School Performance in Rural South Africa- *The Role of Verbal Reasoning*

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Introduction

School success is directly related to adequate language, thinking skills and problem solving ability (Blachowicz 1994; Cummins 1985; Verzoni & Swan 1995; Westby 1994; Zachman, Jorgenson, Huisingh & Barret 1984). The importance of these skills is endorsed in The White Paper on Education and Training, which states that education, including curriculum, teaching methods and text books, should 'encourage independent and critical thought, the capacity to question, enquire, reason, weigh evidence and form judgements, achieve understanding ... and communicate clearly' (White Paper WPJ/1995: chap 4). In a recent study of the Joint International UNESCO-UNICEF Monitoring Learning Achievement (MLA) Project in African countries, South African grade 4 pupils (9 years) were found to perform on the lowest levels of the spectrum for numeracy and slightly better for literacy and life skills (Strauss & Burger 1999). In addition, there is a well documented high failure and drop-out rate amongst black South African primary school children (Macdonald & Bourroughs 1991). Inadequate language skills and related cognitive skills, resulting in poor verbal reasoning and ability to explain, have been postulated as playing a significant role in contributing to this situation. Being able to integrate language and thought, or to encode communication, has been shown to be more significantly related to general cognitive ability than other factors such as age and socio-economic status (Quay, Hough, Mathews & Jarret 1980).

Rural Zulu-speaking children are constantly faced with problems of daily life, and successfully resolve these problems through the application of the appropriate linguistic and cognitive skills required of such experiences. Yet, when they have been faced with problem solving within the context of formal

learning, the high failure and drop-out rate have indicated that they were not able to apply the appropriate verbal reasoning skills which would ensure success in this context (Macdonald & Bourroughs 1991).

The school system, demands of the child an ability to progress from using language primarily as a communication tool, to using language as the primary means of acquiring knowledge. This may be achieved through the literacy experience at progressive levels of complexity (Heath 1992). Research has shown that if children in the primary school phase and beyond, are to cope adequately with written language—language in its most context reduced and cognitively demanding form, a second stage of language development, and development of associated cognitive skills, must occur (Snow and Dickson 1991). It is through re-organizing and reformulating the linguistic structures already present in the child's language in response to new cognitive demands, both at a micro- and macro-structure level, that this is made possible (Westby 1982). This would provide children with the ability to reason and express causality, to make inferences, to devise solutions to problems, to anticipate problems and find ways to avoid them (Zachman, Jorgenson, Huisingh & Barret 1984).

In view of the fact that problem solving in the formal school context has been shown to be problematic for rural African children (Bentley, Kvalsvig & Miller 1990; Macdonald & Bourroughs 1991), educators must seek to understand problem-solving skills through a different context. Social or pragmatic reasoning has been shown to form the basis of abstract logico-deductive reasoning to follow (Hertzig, Birch, Thomas & Mendez 1986; Vygotsky 1962). It may therefore be within social reasoning that rural Zulu-speaking children have a better opportunity to demonstrate their ability to reason and explain.

The Test of Ability to Explain for Rural Zulu-speaking Children, (TATE-ZC) (Solarsh 2001) was developed to analyse how rural African children think, solve problems and verbally express this process within the context of a western education system. A serious attempt was made to take as many aspects of culture and social circumstance as possible into consideration, thereby making the test as culture fair as possible. It is a test that has been designed specifically for a rural Zulu culture and is thus presented in Zulu.

Through analysing verbal explanations about everyday social problems that are presented by primary school children, in which specific thinking skills are targeted, evidence for the development of the second stage of language and thinking skills may emerge. Understanding these processes could enable

educators to identify the extent to which such skills are present in children of different ages in the primary school phase in relation to the demands made by the academic curriculum. Thus, importance of second stage language and thinking skills in contributing to progress in school may be highlighted (Snow and Dickson 1991).

Language for Learning

The main goal of primary school education is to produce children who can effectively use decontextualized language as a tool for learning. This requires a certain level of language and cognitive skill prior to the acquisition of literacy, which in turn may lead to the development of new language skills through the acquisition of literacy. The child in the primary school phase is thus required to participate in literacy-based activities, which aside from the new visual, auditory and motor skills being learnt, places new demands on the child's oral language and cognitive skills. The language and cognitive demands further increase as students move beyond the primary grade levels, and they study subjects in which language becomes increasingly technical and less related to the language of everyday communication. The ability to reason and explain (Donaldson 1986; Wood 1992), closely associated with the development of narrative skills (Applebee 1978; Kemper and Edwards 1986) are noted developments during the early primary school phase.

Evidence has suggested that skill in the use of decontextualized language such as recounting personal narratives, planning future events and explaining ideas and reasoning, is a better predictor of literacy and school achievement, than skill with other challenging language tasks (Snow and Dickson 1991). Decontextualized language embodies three dimensions, which, once achieved are manifest in all aspects of language and learning. Thus the ability to engage in discourse: in the absence of an interactive conversational partner; in the absence of presumed shared knowledge with the listener; and where the message is complex, ensures a level of school achievement and an ability to engage effectively with literacy (Snow & Dickson 1991).

Cummins' (1985) concept of 'cognitive and academic language proficiency', CALP, has highlighted the role of language in thinking, learning and literacy. Out of the social aspect of 'basic interpersonal communication skills', (BICS), externalized in the form of pronunciation, grammar and vocabulary, the conceptual aspect of language, CALP, emerges which is a covert function, resulting from the 'manipulation of language in

decontextualized academic situations' (Cummins 1985:212). BICS and CALP may also be referred to as primary development of language, and second stage development of language respectively.

At a cognitive level, the emergence and development of these skills coincides with Piaget's concept of concrete operations. At this time the processes of decentration—the ability to hold more than one thought in one's mind, reversibility of thought—the ability to move back and forth between different aspects of the narrative, and ability to categorize hierarchically, become evident (Piaget & Inhelder 1968). These skills form the foundation of the ability to answer questions through reasoning, understanding cause and effect, and making inferences.

The role of prior knowledge of the world in problem solving and learning has also been stressed. Blachowicz (1994), has stated that essentially all learning is an attempt to make meaning through a process of problem solving based on prior knowledge of the world. It is the attempt to reconcile something new with something known. This requires skills to formulate what is already known, to hypothesize about various possibilities, and to collect, integrate and evaluate the new knowledge. This process is the result of a number of question and answer processes, which may be self formulated and initiated, or posed by an outside agent.

The importance of life experiences has also been stressed in the area of reading comprehension and text analysis. Pitts and Thompson (1984), have referred to cognitive theory and the concept of 'schemata', which are structures for representing concepts (based on life experience) in memory, and which are said to be the key units of the comprehension process. Inferences about portions of a text that are not explicitly presented are derived from these schemata to access full meaning. If a child possesses sufficient schemata that are easily accessible, cognitive processes such as inferencing are easily achieved. Inferencing enables a child to derive meaning from text by adding personal information in the form of schemata to textual information, thereby creating new meaning and comprehension (Shiro 1994).

At the core of the learning process is ability to encode new meaning that is created and answer questions effectively. This is based on accurate comprehension of the question itself, as well the implicit and explicit information presented, irrespective of whether the problem is concrete, such as solving physical problems in the world, pragmatic such as solving social problems, or decontextualized such as comprehension in reading.

Thinking Skills and Explanation

Thinking skills are those skills that emerge in an individual as a result of the development of language, of cognition, of socialization, and the integration of cultural norms and life experiences. They are the skills that a child calls upon in attempting to represent and explain events in the world. The ultimate goal is the ability to think in a logico-deductive manner, yet social or pragmatic reasoning may play a significant role in achieving this.

Explanation is essential to education. On one hand a child takes in explanations offered by others, and on the other, presents explanations to convey the ability to reason and solve problems i.e. thinking skills. Hence, explanations facilitate our understanding, or are used to convey our knowledge. Within an educational context, ability to explain is the primary means by which a child's knowledge is assessed. By evaluating children's ability to explain we may gain an understanding of thinking skills and how they impact on school achievement. Evaluating this within a rural African context will add to such a body of knowledge.

In formulating a psycholinguistic analysis of children's explanations, Donaldson (1986) has provided a theoretical framework for analysis of questions and answers based on the integration of language and cognition. Thus in combining different clauses, a number of explanations may occur, having both linguistic and cognitive origins and implications.

