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A socio-cultural case study of a primary school system in Venda, South Africa.

Muthivhi, Azwihangwisi Edward

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Chapter 3

3. Experimental Tasks

3.1. Introduction

In South Africa, experimental studies have often found that subjects within the "non-Western", non-industrialised and non-schooled communities (and mainly Black children) generally perform poorly on tasks, or lag behind their White or more westernised counterparts (Moll, 1994; Craig, 1985; Macdonald, 1987b; Kok, 1986; Muthivhi, 1995). For example, Craig (1985) conducted a study looking at the cultural origin of the dyadic patterns between Zulu mothers and their pre-school children. In this study Craig found that the dominant interactional structure followed a culturally derived pattern. Zulu mothers in the study demonstrated what is referred to as the "field dependent behaviour" whereby children were expected to do global imitations of the mothers' models (Craig, 1985). This instructional method is deemed to lead to inefficient problem-solving strategies.

Macdonald (1987b.) conducted an experimental study that also suggests poor task performance by Black African children. Macdonald replicated Pieraut-Le Bonniec's (1980) neo-Piagetian study of the development and use of propositional (hypothetico-deductive) reasoning in primary school children. Macdonald investigated pupils' understanding of the notions of "possibility" and "necessity", as psychological states that demonstrate the acquisition of formal operational thinking.

Macdonald (1987b) compared South African pupils across different cultural-linguistic schooling contexts; children learning in Black township schools were compared to the predominantly White "multicultural" schools that had begun to admit Black pupils. The comparison was extended internationally to include results obtained in a similar study with Scottish children (Macdonald, 1987b.). Macdonald's study replicated Pieraut-Le Bonniec's (1980) study with French children. Macdonald found that the Black-township pupils consistently underperformed when compared with their South African "multicultural" counterparts, as well as with the French and Scottish pupils.

The results of Macdonald's study and the suggestion of a deficit hypothesis pertaining to the culture and schooling of Black children inspired the current study to seek a better understanding of the nature of the problems that lead to such poor performance. The first step toward such an understanding was to replicate, while at the same time modifying, the neo-Piagetian experimental tasks on the basis of which the poor performance, suggestive of a cognitive lag, was established. However, replication of the studies that have served to confirm the cultural and (or) schooling deficit of African pupils would, from the perspective of the present study, not have been sufficient without a complementary experimental method that aimed to understand the cultural basis of psychological processes. Thus, the Vygotsky-Luria experimental tasks that were designed to uncover the cultural basis of the emergence of psychological processes were also used (Luria, 1976; Cole; Levitin and Luria, 2006). These tasks were adapted and used in the South African context by Moll (1994) and Muthivhi (1995), among others.

The Vygotsky-Luria experimental tasks situated cognitive performance within dominant cultural practices. They hypothesised that the forms of social activities in which individuals participate determined cognitive performance. That is, children manifest concrete and context-dependent forms of thinking because these forms of thinking dominated the practical activities and social relations in which they participate. Participation in social activities that required formal and abstract forms of thinking and reasoning would determine the associated forms of thinking and problem-solving strategies. The Vygotsky-Luria experimental tasks modelled this hypothesis in their design.

From this perspective, the cognitive performance of children on experimental tasks is analysed in relation to the cultural activities that inform such performance rather than in relation to the internal, individual, developmental processes that are constrained by external cultural factors. Without denying the importance of children's internal developmental processes, children's performance on the experimental tasks is primarily understood in terms of the meaningfulness that the experimental activity invokes on

their part, within the larger system of their participation and engagement in the activities of their society and culture.

This methodological approach was exemplified in Luria (1979; 1976). Luria conducted his studies during an expedition in the Soviet Central Asian republics of Uzbekistan and Khirgizia in the 1930s. He employed the experimental method that recreates the developmental history of psychological phenomena. The experimental tasks were modelled to uncover the forms of thinking and problem solving strategies that result from the subjects' experiences in their society and culture. The research context of the study suited Luria's research because the Soviet central Asian republics were undergoing rapid socio-economic changes following the 1917 Russian revolution. These rapidly changing social setting afforded Luria the opportunity to investigate the associated changes in basic psychological tendencies of his subjects' thinking (Luria, 1979; 1976).

Luria examined the development and manifestation of new psychological processes that were made possible by the introduction of formal schooling and the industrialisation of the hitherto agrarian and peasant communities. The Uzbeki and Khirgiz traditional societies were going through rapid social and cultural changes necessitated by the collectivization and mechanization of agriculture, and the various literacy programmes that were introduced to facilitate their participation in the new economy. Luria's experimental tasks integrated in their design the subjects' culturally organised activities by representing the two alternative ways in which the problems posed can be addressed. The experimental tasks were designed to determine if the subjects would solve the task problems in a manner that was consistent with their newly acquired modes of thinking that were characteristic of formal schooling It was expected that subjects' participation in formal schooling and its associated industrialised economic activity would generate thought processes that enabled them to transcend their "context-dependent " modes of thinking and use formal thought processes to solve the problems.

This experimental design of the Vygotsky-Luria study clearly situated cognitive

development and functioning in the social and cultural activities in which people participate. It also allowed for the analysis of cognitive development and functioning in terms of its social and cultural origins. That is, the methodology allowed investigation of how the practices of schooling, as well as cultural practices, made possible or constrained the development of concepts and certain modes of thinking and problem solving. This methodological approach complements the Piagetian “cross-cultural” approach exemplified by Pieraut-Le Bonniec’s (1980) and Macdonald’s (1987b) studies respectively. Thus, while the Piagetian approach provided important insight about children’s spontaneous acquisition of conceptual forms of thinking; it required a complementary methodology and interpretive framework that thoroughly addressed the role that the social and cultural factors played in the development of thought. The Vygotsky-Luria approach seems to provide such methodological and interpretive framework.

To achieve a better understanding of of concept development and functioning , the current study replicated Pieraut-Le Bonniec’s (1980) and Macdonald’s (1987b.) neo-Piagetian experimental tasks. The experiment investigated the spontaneous development of thought and the acquisition of formal operational thinking, specifically to do with children’s ability to perceive and to think in terms of what is possible and what is necessary from a given proposition. Piaget and Vygotsky used similar experimental designs that incorporated open-ended questioning methods during interviews to uncover the underlying meanings of the subjects’ responses (Piaget, 1981; 1970; Luria, 1976; Cole, et al. 2006). However, the overall experimental designs differed fundamentally because they were informed by different theoretical assumptions about development and its underlying explanatory principles or generative mechanisms. For Piaget, the mechanism was internal, in the self-regulatory actions of the child, while Vygotsky suggested the external mechanisms located in the relations the child has with its society. These differing orientations informed the differing experimental designs and interpretive framework adopted across the two theoretical traditions. One conceiving of the role of experimentation as the uncovering of the child’s naturally unfolding and internally located thought processes, while the other conceiving of the role of experimentation as the uncovering of externally located, socio-cultural practices and

their psychological consequences. However, these differences did not mean that the two research traditions could not be brought into a meaningful and complementary relationship with each other.

The Vygotsky-Luria experimental approach could complement the Piagetian approach in that the spontaneous development of thought processes in the later is viewed primarily in relation to the cultural developmental process and the capacity of these processes to direct the course of psychological development. Culture is considered to be the primary factor that explains the emergence and the development of the specific forms of thought processes that derive from the practices of human society. The approach, therefore, calls for an interpretative framework that involves, primarily, the extra-individual, social and cultural, processes.

The emergence of intra-individual processes is viewed as resulting from the necessary tension between the social and the individual “moments” of activity (Wertsch (1998; 1995). This is the kind of analysis that Wertsch proposed and which does not emphasise the individual at the expense of the social processes or vice versa. However, the analysis may foreground one or the other of the two elements of a single human activity that, according to Wertsch, are not “reducible” one to the other (1995: p.91).

The Classification and Generalisation Tasks in the present study investigated the developmental acquisition of the formal, abstract, and conceptual forms of thinking that are generated by the teaching-learning activities in which pupils participate in school. An alternative mode of problem solving subsumed in the tasks design involves the perception of a functional category that is informed by the graphic appearance of objects in the concrete, everyday, experiences of pupils. Hence, it is possible to hypothesise that, although the predominance of a formal, conceptual, mode of thinking would suggest that the practices of schooling have generated and reinforced a such a mode of thinking, the predominance of a concrete mode of thinking and problem solving would suggest that pupils’ culture and, possibly, their schooling, generated and reinforced concrete and graphic-functional problem solving modes.

The reinterpretation of the Piagetian tasks from a sociocultural perspective, assumed that poor performance on the tasks could be explained by considering the pupils' practices of schooling and culture. In addition, the predominance of concrete and graphic-functional classification in pupils' response to the Vygotsky-Luria Classification Tasks could also be explained by considering the practices of pupils' schooling and culture. The present methodology, therefore, expands on Luria's (1979; 1976) original findings; that his subjects' participation in formal schooling and the new, industrialised, economy generated new forms of thinking and problem solving consistent with these new societal practices. In the current study, participation in the new societal practices of schooling and economic activity would be expected to produce new forms of thinking and problem solving. Primarily, the nature and the quality of pupils' engagement and participation in the new societal practices of schooling should result in the development of the new, qualitatively different modes of thinking particularly associated with formal schooling. For example, the introduction of a formal schooling system to a traditional society may need to be accompanied by effective classroom teaching and learning practices that make the development of school-specific concepts and modes of learning possible. Should the practices of schooling and classroom teaching and learning reproduce the practices of the pre-existing society and schooling, when these were not necessarily congruent with the formal nature of the practices of schooling, the cognitive shifts and conceptual development necessarily for effective learning of formal school knowledge may be seriously hampered. This notion guided the experimental study and the classroom observation discussed in chapter 4.

3.2. Rationale of the Experimental Tasks

The "Circles Tasks" were adapted from the neo-Piagetian study of pupils' development and acquisition of formal operational thought processes conducted by Pieraut-Le Bonniec (1980) with French children and subsequently replicated in South Africa, by Macdonald (1987b.). These studies investigated the development of the notions of *possibility* and *necessity* in children. The study was premised on the Piagetian idea that children, at the operational stages of development, have some intuition of the "possible"

states of affairs. That is, children acquire the awareness and understanding of what is possible and what is necessary from a given situation once they have reached the formal operational stage of development, which, in Western societies, is fully achieved around the age of twelve. However, this awareness first arises around the age of seven, as a concrete operational form of thinking where the understanding of possibility and necessity, for example, is tied to the child's concrete experiences.

