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The cognitive consequences of the disruption of schooling

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A Research Report submitted to the Faculty of Education, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Education by coursework.

Johannesburg 1999

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ABSTRACT

This research report attempts to establish the cognitive consequences of the disruption of schooling. Specifically the report investigates Vygotsky and Luria's claim that formal schooling necessarily produces scientific concepts in learners, by examining the performance of learners who had been subjected to disrupted schooling.

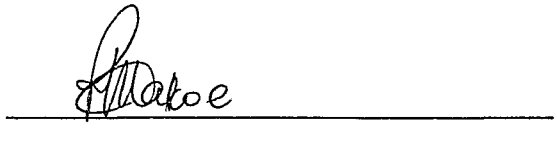
On the basis of empirical research conducted, the report challenges Vygotsky and Luria's claim about the cognitive consequences of schooling.

KEY WORDS

Vygotsky; Luria; Schooling; Scientific concepts; Spontaneous concepts: Graphic-functional thought; schooling disruption.

DECLARATION

I declare that this research report is my own, unaided work. It is being submitted in partial fulfilment of the requirements for the degree of Master of Education by Coursework in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.



(Name of candidate)

26/ 02/ 1999

ACKNOWLEDGEMENTS

I would like to express my gratitude to the following people:

- My supervisor, Mr Rashad Bagus, for his support, advice and more especially his patience.
- The principals and teachers of the two schools where the research was carried out.
- The subjects, whose co-operation was greatly appreciated.
- My mother, Dulcie, for her support and encouragement throughout my studies.
- My dear daughter, Boitumelo, who gave me the reason to go on.

And finally I want to thank my colleagues and friends:

- Ntswaki Rapoo for giving me the courage to go on no matter what,
- Daisy Matlou, for unselfishly giving her services and assistance, and
- Babalwa Mabitsela, for her keen interest.

The interest and support received from the above people made this study worthwhile.

INTRODUCTION

A fundamental idea in Vygotsky's (1978, 1962) theory of the socio-historical origins of minds is the contention that the context of learning impacts significantly on the development of cognition. Specifically, Vygotsky believes that formal learning environments such as schools expose learners to systematic knowledge which leads to the construction of more abstract systematic forms of thinking in learners. By contrast, Vygotsky (1962) further contends, the context of everyday life leads to the construction of more concrete forms of thinking in people.

Given the significance that Vygotsky accords to formal schooling in the development of abstract thinking a number of questions arise. First, we need to ask, 'Is formal schooling solely responsible for the development of abstract thought as Vygotsky appears to suggest, or are there other social-historical processes equally implicated in the construction of formal/systematic thought?' Secondly, if formal schooling is indeed responsible for the development of abstract thought, the obvious question that arises is, 'How much schooling will lead to the construction of formal reasoning?' In this regard Luria's (1976) research in Uzbekistan appears to suggest that even a relatively limited exposure to formal schooling (i.e., 3 months) may be sufficient to provide the individual with the means to construct abstract forms of reasoning. Thirdly, we could ask, 'If schooling is responsible for the development of formal thought, would the disruption of schooling over relatively extended periods of time influence negatively the development of formal thought in pupils exposed to such schooling disruptions?'

The questions asked above have all influenced the nature of the research reported in this study. Specifically, to establish (a) whether schooling is solely responsible for the development of abstract thought; (b) the length of time of such exposure to schooling is necessary to develop

formal thought; and (c) whether the disruption of formal schooling negatively influences the development of formal/abstract reasoning, I conducted research in two schools which were subjected to different degrees of disruption during the period 1984 to 1994. Very interestingly, I discovered that while disruptions of schooling may impact negatively on pupils' development of formal reasoning, the length of time individuals were exposed to formal schooling appeared to have very little impact on the development of their abstract reasoning. In other words, my research shows that notwithstanding an approximate period of 12 years of formal schooling (albeit disrupted periodically) the individuals concerned displayed a remarkable inability to reason abstractly. As such, Vygotsky's prediction and Luria's belief appear to be questionable in the light of this research.