Three of the four different types of explanations she has identified are relevant to an understanding of thinking skills and were used in the TATE-ZC. Explanation of an *event* (why did the car break down?), would result in an empirical answer (what happened to cause such an event?). Explanation of an *action* (why did you hit the boy?) would result in an intentional answer (for what purpose or reason?). Explanation of a *conclusion* (how do you know they are at a wedding?) would result in a deductive answer (how do you know?). Procedural explanations (how do you bake a cake?) were omitted.

Related to event, action and conclusion are three content categories of explanations related to type of causality. *Physical causality* relates to an empirical answer based on the event. *Psychological causality* relates to a motivation for action or reason for action. *Logical causality* relates to a deductive answer, which may be based on an inference, leading to a conclusion. The linguistic formulation of each of these requires cognitive skill in specific areas.

An empirical explanation (what happened to cause?) requires the ability to deal with temporally sequential events in which the explanation

relates to a prior event, which must have occurred. Linguistically, this would be expressed using 'because'. An intentional explanation (for what purpose or reason?) requires an answer related to a purposive, goal directed aim or behavioural intent. Linguistically this would be expressed as 'want to, is going to, would, could'. A deductive explanation (how do you know that?) relates to a concept, idea, judgement, inference or conclusion, i.e. a mental act. This is a situation in which one mental act requires justification in terms of another mental act, rule or observable evidence. Linguistically this would be expressed as 'can tell that, know that, must' Thus whereas an empirical explanation can be considered to require concrete thinking skills, intentional and deductive explanations require abstract thinking.

The issue of the role of language in thought, and vice versa, has been clarified by considering the distinction drawn by Donaldson, between content and mode of explanations.

Content refers to the type of relations, which holds between events, states, actions or mental acts, which are referred to in an explanation. These relations are independent of language, but may also be expressed linguistically. This may also be referred to as the level of competence.

Mode refers to how the speaker's own view of the task affects the type of relation, which he/she expresses in the explanation. These relations are dependent on the use of language, and must be expressed linguistically. This may be referred to as the level of performance.

Explanation, therefore, exists in the complex relationship between content and mode, facilitated by the use of causal connectives, resulting in an overlap between semantics, syntax and pragmatics. Such an analysis may form the basis of a criterion referenced scoring system, which may be used in research into children's ability to explain. (Table 1)

Table 1: Summary of content/ mode, and relationships expressed (Donaldson 1986)

Content/Mode	Relationships Expressed
Physical / Empirical	Cause and effect between 2 events
Psychological / Intentional	Cause and effect between 2 actions OR Cause and effect between 1 action + 1 intention
Logical / Deductive	A relationship between 2 ideas or judgements OR A relationship between a judgement and proof of its logical antecedent

Developmental Aspect of Explanation

Developmentally, Donaldson's research (1986) revealed that by 7 years, children have acquired a number of skills in relation to their ability to explain. Piaget also described developmental stages in relation to cognitive processes and problem solving behaviour (Ginsberg & Opper 1969). Van den Broek's (1997) overview of developmental patterns in event comprehension completes this section giving a comprehensive analysis of different ways of speculating about development of thinking skills.

Donaldson stated that by 7 years, children are able to distinguish between cause and effect. They are able to distinguish between physical, psychological and logical relations. They can produce well-formed causal sentences. Their ability to explain includes the empirical and intentional modes. By 9 years they know an action can be explained in terms of the agent's intention to achieve a particular result. This is also the age at which true narratives, containing all story grammar components begin to appear (Applebee, 1978), reinforcing the relationship between logical thinking and narratives.

At a cognitive level, Piaget identified three interdependent components of thought that show developmental sequence, viz. centration/ decentation of thought, static/dynamic reality and irreversibility/ reversibility of thought. Whereas the pre-operational child (5-7years) shows irreversability of thought, and is attentive to limited amounts of information, which are of a particularly static or concrete nature, the concrete operational child (7-11 years) shows reversibility of thought, can focus on several aspects of a situation simultaneously, and is therefore sensitive to dynamic aspects of reality. The inter-dependence of these skills is emphasized.

Further they have a direct influence upon the manner in which children at different stages approach a problem-solving task. Pre-operational children are said to approach a task in a haphazard way, reporting results in terms of expectations not observations and drawing faulty conclusions based on unrelated evidence. Concrete operational children are said to investigate a number of possibilities, but show limited skill in designing an experimental process, resulting in the process of analysis being unsystematic. Children who achieve formal operations (12years+) are said to be able to plan, test possibilities and design experiments well. They observe results accurately and draw proper logical conclusions. They should, therefore possess all the skills necessary to analyse and explain social problems proficiently.

Finally, it is the study of the development of the ability to detect causal relations between events that has given rise to an understanding of the developmental aspects of event comprehension. It is assumed that like all other language activity, comprehension must precede the expression of such causal relations.

Event comprehension has been related to three main skills, viz the emergence of the ability to recognize multiple causation; to do this at increasingly more complex levels of event organization; and to relate increasingly to internal psychological causes. The different types of events and relations described by van den Broek (1997) show close correlation with types of causal relationships described by Donaldson (1986).

He described observable events as actions and physical events, and non-observable events as goals and intentions, which may include different types of relations such as motivations, enablements, necessary and/or sufficient causal relations, with one or more human protagonist.

His analysis of causality incorporates two important dimensions. One is that causal relations differ in terms of the kind of events they connect, and two is that causal relations differ in their strengths. Thus physical causality refers to relations between two physical events, motivational causality refers to relations between intentions and consequences, psychological causality refers to the effects of events on internal states such as emotions, feelings, intentions. Strength of causal relation refers to whether an antecedent is necessary and sufficient for a consequence to occur, or whether it is necessary but not sufficient and therefore prevents enablement as a consequence. In addition, because events may be caused by multiple antecedents, multiple consequences are possible. Thus explanations may be offered at multiple levels involving a complex of integrated skills.

In the construction of developmental stages for event comprehension, van den Broek (1997) analysed research which attempted to answer the question: Do causal relations between events, affect children's ability to comprehend and recall the events? This has implications for the setting down of schemata and subsequent use of these schemata in answering questions.

A number of age related trends emerged (see Table 2 for summary). Children as young as 4 years consistently recognized causal relations between concrete and observable events such as physical events and actions, but had difficulty with goals and motivations. At 6 years it was noted that the level of coherence in a narrative (measured by no of coherence markers in the form of conjunctions) did not influence the level of recall of causal relations and there

continued to be a focus on concrete observable events. This trend appears to continue till 7 years, when children demonstrated some understanding of goals and actions, and a weak understanding of motivation. By 8 years children continue to focus strongly on directly observable events in answering questions, but they do start to recognize the causal relations between goals, intentions and other events. This occurs only within the same episode. 10 year olds demonstrated that level of coherence did improve recall of causal relations, as did events with multiple causality. By 10 - 11 years children demonstrate an understanding of all causal relations both within and between episodes and can therefore give an answer reflecting the global structure of the events. The final stage in integrating and interconnecting events, which occurs in adolescence, lies in the ability to identify themes or topics that connect events into a cohesive whole, which ultimately lead to the ability to make inferences about more complex concepts such as morals and values. It is also the time at which children enter Piaget's period of formal operations when logico-deductive reasoning increases.

In conclusion, van den Broek recognized the many unanswered questions in relation to development of event comprehension and suggested that a possible way to explore further was to look at the product of comprehension in the form of questions and the encoded answers produced, as has been attempted in this research.

Table 2: Developmental Trends in the Comprehension of Complex Events (van den Broek 1997:335).

Observed ages in Text and Television research					
Developmental Trend	4	6	8	10-11	14-Adult
Increasing centrality of causal structure	Some effect of causal con-nections	Stronger effect of causal con-nections		Very strong effects of causal con-nections	

Shift from focus on within-episode connections only to focus on between episode connections to focus on themes	Within episodes	Within episodes	Within episodes when cognitive demands are low Between episodes when cognitive demands are low	Within episode; between episodes	Within episodes; Between episodes; themes
Shift from focus on observable, concrete actions to focus on internal states (goals, motivations)	Focus on actions	Focus on actions	Some focus on goals, but actions still prominent	Strong focus on goals	
Note: Ages provided for relative rather than absolute comparison					

Explanation as a Production Exercise

There has been support for the study of explanation and causality as a production exercise rather than a comprehension exercise for a number of reasons. Primarily, the goal of education is to facilitate the development of thinking skills in children, which are demonstrated by them first through oral verbal expression and then through written verbal expression as the children enter higher classes. Thus mode, modality and content becomes relevant in revealing to us a child's ability to express thoughts and ideas, and why from a cognitive-linguistic point of view, s/he may be unable to achieve these goals of education.