On the other hand, the pre-operational child, in Western societies just before the age of seven, is more likely to explain situations on the basis of the characteristics of their configurations, rather than on the basis of their transformations or changes leading from one situation to the other. Cognition, at this stage, is still bound up with concrete reality or what events and situations actually look like and is therefore not likely to manifest the understanding of the notions of possibility and necessity (Piaget, 1981; 1970; 1964; Pieraut-Le Bonniec, 1980).

The Circles Tasks was derived from the general Piagetian framework. According to this framework, all children irrespective of their social and cultural situation go through the same stages of development that make learning possible. What differs, from one society and culture to the other, is the pace at which development takes place. This difference can be explained through social, cultural and, more specifically, educational factors. These factors impact directly on the child's maturational, experiential and self-regulatory processes. Children may develop and acquire formal operational conceptual abilities at an accelerated rate when the educational and cultural processes provide the appropriate stimulation. They can also develop and acquire these abilities at a slower pace where the socio-cultural factors inhibit self-regulatory possibilities. Consequently, social transmission and educational processes are often deemed to account for the systematic lag in children's developmental acquisition of operational thought processes. The possibilities for a different developmental trajectory imposed on the child's spontaneous activity by his culture and society have not been adequately considered by the neo-Piagetian studies in the South African research setting. The current study used Vygotskian methodology and extended Piagetian methodology by suggesting an interpretive framework that accounts for the centrality of socio-cultural contexts of

learning and development in psychological analysis.

According to Piaget, concrete operational thought (around 7-11 years of age) is characterized by the extension of actual or concrete reality, towards the direction of the potential, or the possible. It is at this stage that the child begins to think in terms of what is possible and proceeds by formulating hypotheses about possible states, instead of thinking exclusively in terms of his perceptions of concrete situations. Classification of objects, for example, would be viewed as requiring a set of class inclusions. New objects can be included in a system of relationships with the objects that have already been classified. Thus, further class inclusions become continually *possible* within a given system of classification. At about 11 years of age, children have developed capacities for formal-operational thinking, referred to as *hypothetico-deductive* reasoning. Hypothetico-deductive thought proceeds from what is possible to what is empirically real. The deduction refers to hypothetical statements or propositional states rather than to perceptions of concrete situations. As a result, instead of deriving the conclusion about what is possible directly from the empirical data and concrete states, the formal operational child begins with the postulation that certain relations are necessary (Piaget, 1981; 1964; Pieraut-Le Bonniec, 1980).

Pieraut-Le Bonniec (1980) found that children's ability to maintain uncertainty, in relation to undecidable situations, that is, situations that enable them to think in terms of what is possible rather than in terms of what is empirically real, emerges at about ten years of age. By this age, Pieraut-Le Bonniec's children were able to differentiate with regard to experimental situations between instances where information for making a decision is lacking to cases where the information is complete to give judgement. That is, they were able to perceive and to distinguish between situations where something was "possibly the case" to where something was "necessarily the case". Macdonald (1987b) also found the same with regard to South African "multicultural" school pupils in her study. Conversely, pupils from the "township" schools manifest an apparent developmental lag and did not perform competently on the tasks.

Macdonald's results with the township pupils can be interpreted in two alternative ways.

First, it could be supposed that the poor performance was due to the fact that the subjects have not as yet fully acquired the formal thought processes necessary for understanding the notions of “possibility” and “necessity”. In this interpretation, the subjects’ culture, their schooling, language and life experiences would be viewed as inherently inadequate for stimulating the development of the formal operational thought processes. This interpretation is in doubt because the subjects are able to respond to some of the tasks questions and solve the related problems competently. The second alternative interpretation would be that the subjects have achieved the necessary stage of operational thinking, as evidenced by their competent performance on the majority of the tasks situations, but applied this form of thinking inconsistently because of the influence of their culture and schooling. That is, where cultural processes, involving language, emphasize concrete forms of thinking and problem solving, and the dominant approaches in classroom teaching and learning emphasize the concrete forms of knowledge and learning rather than the abstract and conceptually-based forms of thinking and problem-solving processes. This interpretation emphasized the cultural differences in learning and their influence on psychological development and functioning. The specific learning orientation and the linguistic modes that were shaped by the specific cultural contexts, as Piaget (1981; 1964) has acknowledged, have an influence on development and may impact on performance in important ways.

The tasks on Classification and Generalization were derived from Luria’s (1979; 1976) studies conducted in the Soviet Central Asian republics of Uzbekistan and Khirgizia in the 1930s. Luria’s tasks examined the development and manifestation of new psychological processes that result from the introduction of formal school learning and the industrialised economic activities. Luria studied the psychological shifts among the non-literate and semi-literate adults in the Soviet traditional societies was characterised by a rapid social and cultural changes as a result of the collectivization and mechanization of agriculture, following the 1917 Russian revolution. This prevailing social setting offered Luria the opportunity to investigate the associated changes in people’s basic psychological tendencies and content of their thinking.

Luria’s study subsequently established that rapid social and economic changes that

were introduced to the subsistence agricultural economies of the Soviet Central Asian republics, as well as the introduction of formal schooling, had resulted in changes in the ways in which people organize their thinking. According to Luria, the demands of the practical activities in the newly introduced collectivised farms and the experience of schooling and other related literacy practices contributed to the development of a newly emerging consciousness and psychological functioning amongst the Uzbeki and Kirgiz populace (Luria, 1979; 1976).

While Luria's (1976) study was credited for applying the historical-developmental method in studying psychological phenomena it was questioned for its assumption of quite broad changes in people's modes of thinking as a result of changes in their political and economic circumstances and their experience of schooling. Luria's study was also questioned for its apparent assumption of the absence of theoretical forms of thinking in traditional societies (Jahoda, 1986; 1982; Hutchins, 1983; Rogoff, 1981; LCHC, 1983; 1982; Cole, 1988; Cole and Scribner, 1974; Cole and Griffin, 1980; Wertsch,1985a; 1985b).

In his development of the Vygotsky-Luria methodology, Cole (1995; 1988) has suggested a reinterpretation of Luria's (1976) study in "context-specific" terms that calls for a consideration of people's practices, not as universal forms of activity, but as context-bound on the one hand, while also considering the historical origin of such practices on the other hand. That is, rather than emphasising one or the other between the context-specific and the historical-developmental approaches, Cole proposes that to understand the cognitive implications of human social practices we need to know both their internal organisation and the way that this organisation is shaped by the historical circumstances that gave rise to them (Cole, 1988).

Cole's reinterpretation of Luria's results, integrating the cultural-specificity approach with the historical developmental approach, informs the methodology of the current study. Luria's (1976; 1979) research design, and Cole's reinterpretation of the results in context-specific terms, provides an appropriate approach for the current study (Cole, 1996; 1990; 1988; also see Cole, Gay, Glick and Sharp, 1971; Gay and Cole, 1967).

The social setting in which the current study was conducted is characterised by rapid cultural-historical and political changes that have far reaching consequences on people's psychological constitution. Before the more recent changes, Venda had largely been a simple rural and subsistence based society located in the most remote part of South Africa. The difficult terrains and the strong cultural traditions have helped to ward off foreign infiltration and cultural influences in the region for many years. Until more recently, rapid changes brought about by the introduction of the Western political system and the growing industrial economy, as well as the formal schooling, have occurred. As a result, the cultural practices have been undergoing fundamental changes. The traditional practices of food production, traditional patterns of social organization, institutions for socialising the young and the traditional patterns of social relations have been going through transformation. However, this transformation needs to be understood as involving the continuation of these practices, sometimes in new forms, within the newly evolving social setting that encompasses both the new and the old. For example, the missionary activities of schooling and social conversion in Venda, as discussed in Chapter 1, did not lead to widespread rejection of traditional institutions and cultural forms of societal practices. Instead, missionary schooling was itself initially rejected. Schooling was only accepted en masse when it begun to be provided by the traditional leadership as part of the practices of the evolving culture. The support provided by the chieftaincy helped to minimise the contradictions that formal schooling had introduced in the society. School had hitherto been viewed as representing missionary authority, as turning the youth away from their cultural traditions and unsettling the authority structures in society.

3.3. Experiment 1: Circles Tasks

3.3.1. Aim and hypothesis

The Circles Tasks were devised to assess the modes of thinking and problem solving employed by children of different ages attending schools in Venda. The tasks assessed

the developmental acquisition of operational forms of thinking and problem solving by school-going Grade One, Grade Three, Grade Five, and Grade Seven learners in Venda. The Grade One Learners (six year olds) were expected to manifest a lack of operational forms of thinking and problem solving as they have not yet acquired the necessary developmental capabilities for such forms of thinking and problem-solving. However, the Grade Three and Grade Five learners (eight year olds) were expected to manifest operational form of thinking and problem solving, although this form of thinking is dominated by concrete modes. That is, learners would be able to provide competent responses to the task problems about "what is possibly the case" and "what is necessarily the case" about the task situations, only when they can perceive these situations through the concrete elements of the tasks presented to them in the experiment. Without such concrete, material, support to their thought processes, these learners are likely to conceive the solution to the task problem incorrectly.

However, the concrete operational thought processes that characterize the Grade Three and Grade Five learners' problem-solving strategies constitute a necessary precursor to the emergence of full mastery of the task demands, which is acquired at about eleven years old. At this stage, which is acquired by the time the learners reach Grade Seven, thought is no longer characterized by the extension of actual or concrete reality, towards the realisation of possible states. The Grade Seven learners were expected to think in terms of what is possible, and proceed by formulating hypotheses about possible states of the tasks situations. These learners were therefore expected to manifest higher levels of competency on the tasks because they are able to perceive many possible states as well as necessary conditions without having to rely, exclusively, on concrete manifestation of a situation. However, in spite of the spontaneous developmental acquisition of these necessary psychological processes by the Grade Seven learners, it was hypothesized that these learners may still be susceptible to performance errors, and manifest concrete and non-operational forms of thinking and problem solving on some tasks situations, due to the influence of certain dominant forms of their specific modes of learning and development deriving from their specific cultural and schooling context. That is, the practices of culture and schooling that emphasize concrete and experiential modes of learning and knowledge acquisition are

likely to produce the related modes of performance in pupils *pari passu* with the modes of cognitive performance that owe their development to the subject's spontaneous activity.