To illustrate the foregoing conclusion, this research report is divided into five sections. In the first, I provide an exposition of Vygotsky's theory and show the role of schooling in the development of abstract reasoning. The next section consists of a selective review of the literature which attempted to document the effects of schooling on cognition. In the third section I outline the research methodology and tasks used in this study. The fourth section provides a detailed discussion of the findings of my research and in the final part I review and re-assess Vygotsky's contentions in the light of my research findings and attempt to suggest areas for future research.

VYGOTSKY'S THEORY

Vygotsky's (1978; 1962) theory of cognitive development is based on foundations provided by Marxist theory, which sees consciousness as originating in social activity. This implies that the social world plays a very important role in the development of thought. To explicate the role of the social world in the development of cognition, Vygotsky (1929) distinguishes between two lines of development, the natural and the cultural lines of development. The natural line consists of essentially biological functions while the cultural line leads to the transformation of these biological functions into higher mental functions. "Cultural development is superimposed on the processes of growth, maturation and the organic development of the child. It forms a single whole with these processes ... a single line of sociobiological formation of the child's personality" (Vygotsky in Wertsch, 1985:41). The mental functions that develop during biological evolution are called elementary functions, which Vygotsky contends are the same in animals and human beings. The natural line of development, however, is not our concern at this point. Our focus will be on the cultural line which derives from man's social life and social activity.

According to Vygotsky:

> Any function in the child's cultural development appears twice, or in two planes. First it appears on the social plane, and then on the psychological plane. First it appears between people as an interpsychological category, and then within the child as an intrapsychological category. This is equally true with regard to voluntary attention, logical memory, the formation of concepts and the development of volition. (1978:163)

Vygotsky's contention shows that the cultural line of development entails social processes which transform man's biological nature not through organismic means but through the mastery and use of cultural signs. These cultural signs include what Vygotsky refers to as psychological tools.

Signs, together with tools, are means of adaptation. As Vygotsky puts it,

> Like words, tools and nonverbal sings provide learners with ways to become more efficient in their adaptive and problem-solving efforts (1978:127).

The basic analogy between tools and signs rests on the individual function that characterizes each of them. The tool's function is to serve as the conductor of man's influence on the object of his activity. It is externally oriented, must lead to changes in objects, and it is a means of man's external activity aimed at the mastery of or triumphing over nature. The sign, on the other hand, changes nothing in the object of a psychological operation. It is a means of internal activity aimed at mastering man himself. Signs are regarded by Vygotsky (1978) as artificial stimuli which serve as auxiliary means for mastering one's own reactions. It is important to note that the mastering of nature and the mastering of behaviour are mutually linked: just as man's alteration of nature alters man's own nature, the sign acts as an instrument of psychological activity in a manner analogous to the role of tools in labour activity. For example, Vygotsky cites an unnamed psychologist who asserts that "the very essence of civilization consists in purely building monuments so as not to forget" (1978:68). The monument acts as a sign that enables man to remember, just as tying a knot as a reminder may also act in the same way. The term 'higher psychological function' or higher behaviour, is used to refer to the combination of tools and signs in psychological activity.

Signs and words serve children first and foremost as a means of social contact with other people. Prior to mastering his own behaviour, the child begins to master his surroundings with the help of speech. His speech is as important as the role of action in attaining the goal.

> Children not only speak about what they are doing; their speech and action are part of one and the same complex psychological function, directed toward the solution of the problem at hand (Vygotsky, 1978:25).

This shows that through speech the child is able to ignore the direct line between actor and goal. He/she is able to include stimuli that do not lie within the immediate visual field. He/she plans how to solve the problem, and then carries out the prepared solution through overt activity. Direct manipulation is replaced by a complex psychological process through which inner motivation and intentions stimulate their own development and realization. As Vygotsky puts it,

> The most significant moment in the course of intellectual development, which gives birth to purely human forms of practical and abstract intelligence occurs when speech and practical activity, two previously completely independent lines of development, converge. (1978:24)

He further contends that the linkage between tool-use and speech affects several psychological functions such as perception, sensory-motor operations and attention, each of which forms part of a stable system of behaviour. He sees the formation of higher psychological functions, through speech, as the social reorganization of natural psychological functions.