However, production experiments have also been shown to be of particular value when working in a cross cultural context. The main difference between production and comprehension lies in the balance between choice and control that exists between the child and the investigator. In a comprehension study, control rests with the experimenter in that a particular target, decided upon by the experimenter, is present or absent in the child. In a production study, control lies with the child who presents a response borne of the child's own mode of explaining and avoids presupposition about the child's cognitive processes. It has further been shown that when children themselves have selected the events for event comprehension tasks, level of performance has

been achieved at an earlier age (Trabasso & Nickels 1992). Thus locus of control can affect test outcome. This is of particular value cross-culturally in the South African context, as so little in known of thinking skills in rural African children.

Production studies also have been shown to be more reliable when working across socio-economic boundaries. This was demonstrated by a study, which aimed at analysing the communicative accuracy of middle socio-economic status (SES) white children, lower SES white children and lower SES black children in the USA (Quay, Mathews & Schwarzmueller 1977). It was found that whereas there was no difference in performance for decoding information between the three groups of children, there was a difference in encoding information between the middle SES group and the lower SES group irrespective of race. A test that evaluates production ensures that reliability at this level has been accounted for.

Finally, production studies of narratives have been shown to be the more accurate diagnostic measure, in the identification of learning disability in students (Feagens & Short 1984). Whereas 6-7 year old normal ability and learning disabled children displayed equal competence with language when enacting a story told to them, there was a significant disparity between the two groups on a variety of verbal production measures. This may also be relevant for disadvantaged children, in that disadvantaged children possess elaborated codes, which they were unable to use effectively when demonstrating cognitive ability in a formal context (Hertzig, Birch, Thomas & Mendez 1986).

Pragmatic versus Logico-deductive Explanation

Although Pretorius (1994) has refuted the idea that the reasoning achieved in relation to everyday life is equal to formal reasoning, it might be a precursor and facilitate it. This notion was reinforced by the outcome of a training programme for 14 year olds in which pragmatic reasoning schemas presented, assisted the students in bridging the gap between concrete and formal thought (Verzoni & Swan 1995).

These positive effects were explained by the belief that the adolescents learned to use memory of domain-specific (contextualized) inferential rules, to assist them with achieving proficiency with decontextualized reasoning. The pragmatic reasoning schemas facilitated the development of inferential rules from experiences occurring in everyday life.

Thus understanding how rural African children reason within a pragmatic context may have important implications for intervention programmes, resulting in more positive educational outcomes through better event comprehension and inferencing in literacy.

An integration of all the above theoretical concepts created the basis of what informed the development of the Test of Ability to explain for Zulu-speaking Children (Solarsh 2001).

The Test of Ability to Explain for Zulu-Speaking Children (TATE-ZC)

The Thinking Skills

The specific language based thinking skills used in the TATE-ZC which were identified as indicators of verbal problem solving ability by Zachman, Jorgenson, Huisingh and Barret (1984) were:

- The ability to determine causes of a problem
- The ability to determine solutions for a problem
- The ability to explain inferences about the problem
- The ability to identify ways of avoiding problems
- The ability to reason in relation to a negative why question.

These abilities would place both linguistic and cognitive demands on the child. They would require that the child was able, not only to understand the immediate problem, but to draw on world knowledge and past experience, as well as the ability to produce new, creative and imaginative options.

The Test of Problem Solving (TOPS) (Zachman, Jorgenson, Huisingh & Barret 1984), which provided the basic model for the TATE-ZC, is an example of a test that targeted children's verbal problem solving ability through analysing the five thinking skills outlined above. Tables 3-7 have attempted to relate these thinking skills to the education process, and to demonstrate the role each one plays in ensuring academic success.

The tables identified:

- Each thinking skill
- The type of question used to elicit this skill
- The cognitive skills required in order to answer the question

- The linguistic skill required to demonstrate ability to apply the thinking skill
- The mode of explaining
- And the problems with learning, which may result for the child due to the lack of that particular skill.

Analysing each thinking skill in terms of the exact structure of the question that elicits the appropriate response, was critical to the reliability of the test. An understanding of the cognitive skills involved provided a basis for criterion-based evaluation. Analysing the relevant linguistic skills to be applied, provided a structural format for analysing thinking skills and for remediating deficiencies. Understanding the mode of response required to answer a particular thinking skill, identified its level of complexity and was important for a developmental analysis of thinking skills. Identifying the problems that may result due to a lack of that particular thinking skill could alert educationists and researchers as to how the problem may manifest academically. Failure in these academic areas may then be remediated through the development of abstract thinking skills.

Table 3: Explaining Inferences: An Analysis of Linguistic and Cognitive Skills

Target Skill	Quest-ion	Cognitive Skill	Ling-uistic Skill	Mode Empirical / Intentional/ Deductive	Problems due to Lack of Skill
1 Explaining Inferences The child is asked to explain how he knows that something he sees is true.	How do we know... ...	Must understand intention of the question. Must sort relevant from irrelevant information. Must critically evaluate the illustration Must identify specific feature related to question	Encode for syntax and seman-tics	Deduc-tive thinking mode	Difficulty comprehending questions. Unable to determine most critical factor. May lack syntax or semantics

Table 4: Determining Causes: An Analysis of Linguistic and Cognitive Skills

Target Skill	Question	Cognitive Skills	Linguistic Skills	Mode Empirical Intentional Logical	Problems due to lack of Skill
2 Determining Cause The child is asked to state a logical cause for a situation he sees in the picture	Why - for what reason? How - how did it come to pass?	Must understand the intention of the question Temporal sequence must be analysed Backtracking/ reversibility of thought must take place to determine a likely cause Cause must be evaluated Must draw on life experience	Must encode correct linguistic form- use 'because' Must select accurate lexical items	Empirical mode	Difficulty with sequencing of events Difficulty with comprehending science experiments Difficulty with predicting outcomes Difficulty explaining own behaviour

Table 5: Negative Why: An Analysis of Linguistic and Cognitive Skills

Target Skill	Question	Cognitive Skill	Linguistic Skill	Mode Empirical Intentional Logical	Problems due to lack of skill
3 Negative Why *The child is asked to give a reason why one would not behave in a certain way.*	Why… … not? Why would you not behave in a particular way OR carry out a particular action?	Must understand the intention of the question Must note the negative component in the question Must understand the meaning of the question and how the neg. influences the answer Must understand the type of information required Must identify the appropriate answer	Encode the correct linguistic form	Concrete Intentional Logical	Difficulty with problem solving. Difficulty following instructions

Table 6: Determining Solutions: An Analysis of Linguistic and Cognitive Skill

Target Skill	Question	Cognitive Skills	Linguistic Skills	Mode Empirical / Intention-al/ Logical	Problems due to lack of Skill
4 Deter-mining Solutions The child is asked to solve various situational problems that are illustrated and presented verbally.	What should/ could they do?	Must understand the intention of the question Child must place self in position of other Must consider various possibilities Must identify the critical one Must rely on past experience	Encode correct syntactic form 'should have / could have'	Concrete Intentiona l Logical	Problems with reading studies Problems with maths Problems with story sums difficulty planning ahead

Table 7: Avoiding the Problem: An Analysis of Linguistic and Cognitive Skills

Target Skill	Question	Cognitive Skills	Linguistic Skills	Mode Empirical /Intention al /Logical	Problem due to Lack of Skill
5 Avoiding Problems The child is asked to find ways the problem presented could have been avoided.	What could be done so that ... would not occur?	Must understand the intention of the question Must understand the problem at hand Must have reversibili-ty of thought Must identify possible causes Must identify problem to be avoided Must match the problem with the solution	Encode appropri-ate linguistic structure 'should have/ could have' Establish correct tenses	Empirical Logical	Cannot backtrack in time Poor comprehen-sion of complex linguistic structure Difficulty with cause/effect

These five tables highlight the complex nature of an apparently straightforward task- answering a basic question, which formed the basis of the test instrument used in this study.