3.3.2. Research Design

The Circles Tasks involved the subjects responding to questions about *possibility* and *necessity.* The tasks involved hypothesizing about possible colour values that can be made from given task situations as well as the ability of subjects to perceive the necessary states in a given situation. Subjects' responses were considered competent when subjects could hypothesize the possible colour values that could be made from given task situations and when they could perceive if the outcome would be a possible or a necessary condition.

The Grade One learners had not yet achieved the concrete operational forms of thinking and could therefore, theoretically, not be expected to perform competently on the tasks. However, their responses to the tasks questions should provide important insights into the nature of the concrete concepts that prevail at this level of schooling and development, in the specific cultural and schooling context of the subjects' learning and development.

The Grade Three and Grade Five subjects were, from the Piagetian perspective, at the concrete operation stage and could therefore respond competently to the tasks questions about the possible colour values that could be made from the given task situations, as well as the necessary conditions under which such colour values would be possible. However, their understanding of the possible and necessary states represented in the task situations is tied up with concrete situations. That is, they would be able to say that something is "possibly the case" or "necessarily the case" when they can actually observe the relation, or transformation represented before them in concrete terms. It should therefore be expected that the present task would, in comparison to their Grade Seven counterparts, be relatively more demanding, especially where the relations are not easily accessible to observation.

The Grade Seven subjects are at the appropriate age for the formal operational stage of development and should theoretically be able to solve tasks problems that require the understanding and awareness of “possible” and “necessary” states of knowledge with relative ease. These subjects should have achieved a stage in their spontaneous developmental process where they are capable of deductive thought, which proceeds from hypothetical or prepositional states. That is, instead of deriving the conclusion about what is possible, directly from the concrete states represented by the tasks situations, these subjects are more likely to formulate a postulation that certain relations are necessary, and certain states are possible. This approach to problem situations enables subjects to achieve greater success on tasks that require prepositional forms of thinking for their resolution.

3.3.3. Subjects

A total of eighty pupils were interviewed for the present tasks. Twenty pupils were randomly selected from each of the four selected Grades in the junior primary and senior primary schools. Grade One and Grade Three subjects were selected from the junior primary school while Grade Five and Grade Seven subjects were selected from the senior primary school. Only two classes from each Grade were randomly chosen to participate in the study. Subjects were selected randomly from the class register. The researcher would identify a name in the class register, which he asked to keep during the experimental sessions and send for the child to come for the interview. The child would then be asked if she or he would like to participate or if she would not want to take part in the “game”[1]. The formal experimental session would begin only after that the invited child had expressed an interest in participating in the “game’, which was generally the case with all the children invited.

The average age of the learners in Grade One was six years old. Grade one was, for

1. In the interviews with the pupils, the tasks were generally referred to as the “colour game”. The notion of “game” was aimed at making the task less formal and less school-like to the subjects, so that any possible failure to provide an answer is not likely to be interpreted in a negative light.

the majority of learners, their first encounter with formal learning. Kindergarten or similar pre-school formal learning experiences were not accessible. By Grade Three, learners are generally eight years old. The junior primary school has four grades, that is, Grade One to Grade Four. The senior primary school pupils who participated in the study were selected from Grade Five and Grade Seven classes. The average age for Grade Five pupils was ten years old while the average age for Grade Seven pupils was twelve years old.

3.3.4. Materials

The experimental tasks made use of four circles of different colours, two red and the other two green. The circles are made out of a hard cardboard box. Two of these circles, one red and the other green, are each cut in the middle to make four half-circles, so that there are two red halves and two green halves. The other two full circles; one red and the other green, are left uncut and are only used in the pre-test teaching or demonstration stage. The pre-test teaching and demonstration session aimed to assess the subjects' understanding of the concepts and the procedures to be used during the experiment. For example, a red circle was shown to the subject to demonstrate the concept of "circle", and the colours "red" and "green."

The half-circles were used during this pre-testing stage to assess the subject's understanding of the different colour situations that can be made by placing two similar, or two different, colour half-circles together into a full circle. For example, a subject was shown, by demonstration and explanation, that two same colour halves placed together make an all-red or an all-green full-circle. Alternatively, different colour-half-circles placed together to make two full circles, each with two contrasting colours, a green-and-red colour full circle, or a red-and-green full circle.

During the pre-testing stage, the subject[2] was also encouraged to play with the experimental materials. The interviews, in the sense of Piaget's clinical method or

2. The technical term, *subject,* is used, following Pieraut-Le Bonniec's (1980) and Luria's (1976) studies, respectively, to refer to participants in the experimental tasks interviews.

clinical interviews (Piaget, 1981; 1970) were conducted with the subjects, in their home language. However, some of the subjects (especially the Grade Five and Grade Seven subjects) preferred to identify the objects and colour names in English. It was common, during the experiment, for the subjects to refer to the colour names, “red” and “green” by their English derivatives; “rede”, and, “girini”, rather than in TshiVenda ; “*mutswuku”* and *“mudala”*, respectively. Similarly, the name “circle” was mostly identified buy its English derivative; “sekele”, instead of the TshiVenda ; *“mutengelele”,* which the experimenter had used in the pre-test stage.

3.3.5. Experimental procedures

Demonstration: First, the researcher showed the subject the red and the green full circles, and asked if they knew what these shapes were called and what their colours were. If the subject did not know the names of the shapes or the colours, which was rarely the case, the subject was told that they were expected to use these consistently during the testing state. The second part of the demonstration stage involved showing the subject, using the half circles, how the halves combined to form an all red or an all green full circle and a red and green full circle. The third part of the demonstration stage involved the researcher covering two half circles of contrasting colours with a tinfoil paper and asking the subject to take one half out of the “game”. The researcher took one uncovered half out of the game so that a covered half and an uncovered half remained in the game. It was suggested to the subject that the colour value of the covered half was either green or red, and after that the subject agreed or indicated an understanding of the situation; the testing stage began.

Testing: After the teaching-demonstration stage, the experimenter again asked the subject to choose any one of the four half circles in the game and place it aside. After the subject had picked one of the four halves, the experimenter picked up the other half circle of a different colour value to the one that the subject had just picked up. The experimenter took the two halves, one that he picked up and the other that the subject had picked up, and wrapped them using a tinfoil paper. The experimenter made sure that the subject did not see the colour value of either of the two halves as he covered them and that the subject continued to view the colour value of the two halves as either

green or red, after they have been covered. This procedure lead to what became the first situation, *situation 1,* of the experiment.

Situation One then involved the experimenter asking the following questions (see table 3.3.1.below) in the order shown below.

Table 3.3.1. Situation 1. Questions of Experiment 1: Circles Tasks.

- (1a). If we remove the foil, will it be possible to make an all-red circle?
- (1b). If we remove the foil, will it be possible to make an all-green circle?
- (1c). If we remove the foil, can the full-circle be red-and-green in colour?
- (1d). If we remove the foil, will the circle be of one, or two, colours?
- (1e). If the circle that is made out of these two halves is one colour only, what colour does it have to be?
- (1f). A few minutes ago, another child made a one-coloured circle using the same halves as these in front of you. What colour do you think it was?
- (1g). What colour can all the circles that can be made out of these halves be?

During the interviews, a question was either repeated or re-phrased, where necessary, both at the request of the subject or at the discretion of the experimenter, as a way of facilitating the subject's understanding and active participation. See appendix 2.1 for a full representation of the task questions and the model answers.

When Situation 1 had been completed, the subject was presented with Situation 2 questions. Situation 2 involved the experimenter placing into the game an additional, uncovered, half circle –of a contrasting colour to the red half circle. A green uncovered half circle was placed into the game. That is, Situation 2 comprised three half circles; a red uncovered half, a green uncovered half and a tinfoil-covered half. The following questions were asked in the order represented in table 3.3.2 below.

Table 3.3.2. Situation 2. Questions of Experiment 1: Circles tasks.

- (2a). Can we make a red-and-green colour circle?
- (2b). Is there another way in which a red-and-green circle can be made from the half circles in front of you?
- (2c). With these half circles, will it be possible to make an all-red circle?
- (2d). If the tinfoil is removed, will it be possible to make an all-green circle?
- (2e). If the foil is removed, can we make a one-coloured circle from these halves in front of you?
- (2f). If we want to make a one-colour circle, by these halves in front of you, what colour will it be?
- (2g). If the foil is removed, what are the different-colour circles that can be made from the half circles in front of you?
- (2h). If the one colour circle that is made from these halves in front of you has to be one colour only, that is: all-red, or all-green, it has to take the colour of one of these three halves. Can you say which one this half circle is and why do you think so?

3.3.6. Recording of data

The subjects' responses to the task questions were tape-recorded. The summary of the interview, in the form of the interview questions and the subjects' response patterns, were recorded in a notebook while the interview was taking place. For example, a response that revealed the subject's understanding of the notions of possibility and necessity was recorded as a "competent" response while the response that indicated a lack of such understanding was recorded as "not competent" or "incompetent". The subject's response was recorded as incompetent when it ascribed a colour value to the covered element. Conversely, the response was recorded as competent when it proceeded from an "either-or" situation and demonstrated the awareness of the hypothetical state of knowledge with regard to the colour value of the covered element.

3.3.7. Method of analysis

The data were analysed by examination of the patterns of the subjects' responses. That is, in terms of whether the subjects' responses were competent or incompetent with regard to the understanding of the notions of possibility and necessity. A response that suggested that the subject did not ascribe a particular colour value to the covered element but formulated a hypothesis about the covered element, and arrived at an indeterminate decision about the colour situations, was considered competent. On the contrary, a response that suggested that the subject ascribed a definite colour value to the covered element and thought about the covered element in concrete terms of "what is" rather than in terms of "what might be" was considered an incompetent response.