Speech in children brings them into social contact with others. Social interaction implies immediate interaction with the child, affective reactions such as cuddling and touching, as well as mediated social interaction. Mediated social interaction or mediation, is a form of social interaction which can be provided by a teacher or an adult, a significant person or a peer. Adults in the course of history are the ones who invent and elaborate sign systems. These adults initiate the child into the social environment from the interpersonal public to the personal interpretation which comes about only after a long process of development. The child's interaction with the social environment enables him/her to develop from the interpersonal public to the personal interpretation which comes about only after a long process of development. Through mediation the child develops new ways of relating to the environment, in addition to the new organization

of behaviour itself. The interpersonal process of mediation is, according to Vygotsky, "the fundamental motive force for higher cognitive growth" (in Moll, 1994). Higher cognitive growth, or higher psychological functioning, comes about through the internalization of cultural principles which are mediated to a child.

Internalization refers to the internal reconstruction of an external or social operation. As the child grows and interacts with others, so does he/she internalize what is mediated to him/her. The child's cognitive operations start off as concrete cultural relations between people, inscribed in the linguistic sign. Children learn to apply these sign systems in the regulation and direction of their own thinking (Vygotsky in Moll 1994). The developmental changes in sign operation are similar to those that occur in language. Aspects of external or communicative speech as well as egocentric speech turn inward to become the basis of inner speech. "Through signs children are able to internalize the adaptive social means already available to them from society at large" (Vygotsky, 1978:26). This shows that internalization is an operation that involves the co-ordination of the new and the old, and the restructuring of both. Each individual, during the process of internalization, builds up a unique mental construction of reality, even though social others may be involved in the building activities. This transformation of sign-using activity is of particular importance to the development of higher mental processes.

The above discussion has attempted to show that the child, in his/her cultural development, comes into contact with people who introduce him/her to physical tools and signs. These tools and signs enable the child to internalize the cultural means available to him/her, thus developing higher psychological functioning. The higher psychological functioning of an individual is characterized by logical reasoning, voluntary attention, formation of concepts and the development of volition.

The discussion that follows is an attempt to show the differences between learning in everyday life and learning in formal school environments and the types of concepts engendered by these different contexts.

Vygotsky (1962) describes two kinds of concepts, i.e., everyday concepts and scientific or school concepts. He asserts that, more than a mere mental habit, a concept is

> a complex and genuine act of thought that cannot be taught by drilling but can only be accomplished when the child's mental development itself has reached the requisite level (p.82).

The school concepts and everyday concepts differ from each other both in their psychological features and origin, as well as in the direction of their development. Vygotsky (1962) argues that these concepts develop in reverse directions. Everyday concepts which are concrete grow upwards to become more abstract and provide ways or structures for scientific concepts which are more abstract, to develop downwards to a more concrete level. Even though these concepts develop in opposite directions, the two processes, are closely connected. This is true in the sense that, for the child to be able to assimilate a particular scientific concept, he/she must have reached a certain level with regard to the development of everyday concepts.

Everyday concepts are spontaneous or non-systematic. They develop through one's own mental efforts, which implies that they are formed without systematic instruction. They are used unconsciously by the child in the sense that the child's attention is always centred on the object to which the concept refers and never on the act of thought itself. Vygotsky (1962) cites an example of a child who uses the word 'because' spontaneously but is unable to use it deliberately. Such a child, because he/she has not yet grasped school concepts, is unable to realize that the word connects two parts of a sentence. Once he/she has become familiar with school concepts,

the child will then realize the connections between parts of a sentence.

Scientific concepts, on the other hand, are systematic, instruction-based and influenced by adults. They evolve or develop through formal instruction, which Vygotsky says determines the fate of the total development of the mind of the child. This means that school instruction plays a decisive role in making the child aware or conscious of his/her own mental processes. School concepts enable the child to develop what Vygotsky (1962) calls 'reflective consciousness'. Vygotsky emphasizes the idea that the ability to consciously realize one's thoughts arises in the course of the child's mastery of scientific concepts in school.

I will now look at how scientific concepts influence the mental development of the child. This is important because my research study looks at schooling (which supplies the child with scientific information) and its influence on cognition.