The motivation for developing a test such as the TATE-ZC has emerged from the recognition that academic achievement is a function of language and thinking skills. Despite this, culture fair tools to measure this essential function have not been developed. If useful programmatic interventions are to be implemented to improve academic progress for rural children, base-line measures of skill are necessary to provide a sound scientific point of departure. This research project was an attempt to provide such a measure.

Methodology

Main Aim

The main aim of this study, was to analyse the verbal solutions of rural Zulu-speaking children to everyday problems, elicited through the use of The Test of Ability to Explain for rural Zulu-speaking Children (TATE-ZC) (Solarsh 2001), as a measure of the development of abstract thinking skills.

Sub-aims

The main aim was achieved through the following sub-aims:

1.The administration of the Test of Ability To Explain—for Zulu-speaking Children (TATE-ZC) to six groups of rural Zulu-speaking children (N= 292), aged 7-12 years, to obtain a comprehensive sample of 'ability to explain' presented by these children in six years of the primary school phase.

2. To analysis of data obtained on the above test forms the basis of the following procedures:

(i). To identify age levels at which statistically significant development had taken place, and present a tentative set of ages for criterion-based evaluation for the development of thinking skills in rural primary school children.

(ii). To identify whether one thinking skill in particular correlated better with the total score, i.e. represented overall ability to explain

(iii). To analyse the mean scores of the sub-tests at each age level to

attempt to identify a developmental process in the emergence of thinking skills viz. which thinking skill emerged first and which was most challenging.

(iv). To compare the extent to which school performance correlated with results obtained on the TATE-ZC.

(v). To analyse whether gender differences existed in the development of thinking skills, in the sample as a whole and at each age group.

Research Design

A quantitative analytical survey design was used.

Selection of Subjects

Subjects were selected on the basis of a stratified purposive sample. Stratification occurred at six age groups and in six different grades. The purposive sample attempted to account for uncontrolled variables through stated criteria for selection. Teachers were trained to identify children who fell within a 6 month age range per class, and who fulfilled the following criteria:

- **Age:** The chronological age of each of the children had to fall within the specified 6 month age range for the grade.
- **Gender:** An equal distribution of male and female was needed to control for social and developmental factors that may influence performance.
- **Academic Record:** The children had to have a record of no failure or repetition of a school year, to exclude low cognition as a factor.
- **Sensory Impairment:** The children had to be identified by teachers as appearing to have no visual or auditory impairment which may impact on development and test performance.
- **Social and Medical History:** Children had to be identified by teachers as having no social or medical problem which may impact on development and test performance.

Selection of Schools

Six schools in the Valley of a Thousand Hills participated in this study—4 primary schools (Grade 0-7), 1 junior primary schools (Grade 0-4) and 1 senior primary school (Grade5-7). The schools were selected on the basis of the principals' willingness to participate, and their access to roads. All the schools were within a 10 km radius, thus drawing on children in similar

contexts, giving recognition to the fact that even within a disadvantaged community, there is a range of 'poverty' and 'relative wealth'. The subject selection was based primarily on identifying children who complied with the criteria for selection, and who fell within the 6-month age range identified per grade. There was, therefore, no attempt to identify a critical number of children per school. Pupil-teacher ratio's varied from approximately 30-40:1 (Table 8).

Table 8: Selected schools and teacher-pupil ratios

School	Total No of Children	No of teachers	Pupil Teacher ratio
1 Senior primary	440	11	40:1
2 Junior primary	501	15	33:1
3 Primary	797	20	40:1
4 Primary	584	14	42:1
5 Primary	564	14	40:1
6 Primary	586	20	29:1
Total	3472	94	37:1

The description of the schools that follows has been included to contextualize the learning environment of rural Zulu-speaking children. All schools were situated on sand roads, with a high pupil-teacher ratio (see Table 8). All schools had minimal resources, with most classrooms having only desks for children and a table and chair for the teacher. There was minimal evidence of teaching materials or wall charts. There was electricity in the classrooms, but this was sparingly used, thus most classrooms were fairly dark and sparse. Children had their own exercise books and some textbooks were used. All schools were included in the government nutrition programme, thus children were receiving some nutritional supplementation. It was noted that the majority of children made a small purchase, e.g. a lollipop, a small packet of chips or even a small packet of biscuit crumbs from the bottom of the biscuit boxes, from the local women who sold food and sweets outside each school at break-times and after school. Attempts had been made by some schools to create gardens around the classrooms to improve the atmosphere of the school, and all had a rough sandy sports field adjacent to the school. All schools were surrounded by expansive and beautiful rolling hills, with clusters of traditional homes as well as simple more western homes dotted on the hills and along the

roads, which resulted in children walking long distances to school in many cases.

Research Assistants

Three female Zulu-speaking research assistants (RA) were involved in the data collection. All the RA's work in this capacity for the Child Development Unit at The University of Natal, and were therefore experienced in the process of scientific data collection. Two training sessions took place. In the first, the researcher gave the RA's some theoretical background to the study, and explained the process up to and including pilot studies I and II. The second session involved training in terms of the subject selection procedure, the orientation session, the test itself, test administration with an emphasis on probing technique, and discussion on how to monitor and control number of subjects per age group.

Each RA was given a testing kit including: a copy of the TATE-ZC, a tape recorder, a lapel microphone, extra batteries, audio cassettes, the front cover page for each test script, to record each child's details, school, date of testing and RA involved, an exam pad, stationery and packets of sweets as rewards for the children.

Using a hired vehicle, the RA's moved independently from school to school. Besides on-going telephonic communication to deal with any arising queries, the researcher monitored the data collection on two occasions. Once in the early phase of setting the research up and once during the data collection to ensure that data collection was reliable.

The Test Instrument Used: The Test of Ability To Explain for Zulu-speaking Children (TATE-ZC) (Solarsh 2001)

The TATE-ZC consisted of a test booklet in which 16 black and white, line drawn, realistic pictures of different contexts relevant to the life of a rural Zulu-speaking child, and 53 Zulu questions with the English translation below, were adjacently arranged. 1 picture was a demonstration item, and 15 pictures were the test stimuli. 3 of the questions related to the demonstration item, and 50 were test items. There were 2 - 4 questions per picture.

Each question related to one of the five thinking skills identified. The thinking skill linked to each picture was dependent on the context of the picture. There was no specific pattern in which thinking skills were targeted. Thus the total of 50 questions was made up of 10 questions per 5 thinking

skills, which were randomly presented according to the possibilities offered by the different contexts.

In addition to the test booklet of pictures and questions, a form for the recording of personal details for each subject, and a scoring form were also prepared. A booklet of Scoring Criteria provided guidelines for allocating scores to each answer.

Equipment

The following equipment was used to ensure clear audio-tape recordings of the answers presented by the children.

- 3 x Philips D6280 computer compatible cassette recorders were used..
- 3 x AIWA lapel microphones.

Procedure

Subjects in the Study

292 children participated in the study. The target was 50 children per age group, with an equal gender distribution. Due to logistical and practical problems experienced, e.g. listing girls in the boys list as it was sometimes difficult to identify from the name, tape recordings being inadequate in a few instances, the following subjects participated as subjects in this study (Table 9).

Table 9: Subjects in the Study

Age	Grade	Female	Male	Total No.
7.6-7.11	2	27	24	51
8.6-8.11	3	27	24	51
9.6-9.11	4	26	24	50
10.6-10.11	5	23	25	48
11.6-11.11	6	23	22	45
12.6-12.11	7	26	21	47
TOTAL		152	140	292

As stated, it was not intended that a critical number of children be selected from each school. Emphasis was placed on age and passing the selection criteria. Table 10 describes the distribution of children per school and grade.

Table 10: Distribution of Subjects per School

School	Grades	Female	Male	Total
1	Grades 5-7 10-12 years	35	35	70
2	Grades 0-4 5-9 years	24	24	48
3	Grades 0-7 5-12 years	68	44	112
4	Grades 0-7 5-12 years	13	13	26
5	Grades 0-7 5-12 years	9	11	20
6	Grades 0-7 5-12 years	3	13	16
Total		152	140	292

Data Collection

The data was collected over a period of 6 weeks, with each RA testing approximately 80-100 children. The RA's travelled to the schools on a daily basis and testing took place from 9:00am - 2:00pm each day. Testing was interrupted from time to time by sports events, school functions, choir competitions etc.