3.3.8. Results of Experiment 1: Circles Tasks

The Grade One subjects experienced the most difficulty in responding to the task questions. These subjects obtained the overall competent response of only 36%. The Grade One subjects performed worst on five task situations; namely, *situation 1c, situation 1f, situation 2f, situation 2g, and situation 2h*. In these task situations, jointly considered, the Grade One subjects were only able to provide two competent responses.

The Grade Three subjects obtained a 64% competent response score. There was therefore an emergent mastery of the tasks that was manifest by these results. The Grade Five subjects obtained 68.9% while the Grade Seven subjects obtained 84.6% (see the Tables 3.3.3 and 3.3.4).

To determine the competency level of the subjects in each of the four Grades, it was necessary to view their responses to the various task questions in relation to each other. The greater number of consistently high competent responses to the task questions that manifest progressively from the Grade Three, Grade Five and the Grade Seven subjects attested to the developmental achievement of the operational thought processes by these subjects, although such processes may largely be manifest as concrete concepts for the Grade Three subjects. In contrast the incompetent

responses, and the inconsistencies in the competent responses of the Grade One subjects, attested to the lack of mastery of the operational form of thinking, associated with the tasks.

A one way ANOVA procedure was conducted to determine if the change in performance across the grades was significant. The results of the ANOVA procedure (see table 3.3.5. below) indicated a significant difference between the four grades on Experiment 1, (F (3,76) =15.40, p<.0001). A *post hoc,* Bonferroni, test (also see appendix 2.1.2.) indicated that the significant difference was between Grade One and Grade Three, and between Grade Three and Grade Seven. Table 3.3.4 below shows the means and standard deviations of each of the four grades. The means and standard deviations in Table 3.3.4. and Figure 3.1. show that there was a significant differences between Grade One and Grade Three, and between Grade Three and Grade Seven indicating a developmental trend in performance, but there was little improvement in performance between Grade Three and Grade Five or between Grade Five and Grade Seven.

Table 3.3.3. Overall total numbers of competent responses to both *situation 1* and *situation 2* questions by subjects from across the four Grades

Grades	**Grade 1**	**Grade 3**	**Grade 5**	**Grade 7**
Responses in % out of a total of 280 responses per Grade.	**36%**	**64%**	**68.9%**	**84.6%**

Table: 3.3.4. Means and standard deviations of each Grade.

Level of grade	N	Experiment 1	
		Mean	Std Dev
1	20	2.40	1.54
3	20	3.95	2.24
5	20	5.00	1.86
7	20	6.00	1.21

Table 3.3.5.: Results of the ANOVA procedure on Experiment 1: Circles Tasks.

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	142.13	47.37	15.40	<.0001
Error	76	233.75	3.07		
Corrected Total	79	376			

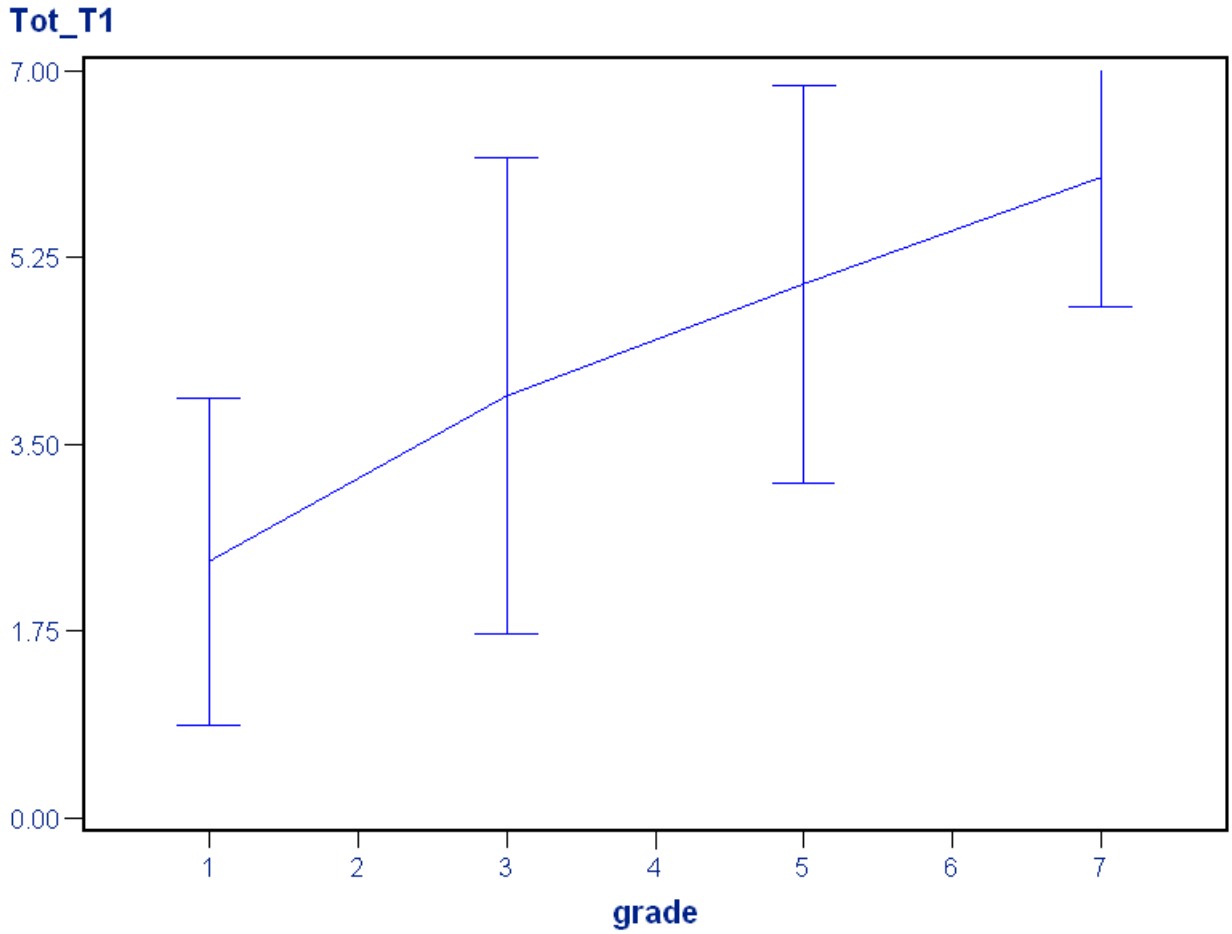


Figure 3.1. Developmental trend in subjects' performance across the four grades on Experiment 1.

3.3.9. Discussion of Results

The performance pattern across the four Grades was consistent with Piaget's theoretical formulation that propositional forms of thinking emerge at the concrete operational stage around the age of seven years old. This is progressively consolidated with the achievement of the formal operational stage—around the age of ten to twelve years old. However, because the emergence of the stages is not strictly tied to the specific age levels, the manifestation of the general capabilities that characterise a particular stage may occur at a slightly earlier or later years, depending on the social circumstances of the child (Piaget, 1964). The results in the current study support this general theoretical proposition, as the pupils' age range in the given Grades was

consistent with those proposed in the theory. The data confirmed the theoretical proposition about major stage-like transitions from lower to qualitatively higher forms of thinking, occurring between the ages of seven and eleven years of age. In the present experiment, the effects of the experience of schooling and the quality of learning and concept development generated by school learning experience cannot be ignored. The learning experience of the subjects seems to have affected the extent to which they employed one mode of thinking or the other in solving the tasks.

That is, unlike the performance of the subjects in similar studies discussed above, only 69% of the responses of the ten-year old Grade Five subjects in the current study were 'competent'. Meanwhile, the twelve-year old Grade Seven subjects offered overall competent responses of 85%. Whereas the overall performance confirms the theoretical proposition about developmental progression of thinking, the results are not consistent with those obtained in similar studies because performance levels of the subjects in the present study fell behind their counterparts in the other studies. These performance differences can be explained only if we consider the subjects' task performance as a social activity.

The subject participated in an activity determined by adults and produced actions that were the result both of his development and his learning. None of these two processes determine the other in a neatly linear fashion. That is, certain forms of learning should be viewed as essentially social and cultural, and as Vygotsky (1978) argued, determining the cultural development of thought and hence producing culturally shaped levels of task performance. The concept of development, from the present analysis, is expanded to include both the essentially *endogenous* processes (in Piagetian sense) and the essentially *exogenous* processes (in Vygotskian sense). The result is a *plural* or *heterogeneous* process that is not reducible, in a simple fashion, to one or the other of the two developmental trajectories that the present theoretical tradition emphasizes.

The explanation for the subjects' task performance should therefore be sought beyond the deficiency notions of culture and cognition. The modes of classroom teaching and learning and the practices of the subjects' culture and society should be considered as

factors that influence development and task performance. That is, subjects' responses to the task questions, and their actions to solve the task problems, were essentially influenced by the practices of their culture and society as much as they were determined by their task-oriented cognitive activity.

Subjects may, for example, adopt a particular orientation to understanding and resolving problems that derive from the practices of their schooling and society; namely their modes of learning in school as well as in everyday situations, their language practices, and the concepts embedded in these practices. They may, for example offer responses that derive from a premise that contradicts the one assumed by the experimenter, without the experimenter realising it. That is, they may interpret a phrase in the task questions, "If we remove the foil…", from the point of view of their language practices and their learning experiences, as suggesting a concrete action of uncovering the task element concerned. As a consequent, the responses they provide may proceed from the assumption that the task questions suggest a concrete activity, something like a cultural riddle that needs to be solved by suggesting a solution that has concrete application.

This view differs from one that assumes that responses to tasks questions, and the actions to resolve the tasks problems, emanate exclusively from the child's own activity. The child's activity needs to be understood within its specific cultural and societal setting. What specific culturally derived conceptual tools do children use to orient themselves to the task problems, to resolve the problems in a manner that makes cultural sense to them? For example, a child may understand situation 1(f) question: "A few minutes ago, another child made a one-coloured circle using the same halves as these in front of you. What colour do you think it was?" in a concrete sense because he has not encountered situations in his language, or in his school learning, where hypothetical situations were presented for the sole purpose of resolving the proposition. This is different from saying that the child has no conceptual ability to understand hypothetical situations. Rather, the use of the hypothetical person does not make reasonable cultural sense to the child because his schooling and his culture do not engage him in such questions. Questions that are emphasised in the child's

experiences are questions that relate to the concrete situations and real life experiences. These modes of practice can be observed in the subjects' practices of schooling and society.