Vygotsky (1962) talks about studies which have shown that higher intellectual functions such as reflective awareness and deliberate control appear in the process of development during early school age. He cites a few examples such as involuntary attention changing to voluntary attention, and mechanical memory changing to logical memory. This happens once the child, through mediation, has been exposed to scientific concepts; assimilated those concepts, and internalized and reconstructed the knowledge that he/she has been provided with by others.

School education is, according to Luria (1976), qualitatively different from education in the broad sense. At school the child comes face to face with a particular task which is to grasp or to master a system of scientific concepts (in Vygotsky 1978). What happens at school is that the teacher

supplies information, explains, questions, corrects and even gives the child the chance to explain. During this process of instruction the child is forming concepts which, with the help of the teacher, enable him/her to solve systematic problems, which he/she could not solve earlier using everyday concepts. He/she also reasons, follows instructions and explanations given to him/her and then reproduces new, logical operations. His/her spontaneous concepts are transformed into a new cognitive relationship with the world.

The discussion above has attempted to provide the theoretical exposition of Vygotsky's theory by looking at tools and signs and the role of mediation, as well as everyday and scientific concepts and how these influence the mental development of the child. The use of tools and signs in psychological activity involves mediated activity and brings about higher mental functioning, which is characterized by intellectualization and mastery, or what may be called conscious realization and voluntariness.

Everyday concepts differ from scientific concepts in that they are non-systematic and do not provide the child with an awareness of how he/she uses them. School concepts, on the other hand, develop the child's cognitive structures which enable him/her to think critically and to reflect on his/her own thinking. In the next section I will review the literature on schooling and cognition, in an attempt to establish the extent to which schooled subjects use scientific concepts to solve systematic problems, i.e., their use of abstract forms of reasoning in solving logical problems.

LITERATURE REVIEW

In this literature review I look at how schooling affects cognition and to what extent schooled individuals use formal operational thought. The specific function of the review is an attempt to answer the question ' Is schooling solely responsible for the development of formal operational thought?'

Luria (1979) asserts that socio-economic and socio-cultural conditions produce certain kinds of cognition. There are concrete and abstract ways of thinking drawn either from the immediate or from the general socio-cultural context.

> For an individual, a cognitive domain consists of the set of phenomenal objects treated as functionally equivalent in the sense that a common set of attributes can be meaningfully used to appraise them. Though a particular set of objects may constitute an identifiable domain for one person, for someone else the same objects may be scattered over several domains, or be included as a subset of some larger domain, or not enter into a cognitive domain at all (Scott et al. 1979 p.56).

In his attempts to test the levels and forms of thinking, Luria took schooled and unschooled subjects and gave them tasks which enabled him to establish the nature of their thinking. His findings indicated that the socio-economic conditions and related cultural practices that people engage in determine their way of thinking. One therefore must attend to context in order to understand people's way of thinking . Luria's subjects were schooled for only two years or so, and their reasoning tended to develop from concrete to abstract. Sometimes their reasoning included both forms of thinking. An illiterate bakery worker, for example, who had had only two years of schooling, was able to categorise tools, although at the same time she restricted the tools to her context when she classified them as building tools. According to Luria (1979) participation in a new economic system enabled his subjects to gain access to new forms of social relations and

hence new forms of thought. In the remainder of the literature review I will at look at research inspired by Vygotsky and Luria's research, in order to establish the extent to which schooling is responsible for formal operational thought .

A cultural practice such as formal schooling is believed to transform the way in which people think (Vygotsky,1978). Vygotsky (1978) argues that through schooling we learn to direct our attention actively and consciously to what we are doing and we can also reflect on our own thinking, because formal schooling provides mediation of scientific concepts, which are responsible for producing conscious awareness. Luria (1976) contends that formal schooling enables people to make a transition from graphic and functional reasoning to abstract thought. According to him, once people acquire formal education, they make increasingly greater use of categorization to express ideas that objectively reflect reality. Tulviste (1991) also believes that thinking changes in the course of formal schooling because children are confronted with the problem of mastering the basics of systems of scientific concepts. He argues that

> attending school, the child finds himself in a cultural environment completely new to him and is exposed for the first time to scientific information and scientific thinking... In school a person is confronted by problems that cannot be solved with the types of thinking that he has. For this reason, a new type of thinking is formed, functionally appropriate to these problems (1991: 25-26).