In five out of the six schools testing took place in a room where the child and RA were seated at a table. In one school testing took place at a chair and table on the veranda of the school, but the setting was generally quiet.

Group Orientations

In order to reduce the possible effects of independents variable such as lack of test experience and anxiety about test performance, a group orientation process was introduced.

A group of 10-15 children was called together, and they were seated in a circle with the RA. The RA welcomed and thanked the children, and gave a brief description of what they would each have to do. Emphasis was placed on the fact that they did not have to be frightened and that their performance results would be confidential. This was followed by an 'ice-breaker' game in which each individual, including the RA had a chance to say his/her name and simultaneously do an action (It was noted that many children found this task difficult and had to be assisted). This action was to be imitated by the whole

group and thereafter an attempt would be made by the group to remember each child's name and action. After this icebreaker the children all sat down together in the circle once again.

The RA then explained that in order to further get to know one another and because the children would be asked to speak into the tape recorder, they should practice by each one individually telling a little about themselves, their families and interests. The RA also participated and used the opportunity to encourage the children to speak loudly and engage in a conversation with the RA.

Before the children were sent back to their classrooms to be called individually for testing, they were instructed not to talk about the test to each other.

Individual Testing

On entry into the testing setting, each child was welcomed by the RA, thanked for participating and informal interaction took place for a few moments to settle the child. Thereafter, the following instructions were given by the RA:

- I am going to show you some pictures and then I will ask you some questions about the pictures.
- Nobody except myself will be hearing your answers.
- This is not like a school test because there is no right and wrong answer. I am just interested to hear what you think and have to say about the pictures.
- You must give the very best answer that you can.
- I am going to tape-record what you say so that I don't have to try and write it down as you speak. Please speak loudly so we can hear you clearly on the tape recorder.
- When you have completed the test and go back to your classroom, I would like to ask you not to talk about the test to the other children.

These instructions were followed by the presentation of the training item.

- Lets look at the first picture together.
- Can you tell me what you see?
- Good. Now you can answer the questions. You can tell me as much as you like.

Each training question was individually presented. If the child gave a good answer, the RA praised the child and stated clearly what was good about the answer, encouraging the child to give more than one answer if desired. If the child gave a poor answer, the RA asked facilitating questions to elicit the answer and/or presented the child with an appropriate answer, so that by the end of the training item the child understood how to answer a question in the best possible way. Three questions were asked, thus the child went through the above procedure three times.

On completion of the training item, the RA proceeded as follows:

- Now let's start the test. You must try to answer the questions as I have explained to you.

The lapel microphone was attached, and the test administered in one sitting, with all 50 questions being administered to each child. Testing took 15-25 minutes per child, depending on the age and competence of the child. Finally the child was again thanked, given a sweet and again reminded not to talk about the test.

During testing, the two identified probes, 'mmmm' (1) to encourage further elaboration, and 'is that all?' (2) when child appeared to have completed the answer, were consistently presented for each question.

Translation and Transcription of the Data

After testing was complete, the RA's went through each cassette, translating and transcribing what the children had said, by listening to each answer then writing it down in English. Each script was concurrently coded for the relevant probes (1) or (2). The cover page for each child was attached to the translated script, and it was then ready to be scored. On completion of all translation and transcription, 11 subjects were randomly selected, and each of the three RA's translated and transcribed those scripts as has been described above, which would form the basis for the inter-translator reliability test, to be carried out at a later stage.

Scoring of Scripts

Using the scoring criteria and guidelines giving examples for each score for

each question, which were devised for the TATE-ZC, the researcher scored 30 scripts. After a period of 6 weeks, these 30 scripts plus all the remaining scripts were scored by the researcher resulting in an accumulated 125 hours of scoring or 25 minutes per script. The 30 scripts that were re-scored formed the basis of the intra-scorer reliability test.

An additional 29 (10%) randomly selected scripts were photocopied, and with the test booklet, the scoring criteria and guidelines, given to a second scorer. The second scorer was a speech pathology lecturer, with extensive experience in test administration and scoring. The results of her scoring were used as the basis for the inter-sc orer reliability test.

In the scoring of each question, the scorer read the answer presented by the child, then reviewed the options provided in the scoring criteria. Use could also be made of a set of scoring guidelines which were derived from the pilot studies and stated examples presented by the children for each score rating, for each question an attempt was made to identify the level of complexity of the answer. Was the answer wrong or irrelevant (Score 0)? Was the answer vague and imprecise, but indicated some understanding of the question (Score1)? Did the child present one concrete fact in the answer, identified in the illustration (Score 2)? Did the child present two concrete facts indicating an awareness of multiple causation or did the child present psychological causality or intent showing use of abstract thinking (Score 3)? Did the child give a full answer in which the critical relationship or factor was clearly identified and clearly expressed (Score 4)? Scores from 0-4 were accordingly allocated. Some answers were obscure and required repetitive review until the appropriate score could be identified. In such cases references could be made to the scoring guidelines, and the child's answer compared with the range of answers in the attempt to identify the correct level.

When each question had been analysed and scored, scores of each subject were calculated out of 200, which was converted to a percentage for total score (50 questions) , as well as for each of the five sub-tests or scales (5 x 10 questions).

Collection of Academic Results

When all the tests had been scored, the RA's returned to the schools and requested permission to record academic results for each child. Permission was granted and the results of the July exams or tests were used. The subjects

targeted were Zulu oraliteracy, as the children's first language and language used for semantic contextual reasoning, and mathematics or numeracy as the subject in which logico-deductive reasoning would take place. Exact marks were recorded where available. Where symbols (A-E) or ratings (1-5) were used in the lower grades, consistent percentage values were allocated for statistical procedures.

These scores formed the basis of the correlational analysis, to evaluate the relationship between pragmatic reasoning skill and academic performance.

Data Analysis and Statistical Procedures for the Main Study

All statistical procedure for the main study were done using SAS. Statistical procedures presented in Table 11 were implemented to evaluate:

1. Validity and reliability of the test instrument
2. Reliability of the testing procedure
3. Analysis of the data

Table 11: Table of Statistical Procedures used in the Experimental Stage

Process	Procedure	Application
1. Validity and reliability of the Test Instrument	ITEMAN Conventional Item Analysis Program (1989)	Item- Test Analysis- The mean of all subjects on an item was correlated with the mean for all subjects for the total score The Pearson product moment correlation between the item scores and total score for that test, was calculated. Item-scale Analysis and The Cronbach Alpha reliability coefficient- This was calculated for each age and the total population Inter-scale correlation: Correlation of scales at different age groups

2.Reliability of Test procedure	Friedman Procedure using the BDMP programme. This is a non-parametric test for paired samples*	2.1 Reliability of Translation: A comparison of % error between 3 Translators on the same 5 scripts.
		2.2.1 Reliability of scoring procedure: Inter-scorer correlation in which scorer 1 and scorer 2 each scored 26 scripts
	Pearson's Correlation Coefficient*	2.2.2 Reliability of scoring procedure Intra-scorer correlation in which scorer1 scored the same 30 scripts twice, with 6 week break between score 1 and score 2)

3. Analysis of the data	ANOVA with Scheffe's Procedure, for definite difference in means*	Significant difference for age: Significant difference in means between the different age groups for the total score
		Significant difference for age: Significant difference in means between the different age groups for each scale or thinking skill
		Significant difference for gender: Significant difference in mean scores between the two genders for the test as a whole and for each scale
	Pearson's Correlation Coefficient*	Correlation between TATE-ZC and academic performance. Correlation of 3 sets of scores, TATE-ZC, *Zulu/literacy and mathematics/numeracy*
	Descriptive statistics-Comparison of mean scores*	Comparison of mean scores for each age group and thinking skill Comparison of mean scores to detect developmental process

*= (Steyn, Smit, du Toit & Straheim 1994)

Results

Reliability of the Test Instrument

The test instrument was found to be valid and reliable (Solarsh 2001). A more detailed presentation of results has appeared above.