3.3.10. (a.) Grade One

The Grade One subjects showed no understanding of the experimental tasks as a whole. They did not make sense of the task procedures and they did not focus on the task questions. Their responses to the task questions were generally incompetent. Their overall performance score of 36% indicates a lack of consistency in their responses to the task questions. Most of their responses proceeded from the students' engagement with the empirical realm. Although the Grade One subjects occasionally demonstrated an apparent sense of understanding of the possible, this understanding was closely tied to the concrete appearance of the tasks objects. For example, in response to task situation question 1a, subjects would say, that it was possible to make an all red circle, but not perceive this possible state in hypothetical terms. The subjects' notion of the possible may be closely related to the notion of the actual, where a situation is perceived as possible and simultaneously perceived to be the actual. The perception of possibility is actually subordinated to the overarching structure of the concrete and the real.

3.3.10. (b.) Grade Three and Grade Five

The Grade Three and Grade Five subjects demonstrated greater competence when applying the concepts of possibility and necessity in addressing the task problems. The performance score of the Grade Three subjects was 64% while the Grade Five subjects obtained a 69% competent responses on the tasks. These subjects could clearly address the task questions competently, demonstrating an understanding of possibility and necessity situations. Therefore they cannot be considered not to have acquired the necessary forms of operational thought structures that make such understanding possible. However, they did not obtain a competent performance score on all the task questions. The inability to perform competently on some tasks' questions may therefore

be explained by reference to the experimental activity and the subjects' assumptions about the experimental tasks. This is where the subjects' culture and everyday activity vis a vis their formal school learning needs to be examined. Culture and schooling provide settings for the developmental acquisition and functioning of the formal thought processes. The practices of culture and schooling may inhibit the manifestation of formal thought processes.

Although in most of the task situations the subjects demonstrated that they had mastered the understanding and use of the notions of possibility and necessity, there were instances where the subjects went beyond the framework of the experimental tasks' demands. For example, 40 percent of the Grade Three subjects argued, with regard to situation 1b question, that it is possible to make a circle that is green in colour. Twenty five percent of the Grade Five subjects also responded to this question in a similar fashion. This situation was in fact not possible because the uncovered half was red. In justifying their responses, most of these subjects argued that the green uncovered half, outside the game, could be joined with the covered half to make a green circle if the covered half turns out to be green. In this way, these subjects applied concrete thought processes, interpreting the possible in terms of the actual by importing outside information to enable a creation of a concrete situation.

The subjects used their global understanding of what different colour circles could be made, as demonstrated to them during the pre-test demonstration stage, and perceived the situation in terms of the "possibly-real". A similar mode of thinking was manifested in the subjects' responses to the situation 1f question. Subjects responded to question 1f: " A few minute ago, another child made a one-coloured circle using the same halves as these in front of you. What colour do you think it was?", in concrete terms. They would respond that they did not know what the other child did because they did not see the other child performing the task. Apart from these specific patterns, in many of the task situations where they failed to perform competently, the subjects ascribed a definite colour value to the covered element and responded to the task questions from the perspective of what the situation "is", instead of what "it could possibly be".

3.3.10. (c) Grade Seven

The Grade Seven subjects responded competently on 85% of the task situations. This demonstrated that these subjects understood the notions of possibility and necessity in the experimental tasks. However, the subjects were also susceptible to responding incompetently on specific task situations. For example, the Grade Seven subjects, like the majority of the subjects in the other grades, tended not to respond competently to situation 1f and 1g.

Situation 1f proved to be the most difficult for the subjects. This is because the hypothetical statement: “A few minutes ago another child made a one-coloured circle using the same halves as this in front of you…”, was often interpreted in concrete terms, where its meaning was given a literal interpretation. The notion of “another child” tended to be interpreted as referring to a real person who had earlier on participated in a similar experiment. As a result, most subjects argued that: “It depends on what colour halves the other child has used”, or “I cannot say what colour it was because I did not see what the other child did”. These subjects interpreted the hypothetical child in the task question in a literal sense, as referring to a real event that happened earlier on, and sometimes thought of the participants who have gone before them as the child the statement referred to.

In the case of situation 1g, as in questions 2g and 2h that required the formulation of a double hypothesis about the covered element, most subjects performed incompetently. This may be due to the subjects’ tendency to think of the possible as also involving the real, thus assuming that the alternative state becomes impossible once first or second state has been proposed.

In conclusion, the results generally support Piaget’s developmental theory about the order and the age range around which the major stages of cognitive development occur. The apparent lack of competent responses on all the tasks situations, especially by the age of ten years old, should not be cause for concern as the results demonstrate

that the subjects have, in fact, achieved the necessary forms of thinking that enable them to understand hypothetical situations involving necessity and possibility.

The subjects' incompetent performance on some of the tasks situations does not therefore suggest a lag in the subjects' overall development. Rather, the subjects demonstrate the cultural aspects of their learning and development. Culture mediates the modes of thinking and problem-solving strategies that the subjects assume to be appropriate for the nature of the problems that they encounter. Task performance and performance in general, is therefore not explainable only through the subjects' already developed cognitive capacities. Culturally derived patterns of human social relations such as those embedded in formal schooling and other institutional settings introduced, in the course of the child's spontaneous developmental process, essentially social and cultural forms of thinking and problem-solving. As a result, the forms of thinking and problem-solving strategies that children use in problem situations would not exclusively derive from their individually attained, ontogenetic, domain of cognitive achievement. The social and the historical domains of the subject's cognitive development and functioning continue to influence and shape individual performance, even when acting alone in apparent isolation from the obvious influences of others in his social surrounding.

The heteroglossia of thought processes manifested in the subjects' tasks performance should therefore be explained by a consideration of the nature of the developmental context of the subjects' society and schooling. Participation in the learning activities that emphasise the empirical methods characteristic of those that dominate everyday learning situations would generate the development of spontaneous concepts. That is, the learning situation that emphasize the acquisition of the spontaneous concepts is not likely to generate a deliberate use, on the part of learners, of the modes of thinking that require abstract-theoretical form of thinking such as the one represented in the present experiment. The learning situation in which development takes place is however not conceived only in terms of the physical environment but also of the social environment involving the cultural patterns adult-child relations and the patterns of thinking and concept organisation embedded in language. This was further examined in the

Classification and Generalization task below.

3.4. Experiment 2: Classification and Generalization Tasks

3.4.1. Rationale for Experiment 2

The Classification and Generalization Tasks investigated the historically acquired practices of schooling and society within the specific cultural context of their development. The Classification and Generalisation Tasks were designed to simultaneously subsume the culturally shaped, spontaneous, practices of the subjects' everyday life on the one hand and the historically acquired institutional practices of formal schooling on the other hand. By subsuming the two alternative problem solving methods with divergent developmental trajectories within a single experimental activity, the tasks provided the subjects with the opportunity to use one or the other modes of thinking and problem solving.

The Classification and Generalization Tasks were replicated from the original study conducted by Luria in central Asia in the 1930s (Luria, 1979; 1976). Luria examined the development and manifestation of psychological processes that resulted from the introduction of formal school learning and new, industrialized economic activities. Luria hypothesized that rapid social and cultural changes as a result of the collectivization and mechanization of agriculture, as well as the introduction of formal schooling, would result in similar shifts in people's psychological processes. Luria's study subsequently established that formal schooling, and the rapid social and economic changes that were introduced to the subsistence agricultural economies of Soviet Central Asia produced the associated changes in people's basic psychological tendencies and organization of thinking. According to Luria, the demands of the new practical activities of industrial farming and participation in formal schooling contributed to the development of new psychological functioning amongst the Uzbeki and Kirgiz populace, characterized by formal, abstract modes for thinking and problem solving (Luria, 1979; 1976).

In South Africa, Luria's study was replicated by, among others, Moll (1994) and Muthivhi (1995) respectively. Moll (1994) conducted a study with an elderly illiterate rural male subject in South Africa using the tasks derived from Luria's study. In this study, Moll found that his subject lacked abstract forms of thinking and, as a result, responded to the task questions in a concrete and context-specific manner. Moll argued from this finding that formal schooling was necessary to the explanation of the emergence of formal, abstract thought processes (Moll, 1994).

Muthivhi's (1995) study, inspired by Moll's (1994), compared the task performance of learners in two rural, neighboring secondary schools with differential experiences of the effects of the 1980s political disruptions of schooling in South Africa. In this study, the school most affected by the disruptive political activities and learner activism performed relatively poorly on the tasks and emphasized concrete and functional mode of thinking and problem solving. Although the less affected school performed better, the subjects, nonetheless, manifested an inclination to slip into functional mode of solving the task problems. However, what was particularly revealing in the responses of these subjects was the use of a third category not explicitly accounted for in Luria's (1976) analysis. The subjects used abstract-linguistic but functionally oriented category that employed a differentiated concept of "animals". That is, the subjects classified "wild" animals separately from the "domestic" animals and resisted classifying "animals" together under a single category.

The result of this study suggested that the effects of schooling and socio-cultural change on psychological processes could not be viewed in a simple, universalist sense; as transposition of pre-existing forms of thinking by new ones emanating from newly introduced practices. Cole's (1988) critique of Luria's (1976) universalist stance and the suggestion of global transformation of existing psychological processes resulting from the introduction of new practices of schooling and economic activity seemed to be supportive of Muthivhi's (1995) findings. However, the nature of the transformation that occurs in specific socio-cultural settings as a result of rapid socio-cultural change and specific experiences of formal schooling still needed to be systematically and thoroughly

investigated.

3.4.2. Aim and hypothesis

The Classification and Generalisation Tasks aimed to investigate the development and functioning of pupils' thought processes in their specific social and cultural setting, characterised by rapid changes in the practices of their schooling and society. The study investigated the hypothesis that participation in formal schooling resulted in associated shifts in the forms of thinking, especially in the development of formal, abstract, thought processes.

