently. It is important to understand the structure, and to know that structure is flexible and depends on the eye of the beholder. Furthermore, Schwab (1978) says that teachers focussing on communicating knowledge tend to look substantively at the structure of the discipline (focussing on facts, concepts and principles, and how they should be sequenced). However, teachers also need to look critically when there are conflicting claims in science, in order to decide what to believe. This involves looking at the discipline structure syntactically. Shulman (1986) describes syntactic structure as involving ways in which 'truth' is established within a discipline where contradictory claims exist. In the case of evolution, where many people are doubtful about the legitimacy of evolutionary theory, teachers must be knowledgeable about the evidence that supports evolution (for example, comparative anatomy, paleontology, biochemistry, embryology and biogeography).

2.6 CONCLUDING REMARKS

The stages of concern theory is relevant in my study. Understanding about the stages of concern theory has helped me to structure and design my study (see next chapter which deals with the research design and methods) and to code the concerns and needs of the teachers involved in my study (see Chapter 4).

Subject matter knowledge has helped me to understand the depth and breadth of concepts that teachers need to know in order to teach evolution effectively, and to analyze my data more meaningfully.