Reliability of Translators

A Friedman non-parametric analysis of variance was performed. The following results were computed on scores, which reflected whether there was concordance or difference in the language of scripts translated and transcribed from Zulu audiotapes into English. No significant difference between the translations of the 3 RA's was found, confirming reliability of the translations used. Table 12 reflects the means, Standard deviations and the Friedman test statistic.

Table 12: Results from the Friedman Procedure for inter-translator reliability

Translators (T)	Mean scores	Std Deviation	Friedman Test Statistic	p value
T1	47.7272	1.6181	0.59	0.7442
T2	48.2727	1.3484		
T3	47.7272	1.6181		

$p < 0.05$

Reliability of Scoring Procedures

A Pearson's Correlation Coefficient was calculated. Two calculations were computed (see Table13)

- Scorer 1 scored the same set of 30 scripts with an interval of 6 weeks between scorings- intra-scorer reliability.
- Scorer 1 and Scorer 2 each scored 29 scripts and results were compared- inter-scorer reliability.

The high levels of significance across all scales and for the test as a whole indicates that the scoring criteria, the 5 point scale and examples for each

score that were devised are reliable for evaluating thinking skills using the TATE-ZC.

Table 13: Pearson's Correlation Coefficient for Reliability of Scoring

Scale (Thinking skill)	Scorer 1, on 2 occasions	Between Scorer 1 and 2
Explaining Inferences	.97647	.90999
Determining cause	.96135	.87106
Negative why	.98030	.94183
Determining solutions	.92099	.85075
Avoiding the problem	.82800	.88230
Total Test	.97551	.93922

$P < .0001$

These scoring criteria may therefore form the basis of a criterion-based system of evaluation, which has been suggested as being more applicable for non-mainstream population groups.

The Results of the Administration of the TATE-ZC

The results presented in Figure 1 and Figure 2 formed the basis of the analyses of the five thinking skills (Explaining Inferences- EI, Determining Cause- DC, Negative Why- NW, Determining Solutions- DS and Avoiding Problems- AP). They were analysed by age for each thinking skill and for the test as a whole, as well as for each thinking skill by age and for the sample as a whole.

Figure 1 demonstrated the clustering of the 7 and 8, 9 and10, and 11 and 12 year age groups. It also showed that while Explaining Inferences tended to have the highest scores, Negative Why and Determining Solutions appeared to be the most difficult.

Figure 2 indicated that while the trend is not absolutely consistent, there was a pattern in scores within each age group, as to the thinking skills that appeared to be easier as opposed to those that were more difficult.

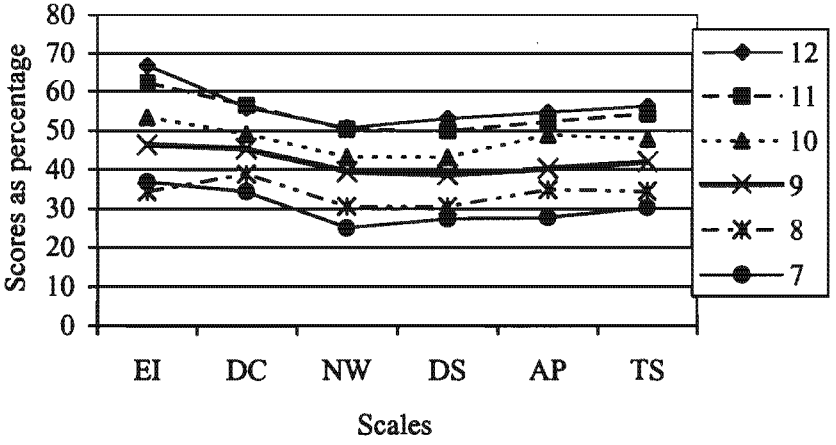

Figure 1: Mean scores per age and scale

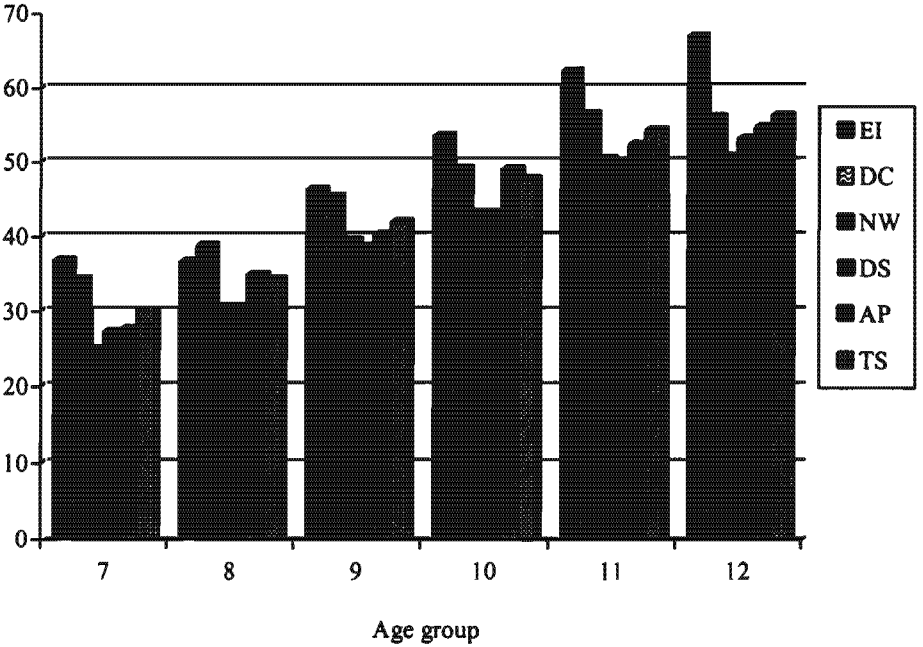

Figure 2 Scores per age and for the total group

Analysis of the data

Analysis of the data has focused on five areas related to the research questions in sub-aim 2:

1. Significant difference between scores at each age group
2. Correlation between mean scores for each scale and for the total score
3. Identification of a developmental process in the emergence of thinking skills
4. Correlation of scores for TATE-ZC with academic performance
5. Significant difference between the scores for the two gender groups

1. Significant Difference between Scores at Each Age Group

The motivation to answer the question of how thinking skills develop from year to year in the rural Zulu-speaking primary school child has formed the basis for the whole research project.

Significant difference was computed from mean scores obtained for each age group and the group as a whole, on each scale and for the test as a whole.

An ANOVA, using Scheffe's test, a post hoc test for pair-wise comparisons, was applied to these results. Measures for significant difference were calculated between means for each age group for each scale, and for the total score. These results indicated that over all the comparisons made, there were only 3 instances in which significant difference (improvement) in performance in a particular thinking skill was evident on an annual basis, i.e. each year. *In the majority of cases, significant difference was noted every two years and in a few instances, significant difference was noted over 3 years.* This result is a cause for great concern in the education of rural children in South Africa today.

These results indicated that there were only 3 instances out of all the age groups, on all scales and for the total test, in which statistically significant development took place from one class level to the next. On the test as a whole, and in two thinking skills only, Explaining Inferences and Negative Why Questions, statistically significant development took place from grade 3 to grade 4 over 1 year. Although this was not a generalized trend even for the 8-year group, it could be explained in terms of indications that education may be improving, and that this improvement was starting to be seen in the younger children.

The finding that for three of the thinking skills, the children of 10 - 12 years, did not show significant improvement over 3 years has critical implications. It implies that there was an even greater limitation in the development of Cognitive and Academic Language Proficiency (CALP) in the second phase of the primary school, during which there is a heavy emphasis on language for learning, than the first. If children are only showing significant development in thinking skills every two years, then by the end of the primary school phase, they would only have progressed to a class 5 level of thinking skill at the most. This has great implications for their ability to use language for learning and to access information independently, as well as for their ability to access literature and make appropriate inferences from reading materials. It also has implications for high school, with children entering the next academic phase with CALP appropriate for a grade 5 pupil.

2. Identification of a Particular Thinking Skill Showing High Correlation with the Test as a Whole

This research question aimed to identify whether one particular thinking skill correlated very highly with the total score and could be used as an accurate indicator of thinking skill as a whole (see Table 14). Implications here were that a shorter test or screening test could be devised. All thinking skills showed a high correlation with the total score, and were therefore equally representative of the construct of thinking skills. Thus a shorter screening test could be devised.