Te transformation of thinking that results from the practices of schooling and society would not constitute a global transformation of thought processes but would result into a heteronymous developmental process. The social and cultural factors that generate the development of thought processes in spontaneous activity settings on the one hand, and in formal school settings on the other are not homologous. The structure and content of phenomena that direct development in spontaneous, everyday, situations differ qualitatively from that which pertains to formal school learning situations. Formal school learning is primarily concerned with pupils' acquisition of the formal, scientific, knowledge using the most appropriate methods for such acquisition.

The cognitive performance of these subjects, who have experience of formal schooling within a traditional cultural and schooling setting, may reveal the inadequacies of the particular schooling to which they are exposed and reflect aspects of both formal thought and concrete or empirical thought processes. Therefore, the results of the present experiment were expected to reflect, not only the transformation from concrete and spontaneous thought processes to the formal, theoretical, forms of thinking, but also a pattern of thinking that reveals the quality of classroom teaching and learning, characteristic of the subjects' specific forms of schooling in their unique socio-cultural setting.

That is, it was expected that the Grade One subjects would tend to manifest concrete

and functional forms of thinking in their responses to the task questions. The Grade Three and Grade Five subjects were expected to manifest abstract-categorical forms of thinking and problem solving, although they would also manifest tendencies for concrete and functional mode of thinking due to the specific nature of their schooling and socio-cultural setting. The Grade Seven subjects were expected to manifest abstract and categorical form of thinking as a dominant mode of solving the task problems, although they would, at a much lesser degree, also manifest tendencies towards concrete and functional mode of thinking. This hypothesis took into account the subjects' development, the specific nature and quality of their schooling, as well as the cultural setting in which the subjects' learning and development took place.

3.4.3. Research Design

The design of the Classification and Generalization Tasks was informed on the one hand by the assumption that subjects with the experience of schooling solve problems using the psychological tendencies that are shaped by the practices of formal school learning. That is, when faced with problems that require the classification of objects, schooled subjects would use the formal mode of classification that characterise school-specific forms of knowledge and learning. They would, for example, use the abstract and categorical mode of classification to solve classification problems presented to them in the experimental tasks. The abstract and categorical classification mode emphasizes linguistic concepts, rather than pure experience, to establish object relations in task situations.

On the other hand, subjects who do not have the experience of formal school learning, and a meaningful participation in industrial economic activity, would tend to solve the task problems using the classification mode that is dominated by the graphic appearance and concrete relations among objects. They would tend to emphasise the knowledge that they derive from their concrete situations through observation and verbal modes, involving how things appear and how they function, than their essential qualities, encapsulated by abstract, categorical, concepts.

The experimental tasks involved the demonstration or “teaching “stage and the main, presentation, stage. During the demonstration stage, the subject was presented with the task situation and asked to say which three of three, of the four, objects represented in the four drawings belong together. The experimenter demonstrated where the subject groups the objects in a functional way, how the objects are classified using abstract, and categorical classification mode.

The presentation stage involved the subject responding to questions about which three of the four objects represented in the drawings belong together, or saying which one of the four objects does not belong with the other three. After that the subject had responded to the classification question by carrying out a classification action, described above, the subject was further asked to explain the basis of his or her classification. The subject’s reasons for his or her chosen classification were important for determining the conceptual basis of the subject’s classification mode.

3.4.4. Subjects

Eighty pupils, the same subjects that participated in the Circles Tasks, took part in the Classification and Generalisation tasks. The Classification and Generalisation tasks were presented immediately after the Circles tasks. The subjects were randomly selected from the class registers of Grade One, Grade Three, Grade Five, and Grade Seven classes. The age of the subjects ranged from six years in Grade One, eight years in Grade Three, ten years in Grade Five and twelve years in Grade Seven. Twenty subjects are selected from each Grade.

Non-participating subjects were welcome to observe the interview during breaks or free periods. As participation in the interview was voluntary, subjects who expressed unwillingness to continue participating in the interview were allowed to withdraw. This was however a rare situation as the majority of the pupils in both junior and senior primary schools were expressed their enthusiasm about participating in the “games”, to the effect that most pupils had to be excused as they could not be accommodated.

3.4.5. Materials

The materials comprised four stiff A4 size white cardboard sheets, each having a set of four black-ink drawings, representing objects ranging from animals, tools and plants. The following objects were represented in each of the tasks situations:

- Task A: pick, panga, hoe and wheat
- Task B: kraal, giraffe, goat and cow.
- Task C: tree, donkey, lizard and cow
- Task D: hut, wheat, tree and mealie plant

An additional A4 size cardboard sheet, with drawings of *knobkerrie*, *bow and arrow*, *spear,* and *antelope,* was also used for the pre-testing demonstration and teaching purposes (see *Appendix* 2.1. for a picture representation of all these tasks materials).

3.4.6. Experimental procedures

The first stage in the presentation of the tasks involved showing the subject the task materials and explaining the procedures. This was the demonstration stage where the subject was encouraged to touch the tasks materials and ask what the different picture representations were. All the subjects knew the objects represented in the tasks, either by experience or through school learning.

The subject was then informed that each of the tasks was going to be presented to him so he could determine how to classify three of the four objects which he thinks belong together, or takes out one of the four objects that he thinks does not belong with the others. The demonstration task involving the drawings of *knobkerrie*, *bow and arrow*, *spear* and *antelope* were used during this stage.

After the demonstration stage, the testing stage began with the experimenter asking the subject to classify the objects using one of the two alternative classification modes. The experimenter started by asking a question that required classification, namely; “Which

of these does not belong with the others?" or "Which three of these four objects belong together?" After that the subject had classified the objects by pointing or naming one object that did not belong with the others (or pointing or naming the three objects that belonged together), the experimenter asked a second question requiring the subject to provide the reason for his chosen mode of classification. This was the crucial question because it determined the quality of the subject's thinking regarding the actual classification mode of the subject's overall response or solution to the tasks problem. The question seeking the subject's reasoning behind her classification was, "Why do you think the object (naming it) does not belong with the others?" or "Why do you think the three objects (naming them) belong together?"

Probing questions were asked in situations where a subject provided a concrete, functional, classification to see if the subjects would change their classification and adopt the formal, categorical, classification that the experimenter proposed. For example, the experimenter proposed an alternative classification mode, posing the question: "What if I take this (naming the object) out?" or "What if I group these three objects (naming them) and take this one (naming it) out?" Should the subject maintain his/her chosen classification mode, the classification pattern was determined to be characteristic of his chosen mode of object classification.

3.4.7. Recording of data

The interview was tape-recorded, at the same time that the pattern of the subject's responses was recorded in the notebook. The subject's response to the question requiring him/her to classify the objects is recorded as either "graphic-functional" or "abstract-categorical".

A classification was recorded as graphic and functional if it reproduced the relations that objects had in real-life situations or if it emphasized the concrete form of the objects to be classified. That is, a *panga* and *hoe* may be grouped together with *wheat,* or a *goat* and *cow* grouped together with *kraal*. In the everyday-life situations of the subjects' traditional existences, these objects were experienced as functioning together.

A classification action alone was not considered sufficient to make a decision about the fundamental nature of the subjects' thought processes. The subjects' reasoning behind each of their classification was always probed. The subject's overall response was recorded as categorical only if it was supported by reasoning based on the use of linguistic concepts such as "animals", "tools", "plants", etc. These concepts denote the category to which the objects identified are deemed to belong. However, if the subject revealed reasoning based on the functional relations of objects or their concrete manifestation, the overall response was recorded as functional and graphic. This form of reasoning may be given to support a clear instance of a functional classification action or to support an apparent categorical classification action that involved, for example, the classification of *pick, panga* and *hoe* into a single category.

The classification action was recorded as graphic and functional if the reasoning behind it was not based on the use of abstract linguistic concepts but on the functional relations and concrete manifestation of the objects. For example, the reasoning behind the classification action for *pick, panga* and *hoe* that proceeded from the assumption that these objects are used together in the fields; a *panga* cuts down the bushes, a *pick* digs the stumps as the fields are prepared for ploughing with the use of a *hoe*, was recorded as a fundamentally functionally-oriented form of reasoning.

3.4.8. Method of analysis of the results

The analysis focused on whether the subjects' response revealed a graphic-functional or abstract-categorical classification mode. A graphic-functional classification mode involved the classification of objects according to their appearance and functional significance. The abstract-categorical classification mode involved the classification of objects according to their abstract linguistic categories, established on the basis of the use of linguistic terms or conceptual relations.

For a graphic-functional classification of an item that comprises a *giraffe, goat*, *cow* and *kraal*, the *giraffe, goat* and *cow* will be grouped together and a *kraal* excluded because

the former are *animals*. A graphic and functional classification would, on the contrary, emphasise the real-life relations the objects are deemed to have as experienced by the subjects. For example, in an item that comprised a *giraffe, goat, cow* and *kraal*, the *goat* and *cow* would have been grouped with the *kraal* because the *goat* and *cow* are kept inside the *kraal*, but the *giraffe*, as a wild animal, would not be kept in the *kraal*. A reasoning pattern that justified a categorical classification action such as: giraffe, goat and cow, in functional terms, was identified as a functional mode of classification. This comprised reasoning patterns that classified these objects together because they all eat grass or would be found together in the bush. The emphasis that the subjects placed in justifying their classification determined what underlying mode of reasoning they used to get to such classification.

3.4.9. Results of Experiment 2: Classification and Generalization Tasks

3.4.9. (a.) Grade One

The Grade One subjects emphasised a functional and graphic mode of object classification. Only 2.5% of their responses to the task questions were abstract-categorical. Only in two occasions, in Task A and Task B, did the Grade One subjects offer categorical responses, one on each of the two task situations. In some instances, the Grade One subjects offered what appears to be categorical classification, which, however, was accompanied by seemingly functional reasons. For example, in Task A, the Grade One subjects classified *pick, panga* and *hoe* together but were unable, except for a single instance, to justify their classification by using the term “tools” as a basis for their classification. The Grade One subjects did not, therefore, use the linguistic concepts to establish conceptual relations among the objects. Almost all of the reasons for the Grade One subjects’ classification (97%), emphasised graphic and functional relations that the objects have in concrete, everyday, situations where they are encountered.

3.4.9. (b.): Grade Three, Grade Five and Grade Seven

The performance of the subjects in the three other grades, Grade Three, Grade Five and Grade Seven, with regard to the use of the abstract-categorical classification mode, was not significantly different. The Grade Three subjects obtained an overall performance of 45%, Grade Five 49% and Grade Seven 56%. The results showed that these subjects used both the graphic-functional and the abstract-categorical modes, with equal emphasis. None of the two distinctive mode stands out as particularly dominant (see tables 3.4.1 and 3.4.2).

Table 3.4.1. Summary of the subjects' overall response patterns on Classification and Generalization tasks.

Grades	Grade 1 (n=20)		Grade3 (n=20)		Grade5 (n=20)		Grade 7 (n=20)	
Abstract-categorical classification	2	2.5%	36	45%	39	49%	45	56%
Functional-graphic classification	78	97%	44	55%	41	51%	35	44%

Table 3.4.2. Means and standard deviations of each Grade.

Level of Grade	N	Experiment 2	
		Mean	Std Dev
1	20	2.4	1.54
3	20	4.85	1.39
5	20	5.15	1.93
7	20	6.5	1.54

Table 3.4.3. Results of the ANOVA procedure on Experiment 2: Classification and Generalization tasks.

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Grade	3	175.1	58.4	22.52	<.0001
Model	3	175.1	58.3	22.52	<.0001
Error	76	196.9	2.6		
Corrected Total	79	371.95			

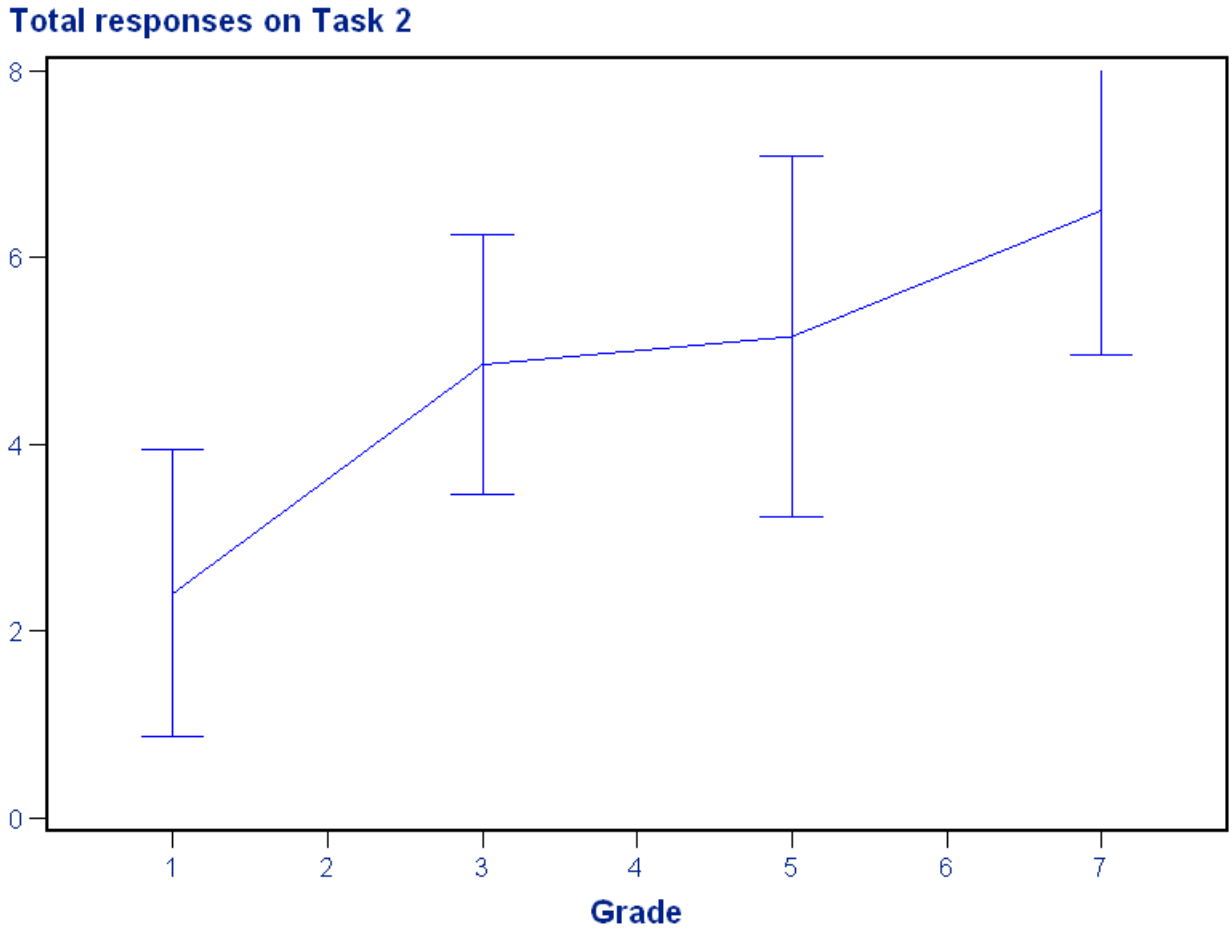


Figure 3.2: Developmental trend in subjects' performance across the four grades on Experiment 2.

A one way *ANOVA* procedure was conducted to determine if the change in performance across the four grades was significant. The results of the ANOVA procedure (see table 3.4.3 above) indicate that there was a significant difference (F (3, 76) =22.52, p<.0001). A *post hoc,* Bonferroni, test (see appendix 2.2.2.) indicated that the significant difference was located between Grade One and Grade Three, and between Grade Three and Grade Seven. Table 3.4.2 shows the means and standard deviations in each of the four grades. The developmental trend demonstrated by the subjects' performance is shown in Figure 3.2. It is also clear from the means and standard deviations in table 3.4.2, that there was little improvement in performance between Grade Three and Grade Five and between Grade Five and Grade Seven, respectively.

3.4.10. Discussion of the results

This data confirmed Vygotsky's theoretical proposition about children's development in the context of their specific society and culture (Mahn, 2003). The critical periods, at which major conceptual transformations occur, are around the age of six/seven years old, and the onset of adolescent period (involving formal, operational, thought). The results confirmed the change in categorical thinking between grades 1 and 3.

3.4.10. (a.) Grade One

The performance of the Grade One subjects on the tasks revealed a predominance of graphic and functional mode of thinking. This is not surprising because Grade One subjects had just begun schooling in the same year in which the experiment was conducted. They could therefore not be expected to have acquired the school-specific formal, abstract, mode of thinking and problem solving that the tasks solutions required.

The dominant mode of task classification used by these subjects was based on the functional relations that the objects had in their concrete situations in which they were encountered. This classification mode was revealed when the subjects had to give reasons for their classification actions. The reasons that they gave emphasised the functional relations of the objects. For example, the subjects would group *goat, cow* and *kraal* together because *goat* and *cow* live in the *kraal* while the *impala* is a "wild animal"-*tshipuka*. Alternatively, the *impala goat* and *cow* would be grouped together, and the *kraal* excluded from the grouping, because the *cow, goat* and *impala* have four legs each. In most instances, the subjects would not make explicit use of a linguistic concept like "animals" as basis for their classification. In fact, they resisted the experimenter's suggestion of subsuming these objects under the concept "animals".

The TshiVenda equivalent of "animals" is indeed "zwipuka", although this term is strictly used with reference to "wild animals" and commonly excludes "domesticated animals". Therefore, the subjects resisted referring to *cow* and *goat* as "zwipuka" because they probably did not perceive them as "wild animals", but as belonging to a class of

"domestic animals" *zwifuwo*. The subjects' justification of their (apparently categorical) classification action revealed that the basis of their reasoning was, generally, on their perception of how the objects appeared and were related in the concrete situations where the subjects encountered them. In this way, as Vygotsky (1987; 1986; 1978) argued, the manifest form of the subjects' activity did not coincide with its substance. The internal dynamic organisation of the subjects' thought processes on the task problems seem to lie in their use of the language in which they expressed the basis of their reasoning.

3.4.10 (b.) Grade Three, Grade Five and Grade Seven

The pattern that dominated the responses of these subjects revealed an interesting phenomenon. Two distinctive modes of object classification were used to classify three out of the four objects presented. These modes were either categorical or concrete. However, subsequent justification of the initial classification actions revealed that there were three modes of reasoning underlying the subjects' classification performance. That is, subjects who classified the object in a concrete and graphic manner justified their classification by offering concrete and graphic-functional reasons. However, unlike in the subjects in the Vygotsky-Luria study (Luria, 1979; 1976; Cole et al. 2006) a subject who classified the objects in a categorical manner did not necessarily proceed to offer abstract categorical reasons to support their classification. While this was, in the main, the dominant form of thinking, there was a middle mode of thinking that was revealed by the nature of the subjects' reasons for their initial categorical classification. This was derived from the subjects' socio-cultural and linguistic context and tended to emphasise the functional relations of objects while simultaneously using the abstract categories of classification derived from the subjects' language. This pattern was manifest in the discussion of the subjects' tasks performance below.

Task A: For Task A, the majority of the subjects' responses (90%), classified *pick, panga*, and *hoe* together and excluded *wheat* as not belonging with the others. However, when it came to supporting this classification mode with appropriate reasons, only 45% of the responses made use of the linguistic terms such as "tools", "animals",

and “plants”, etc., as a sole basis for their classification action. That is; “ *Pick, panga* and *hoe* belong together because they are tools”.

The remainder of the subjects’ classification responses (90%), were concrete, and the reasons provided to support these were similarly concrete and graphic-functional; emphasising the concrete appearance and the functional relations of the objects. For example, a *panga, hoe* and *wheat* were grouped together and the *pick* excluded from the grouping. The common reason for this classification was that “*panga* and *hoe* are used in the fields for planting *wheat*, while *pick* is not used for that purpose”. Alternatively, the objects would be grouped together for the reason that: “*Pick, panga* and *hoe* can be used at various stages of the preparation of the fields for planting wheat. Unlike hoe and panga, which have always existed in Venda society, pick is a relatively new tool that was not extensively used in Venda homes.