Table 14: Correlation between Scores per Scale the Total Test for the Whole Group (N=292)

	Total Score
EI	.86394*
DC	.87106*
NW	.86720*
DS	.85203*
AP	.85403*

P < .0001

3. *Identification of a Developmental Process in the Development of Thinking Skills*

A non-inferential analysis of mean scores as well as patterns in the inter-scale correlation per age group, provided the data for this section.

Table 15 provides the mean scores for the different ages and for the group as a whole, for each scale. An attempt was made to identify whether a particular thinking skill emerged earlier by ranking the scores for each thinking skill from one to five for each age group and the group as a whole (see Table 15)

Table 15: Ranked Order of Mean Scores for the Different Thinking Skills

Ranked order	7year group	8year group	9year group	10year group	11year group	12year group	Total Group (n=292)
1 (highest score)	EI	DC	EI	EI	EI	EI	EI
2	DC	EI	DC	DC	DC	DC	DC
3	AP	AP	AP	AP	AP	AP	AP
4	DS	DS	NW	DS	NW	DS	DS
5	NW	NW	DS	NW	DS	NW	NW

Table 15 showed that in the majority of instances Explaining Inferences scored the highest, followed by Determining Cause and avoiding the problem. This was followed by Determining Solutions and the Negative Why. Although this order was not 100% consistent, it was relatively consistent and may therefore provide a basis for further investigation into a developmental order, for the development of thinking skills in rural children.

4. *Correlation between TATE-ZC Scores and Academic Performance*

The attempt to collect accurate marks for academic performance at the rural schools proved to be problematic. This was due partly to poor administrative

infrastructure in the schools, and partly due to a lack of consistency in allocating grades.

In some instances marks for some classes were not available because the teachers had taken the mark books home for safekeeping and the teachers were not available on the day of the data collection. In other cases, particularly in the junior classes, teachers did not have a defined mark for Zulu or Language. It was therefore decided that a mark for literacy and numeracy would be interchanged with Zulu and maths. Due to the confusing changes with education at present with the Outcomes Based Education (OBE) approach being introduced then withdrawn, and traditional marking schemas being changed to symbols, there was little consistency within the schools. Some grades within one school were on previous traditional programmes, some were on OBE, some grades defined academic performance by marks, others by symbols 1-5 or A-E.

Despite the total lack of consistency in the recording of academic performance, the researcher decided to persevere with the attempt to correlate the TATE-ZC scores and academic performance. This was done by using actual marks, if they were available and converting symbols to an equivalent mark allocated by the researcher. This was considered to be the best option as the Spearman Correlation coefficient used for this analysis, computes ranked scores (see Table 16).

Table 16: Correlation of TATE-ZC Scores with Academic Performance using the Spearman Correlation Coefficient

Age Group	Correlation between TATE-ZC and numeracy/ maths	Correlation between TATE-ZC and Literacy/Zulu	Correlation between Numeracy/maths and literacy/Zulu
7year (N=43)	.22811	.21482	.92056*
8year (N=38)	.46849	.46431	.84189*
9year (N=38)	.19392	.10827	.68526*
10year (N=44)	.25499	.33748	.36211*
11year (N=33)	-.07650	.04826	.69973*
12year (N=39)	.15549	-.05962	.62133*

$p < .0001$

Results indicated that there was no significant correlation for any of the age groups between academic performance as measured by teachers at the schools, and thinking skills as measured by the TATE-ZC. There was significant correlation between the literacy and numeracy marks as allocated by the teachers, for all ages.

Children were passing each year, but are not showing statistically significant increases in certain cognitive skills as measured by the TATE-ZC, required for academic progress. Although demographically this sample was small, it did provide some statistical evidence for the fact that rural schools have a low standard of education, and that children were reaching the end of the primary school phase without adequate skills for secondary education.

5. Significant Difference between Scores for Gender

An ANOVA using Scheffe's procedure was performed in which gender was related to means for each scale or thinking skill and the total score, and levels of significant difference calculated. Table 17 indicated the significant difference between the genders for most thinking skills.

Table 17: ANOVA Measures of Significant Difference for Gender

Scales	p value	Mean Values
Total Score	P=.0076*	M=45.3 F=42.1
EI	P=.2942	**M=50.7** **F=49.1**
DC	P=.0003*	M=48.9 F=43.8
NW	P=.1438	**M=40.6** **F=38.3**
DS	P=.0447*	M=41.7 F=38.7
AP	P=0170*	M=44.7 F=40.8

p<0.05 M=Male F=Female

The result of significant gender difference, in which males did better than females in 4 out of the 6 measures, was unexpected. Equal performance appeared to be demonstrated for the two thinking skills at either end of the developmental scale. Explaining inference means the thinking skill to develop

fastest and the Negative Why, the thinking skill which appeared to be most difficult.

Overview of Results

The following results were obtained:

1. The test instrument was shown to be valid and reliable.
2. Translation of scripts by the three translators was found to be reliable.
3. The test procedure was also shown to be reliable in terms of scoring, particularly in terms of scoring criteria identified, the 5 point scale and inter- and intra-scorer reliability.
4. A high level of inter-scale correlation indicated each of the thinking skills in the test represented a valid aspect of thinking skills, and all were testing the same theoretical construct.
5. There was no indication that one of the thinking skills in particular measured the construct of thinking skills better than any of the others.
6. Statistically significant development in thinking skills in rural African children was shown to occur every 2 years in the majority of cases, and every 3 years in 3 instances.
7. Non-inferential statistics and an inter-scale correlation indicated there was a pattern in the emergence of thinking skills and that some thinking skills tested were more challenging and developed later that others.
8. No correlation was found between scores on the TATE-ZC and academic performance for any of the age groups.
9. Some statistical differences in scores between the genders were shown to be present.

Discussion

The three most pertinent issues arising from the above results related to:

- test evaluation: norm-based versus criterion-based;
- the relationship between performance on the TATE-ZC and academic performance;
- the difference in performance by boys and girls.

Norm-based versus Criterion Based Evaluation

The most salient issue requiring further discussion relates to a criterion-based evaluation system as opposed to a norm-based evaluation system when working in a cross-cultural context.

The 5 point scoring schedule for the TATE-ZC has been presented in Table 18, and the associated criterion-based evaluation system in Table 19. It was felt that the score plus criterion-based evaluation provide a much more useful result in understanding the performance levels of these children. Table 20 relates the score and criterion-based evaluation to results obtained by the children, and cautiously compares them with equivalent scores demonstrated by American children on an equivalent test, The Test of Problem Solving (TOPS) (Zachman *et al.* 1984).

Table 18: Scoring Criteria for the TATE-ZC using a 5 Point Scale
Each question will be given a score using the following criteria as a guideline.

Score	Criteria
0	* No response. * Simple affect is used as the explanation * **The response is inappropriate or irrelevant.**
1	* There is indication that the question has been understood, although the most relevant information for the problem is not presented. * Precise vocabulary is not used. * The answer may be correct, but does not directly relate to the context in the illustration * **The answer is vague and imprecise in relation to the question.**
2	* There is indication that the question has been understood in that the response relates accurately to the question. * Use is made of precise vocabulary. * Physical causality related to the context of the illustration is expressed. * **One concrete/observable factor is presented in the answer.**
3	* The response reflects clear understanding of the context. * Use is made of precise vocabulary * The answer relates directly to the context of the illustration * **Two or more concrete factors** may be presented in relation to physical causality between two events. OR * **One abstract factor** in relation to psychological or logical causality may be expressed between: two actions or an event/agent and an action
4	* The response reflects a clear understanding of the context. * Use is made of precise vocabulary and language is clearly formulated * Physical or psychological causality is presented in addition to logical/deductive causality. * At least one concrete factor plus one abstract factor is presented. * **A complete answer giving cause and effect / A creative answer**

Table 19: Criterion-based Evaluation Indicators from the TATE-ZC

TATE-ZC score	Categories of TATE-ZC scoring criteria	Related skills or criteria	Related educational level	Age
0-25	Answer vague and imprecise	Demonstrates some understanding of the question. Must be able to engage in a question/answer discourse	Entry into preschool	3 years
26-50	1 concrete factor presented. Precise vocabulary used	Concrete reasoning presented. Able to derive an answer from a picture and express it verbally	Entry into formal education- Grade R (reception class equivalent to a pre-school preparatory year)	5-6 years
51-75	2 concrete factors or 1 abstract factor	Able to see multiple reasons. Abstract reasoning presented. Accurate verbal expression	Entry to formal learning and literacy	6-7 years
76-100	Complete cause and effect reasoning. Creative answers	Ability to draw on world knowledge and previous schemata. Language reflecting an identification of the critical issue for that question. Competent verbal skills.	Entry to class 5. Emphasis is now shifted from developing oral language and acquiring literacy, to using language and literacy for learning	10 years +

Table 20: Comparison of TATE-ZC and TOPS Scores for the Test as a Whole

Age Group	TATE-ZC mean score per age group	TOPS mean score allocated to each age group, i.e. norm	TATE-ZC criterion and age equivalent (from Table 23)	TOPS age equivalent for TATE-ZC score (column 2)
7 yr	30	53	Concrete reasoning presented. Able to derive an answer from a picture and express it verbally. Entry into more formal education- Grade R (reception class equivalent to a pre-school preparatory year) 4-6 years	4.4 years Entry into a pre-school programme
8yr	34	60		4.9
9yr	42	67		5.8
10 yr	48	73		6.5
11yr	54	78	Able to see multiple reasons. Abstract reasoning presented. Accurate verbal expression Entry to formal learning and literacy 6-7 years	7.2
12 yr	56	83		7.5

When the results obtained on the TATE-ZC were evaluated according the criteria identified in Table20, they indicate that, at the level of verbal reasoning, the responses of the grade 2,3,4, and 5 children (7-10year), were equivalent to those required by children entering a pre-school or readiness programme or 4-6 years. They had the ability in general to give one concrete answer using precise vocabulary. They did not spontaneously provide multiple answers, and did not demonstrate use of abstract thinking skills. The 11 and 12-year group demonstrated verbal reasoning skills equivalent to those required for entry into literacy, or 7 years. They were able to present multiple

reasons, show some level of abstract reasoning and make use of accurate verbal expression.

Although it was with great caution that results on the TATE-ZC were compared with results on the TOPS, it was interesting to note that the comparison did tend to confirm the findings discussed. Table 20 presented the TATE-ZC and TOPS scores and age /criterion equivalents. Not only did the identified stages of the TATE-ZC criterion-based evaluation correlate with the TOPS age equivalents, but so did the TATE-ZC scores themselves.

An almost equivalent gap in achievement levels between the Zulu-speaking and the American children has been demonstrated using the Bender Gestalt test of visual-motor perception (Viljoen *et al.* 1994). In this test, American children reached maturity for this skill by the expected 9 years, whereas Zulu-speaking children reached the same level at 13 years. Although the original test had not been altered in any way, the researchers had been extremely sensitive to cultural difference in the administration of the test. In the TATE-ZC, what was demonstrated by the Zulu-speaking children in terms of a verbal reasoning test at 12 years was demonstrated by American children at 7.

This demonstrated that even when as many cultural and linguistic aspects as possible were attended to, rural Zulu-speaking children still demonstrated limited performance in skills related to academic performance. In the instance of the TATE-ZC, we can say with a fair amount of confidence that the performance levels demonstrated were reliable, and not the product of an inappropriate test.

TATE-ZC results, indicating a significant development in thinking skills only every two years rather than annually, highlighted that development of cognitive skills was slower for rural African children. It must be noted and emphasized that the development of thinking skills as tested by the TATE-ZC is second stage language development or CALP and would develop *in response to external stimulation.* It is *not* a comment about the child's inherent potential. It serves to focus on the fact that the children could achieve better academic results if opportunity was provided to improve abstract thinking skills.

In the study using the Bender Gestalt the rural Zulu-speaking children were shown to improve more slowly and continued to improve until 18 years, whereas the American children showed maximum improvement between 7 and 10 years when development was complete. Further with significant development taking place every 2 years, children of 12 would emerge from primary school with a level of thinking skill of a grade 4-5 year child (9-10

years). Postulating that this trend would continue through high school would imply that children in grade 12 (17years) would demonstrate thinking skills of a grade 7 (12 year) child. The direct relationship between ability to explain, make inferences and reason, orally and in literacy or in text, make the findings of the TATE-ZC critical for intervention programmes aimed at improving academic performance even at tertiary levels.

What this indicates, is that there is a strong relationship between the level of reasoning developed at the pre-school level, where oral reasoning first emerges, and performance at universities where high level reasoning must be applied to high level content. It indicates that the ability to reason or understand events and causal relationships, must develop into a clear ability, to recognize and express multiple causal relations, at increasingly more difficult and complex levels of event organization, with a greater focus on internal and psychological causes (van den Broek 1997), if children are to achieve academically.

The type of errors made by the children in the TATE-ZC, were typical of errors made by disadvantaged students at a tertiary level (personal experience of the researcher)
The majority of errors in the TATE-ZC were made in four main categories:

- Errors due to problems with the analysis of the question, e.g. the answer to a question in the scale Avoiding the Problem, would be presented as Determining the Cause, demonstrating lack of attention to the need to process questions analytically.
- Errors due to giving literal not inferential responses, demonstrating a high level of concrete thinking.
- Errors due to language in terms of clearly identifying the referent, demonstrating a high level of pre-supposition in thinking style.
- Errors due to a failure to pick up the critical cue or 'rule' in the context, in which the relationship between the two events in the context is clearly recognized and expressed, demonstrating limited abstract inferential thinking. This last feature is what would have earned the child 4 points (maximum) per question, and is what is required of children from grade 5 (10years) for adequate academic performance.

The error analysis emphasizes yet again, the great need to develop abstract thinking skills in oral language, as a precursor to effective literacy and learning.

Thinking Skills and Academic Performance

A review of the findings showing lack of significant correlation between academic performance and the scores on the TATE-ZC for any of the age groups was cause for some speculation. It indicated that when scores for all the children were ranked, children who perform best academically do not necessarily perform best for thinking skills and vice versa. The similar pattern of performance of Zulu-speaking children on the TATE-ZC and Bender Gestalt (Viljoen *et al.* 1994), as well as previous findings of the reliability of the TATE-ZC uphold the overall reliability of the test itself. It thus raises the question of the reliability of school marks as a reflection of achievement levels for these children.

What was of concern was that there were children who were performing relatively well on the TATE-ZC, but are not demonstrating this academically. These children needed to be followed up individually. A deeper analysis of SES, regularity of school attendance, distance child lives from school, social environment in terms of other stressors, attitude of parents and the child to schooling and education, as well as teachers' attitudes to education and to the particular child, may provide some explanation for this finding.

If one considers the broad findings of UNICEF-UNESCO Monitoring Learning Achievement Project, levels of academic achievement amongst the grade 4 pupils were considerably lower than the expected range of school marks. This indicated that high marks for the children on school work, while following a normal distribution for the class, should in the majority of cases be clustered around the lower end of the distribution. This may contribute to some extent to improving the correlation between TATE-ZC findings and academic performance.

Thinking Skills and Gender

Results indicated that boys performed significantly better than girls for the test as a whole and for three of the five thinking skills (DC, DS, AP). This was also found for grade 1 children, on a measure of receptive vocabulary (Pakendorf 1996), but was not a significant issue in the development of visual-perceptual skills (Viljoen *et al.* 1994). This very small sample of tests did indicate that, unexpectedly, on the language based tests the boys were out-performing the girls. Explanations given for such findings usually revolve

around the status of the 'boy-child', who joins the male-dominated adult Zulu society, self-perception of sex-role and attitude of teachers to boys and girls. If gender bias was proven to be true, intervention should focus extensively on enhancing the aspirations and self concepts of the girls, because of the strongly held belief that: 'When you educate a man, you educate one person. When you educate a woman, you educate the nation.'

Conclusion

The test results of rural Zulu-speaking children when tested on the TATE-ZC, have been shown to lack the necessary cognitive and academic language proficiency (CALP) that would enable them to reach their full potential as learners. The cause of this has been noted to be due to a multiplicity of recognized factors, but lack of exposure to stories and books, which are essentially language-based activities do play a significant role. Using the five thinking skills identified in the TATE-ZC in combination with an intensive campaign to up-grade levels of literacy in the community as a whole could offer a programmatic option for improving the academic future of children in Africa.

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