A third mode of classification appeared in the subjects’ responses to the task questions. Although this was categorised as a functional mode of object classification, it seems to have be peculiar to the subjects’ specific socio-cultural and linguistic context. In this task, 45% of the 90% categorical classifications were functional, but, to be more precise, they were “abstract-functional” in that the subjects argued that *pick, panga* and *hoe* belong together because they complement each other in their use. While the reasons that the subjects provided for this task were not exclusively based on the use of a single abstract linguistic term like “animal” or “tool”, the basis of their classification was abstract. This classification mode may be identified as abstract-functional. The functional reasons derived from the peculiarities of the subjects’ cultural context of learning and development.

This mode of performance on the tasks therefore manifests a pattern, peculiar to the specific socio-cultural context of schooling and the linguistic experience of the subjects. That is, the subjects employed the available TshiVenda categories which, according to the analytical framework derived from the Vygotsky-Luria study (Luria, 1996; Cole et al. 2006) would probably be classified as functional, because, although the objects are classified in an abstract manner, they are subsequently justified in terms of their

functional relations or how they are used, or work, in relation to each other. The subjects therefore employed multiple linguistic categories, derived from TshiVenda, which would be undifferentiated in English, and possibly, in Russian.

For example, these subjects argued that *pick, panga* and *hoe* belong together because they are used together to carry out particular functions. That is, ”*Panga* cuts bushes down*, pick* is used to dig the stubs up while *hoe* is used to till the land so that *wheat* can be planted.*”* Wheat is usually excluded from the group because it is initially not needed during the stage of preparation of land for planting. What seems, therefore, to be lacking in this classification mode is conscious use of a linguistic term that conceptually define the objects collectively to justify the subjects' classification. This leads to the subjects deriving their reasons for their classifications from the functional relations that the objects have in everyday life situations.

Even when subjects sometimes make use of the English word, “tools” or TshiVenda word “*zwishumiswa*—things for use”, they usually extend their reasoning to include the functional aspect of the objects. That is, they would argue that, “*Panga, pick* and *hoe* belong together because they are things we use in the fields when we till the land so that we could plant wheat or maize”. That is, the objects identified are needed together for use in the fields. As a result, the concept of “tool”, even where it is implicated, is not conceived as an abstract notion independent of the functional aspect of “things to be used in the fields”. This phenomenon suggests the problem as not only to do with concept development but also as involving the challenge of language development for effective classroom teaching and learning purposes.

Task B: A similar pattern can also be seen in the case of Task B. In this task, 80% of the subjects' classification responses appeared to be categorical. That is, the subject classified *giraffe, goat* and *cow* together and excluded a *kraal* as not belonging with the others. However, only 61% of the reasons the subjects provided were based on an abstract linguistic term, “animals”. That is, valid to the task demand, the subjects argued that: “*Giraffe, goat* and *cow* belong together because they are animals.”

The subjects who classified the objects in a concrete manner (20% of the responses) offered concrete-functional reasons for their classifications. For example: "*Goat, cow* and *kraal* belong together because *goat* and *cow* are kept in the *kraal* at night while *giraffe* is a wild animal that is found in the bush and cannot be kept with domestic animals." Children become familiar with these concrete functional categories early on in their life from their everyday life experiences. Subsistence farming of goats and cattle, etc., as well as kraals and similar enclosures where domestic animals are kept overnight, is still widespread. In addition to a number of nature reserves where wild animals like giraffes are kept.

The rest of the functional reasons (19%) emphasised the functional relations the objects had. They argued that: "*Giraffe, goat* and *cow* belong together because they eat grass". Even in instances where the subjects made use of the term "animals" in their justifications, they would extend their reasoning to include the functional aspect of the objects. They would, for example, argue that: "*Giraffe, goat* and *cow* are animals that eat grass and plant leaves and have four legs".

For Task C, 80% of the subjects' classification responses were categorical, but only 58% of the reasons for these classifications were based on abstract linguistic concepts. The 58% of the subjects who offered reasons based on an abstract-linguistic category to justify their classification argued that: "*Donkey, lizard* and cow belong together because they are animals". The subjects who classified the objects using a concrete classification mode (20%) of the responses, usually excluded *lizard* from their classification and argued that the *lizard* was not "an animal", or that the *lizard* did not eat plant leaves and would therefore not need to feed on *tree* leaves, as would *donkey* and *cow.*

These subjects generally disagreed with the experimenter's identification of lizard as "animal". They preferred to identify it as a "creature"—*tshikhokhonono,* or something similar to the concept "organism". In TshiVenda, donkey and cow are identified as *zwifuwo*—"domestic animals". A lizard would not normally be identified as a "domestic animal"—*tshifuwo*, or a "wild animal"—*tshipuka,* because it is neither kept domestically

as pet or livestock, nor does it live in the “wild”, as the other wild animals like giraffe or elephant. A lizard is identified as a creature—*tshikhokhonono,* a concept that seems to suggest that it is neither “wild” nor “domestic”, but a creature that is found both in the wild and in the homes. The concept “animal” in TshiVenda does not, therefore, seem to equate directly to the English concept, as it seems to be more differentiated in its TshiVenda occurrence. As a result, the subjects would argue that: “We cannot group *lizard (tswina)* with domestic animals *(zwifuwo)* because *lizard* is not kept in the home like domestic animals.

Of the remaining subjects’ responses (22%), were abstract-functional. These subjects argued, in support of their initial categorical classification action, that *donkey, lizard* and *cow* belonged together because they all live on the *tree.* That is, the *lizard* would be found in the *tree*, while both *cow* and *donkey* live on tree leaves and rest in its shade when it is hot. These subjects also argued that *donkey, lizard* and *cow* have four legs, or that they are living thing.

Task D: The same general pattern of task responses as in Task A and B, continued. For this task, 83% of the subjects’ classification responses were categorical. That is, 83% of the subjects identified *wheat, tree* and *mealie* as belonging together, and excluded *hut* as not belonging with the others. However, only 33% of the reasons given to support the classification action used the linguistic term, “plants”, as conceptual basis for the classification.

The remaining 17% (of the 83%), used the concrete classification. That is, they mostly classified *hut, mealie* and *wheat* together and argued that these would be stored in the hut when harvested. The concrete and functional reasons dominated their justifications of their concrete and graphic classification action.

The majority of the subjects’ responses, 50%, were functional-linguistic in that they justified the initial categorical classification in terms of the objects’ functional relations, using abstract linguistic categories of class relations. The subjects argued, for example, that *wheat*, *mealie* and *tree* provide food while *hut* does not. Some argued that *hut* can

be used for storing *wheat* and *mealies* at harvest, but that *hut* is not built in the fields where *wheat* and *mealie* grow, or else the *tree* growing next to it will cause it to crack and collapse by its roots.

Even in situations where a linguistic term, *zwimela*—which is the equivalent of "plants", is used to justify the classification, this is further extended to relate to the functional relations of the objects in concrete situations. In TshiVenda , *tree*, is called "*muri",* while *wheat* and *mealie* can collectively be called *"zwimela",* generally equivalent to the concept, "plant". There is, in TshiVenda , a peculiar distinction between plants that are *"miri"*—"trees" and plants that are *"zwimela"*—such as mealies, wheat, etc. There is therefore an apparent tension, in the responses of the subjects, between the school-specific concept of "trees" on the one hand, and the TshiVenda derived concept of "*zwimela"*—"plants" (—other than trees) and "*miri*—"trees" on the other hand.

3.5. Conclusion

The results of the experiments presented in this chapter suggest that the subjects' acquisition of concepts, and the specific modes of thinking and problem solving, were related to their socio-cultural context of development and learning. The children's context of development and learning is multifaceted, multi-layered and complex; encapsulating their schooling and everyday life situations, which were, in turn, located in the history and society of South Africa and Venda. The experimental tasks introduced, to the subjects, problems that were located within the processes of schooling and classroom teaching and learning to assess their acquisition and functioning of the school-specific concepts and modes of thinking and problem solving.

Experiment 1, Circles tasks, revealed that the subjects in the present study acquired formal-operational concepts at almost the same age-range as that suggested by Piaget's framework (Piaget, 1981; 1970; 1964). The results for the Circles Tasks support the theoretical idea that children acquire the basic cognitive capacities for operational thinking around seven and eight years old. However, social and cultural

factors, such as language and schooling, accounted for children's ability to use, deliberately, and apply, these thought processes to problem situations that required the application of operational thought processes.

The Vygotsky-Luria inspired Classification and Generalisation Tasks examined the psychological consequences of subjects' socio-cultural settings of schooling on the one hand and the subjects' everyday, spontaneous, learning and developmental situations on the other hand. Subjects' performance on tasks reveals that, by Grade Three, they could classify the tasks objects and explain their classification using an abstract mode of object classification. Three modes of object classification were revealed. First, is the abstract-categorical mode that emphasised abstract linguistic terms like "animals", under which the classified objects are subsumed. Second, was the abstract-functional mode, which emphasised objects' functional relations, using abstract linguistic categories peculiar to TshiVenda . Third was the concrete and graphic-functional mode, which emphasized the concrete and graphic appearance and the functional relations of objects. This mode of classification occurred in instances where subjects had classified the objects in a concrete and graphic manner in their initial classification action.

Therefore, both experimental tasks revealed the importance of the socio-cultural context of learning and cognitive development. The immediate context of the subjects' learning and development in the present study comprised their schooling and out-of-school, everyday, spontaneous learning and developmental situations. Both of these situations influence and shape subjects' learning and development in a peculiar manner that results in the development of plural cognitive processes such as the ones outlined above. The contribution of the subjects' linguistic context in their development and learning, manifest in their responses to the experimental tasks, is undeniable. However, the apparent inability of the subjects' schooling to transform the essentially everyday, spontaneous, concepts and modes of learning and problem solving, manifest in their responses to the tasks problems, needs further examination. This examination was carried out through the observation of the practices of schooling and classroom teaching and learning that Chapter 4 addresses.