In this argument Tulviste shows that a person develops the kind of thinking that is functionally appropriate to his/her situation. For example, in a formal schooling situation the learner is provided with scientific concepts which, once acquired, serve as an `amplifier' of thought processes (Bruner, 1972). Bruner contends that " in school, language is used out of context for special analytic purposes, and the new tool of written language is made available for cognitive operations. School learning thus demands and fosters abstract modes of thought" (1971:48).

Lawrence and Valsiner (1993) also claim that formal schooling is generally conceived of as "a straightforward, progressive, cumulative process. It is characterized in terms of development, growth, accumulation of knowledge, skills and experience. ...the earlier stages are ideally incorporated into more sophisticated later stages " (p.152). In a similar vein Moll (1994) argues that schooling is the only social domain in which formal thought is the dominant mode of cognitive activity and sustained over long periods of time. From this it follows that formal schooling creates an awareness of scientific concepts in an individual. The pupil, faced with new challenges and problems, has to find ways of reaching the solution to those problems, because attendance at school encourages an approach to tasks that incorporate a search for a rule or a principle that can generate solutions. The process that he/she engages in (i.e., questioning, correcting, analysing, etc.) is at the heart of problem solving and indicates learning and an advancement in cognitive functioning. According to Cole and Scribner,

> schooling seems to promote an awareness of the fact that alternative rules are possible, such that one might call this a formal approach to the task in which the individual searches for and selects from the several possibilities a rule of solution (1974:122).

Cole and Scribner's (1974) argument agrees with that of Rogoff et al. (1984) who contend that the cultural tools and techniques used in school involve certain conventions and genres, such that schooling may provide students with particular ways of thinking, like classifying objects by taxonomic category rather than by their function, as well as providing them with the conceptual means to describe and explain their own mental operations.

The foregoing literature generally concurs on the significance of schooling and its effects on the mental processes of individuals. The literature also shows that material conditions which include culture, social history, social activity, and social relations of an individual are of particular

importance in understanding the thought processes of an individual because they determine the type of cognition that an individual develops. The literature furthermore appears to support the idea that schooling is responsible for the development of formal operational thought.

From the review of the cognitive effects of schooling one might reasonably infer that under conditions where there is a disruption of schooling, pupils will fail to develop the cognitive skills necessary to function in a formal educational environment. They might also, at the same time, lose the skills that were initially gained before the disruption of the school. The reasons for this might be the following:

1. Mediation by the knowing other (eg. teacher) is disrupted;
2. Inadequate or incomplete mediation especially of scientific concepts; and
3. The time for the full development of systematic concepts is disrupted and contracted.

The hypotheses above influenced me to look at the nature of the disruptions of schooling in South Africa from the year 1976 to the early '90s. The concern in this regard is 'what happens to the cognition of learners if their schooling is disrupted?' I believe that it is important to look not only at how the disruptions have affected pupils cognitively but also at how their attitude towards schooling was affected by these disruptions. This I believe is important because one's attitude towards schooling would influence one's performance in school related tasks which require active mental involvement. The activity of the schools is also important because this affects the way in which pupils react towards schooling as a whole. In this regard Tharp and Gallimore (1988) argue that we must look not only at the individual but also at the external world in which that individual life has developed. We must examine human existence in its social and historical aspects, not only as it appears at a particular point in time.

Schooling in South Africa has, for the past 22 years , been subjected to periodic disruptions which were mainly political. The disruption of schooling resulted in significant school drop-outs, and while some students sought employment others spent their time in idle activities unrelated to schooling. After spending many years (±5 years) out of school, some dropouts finally went back to school to continue with their schooling. Others who had remained in school, have been in there for more years than is normally the case in situations where schooling has not been disrupted. For example, there are pupils who have spent more than three years in one standard, who still do not show any signs of improvement on their school performance, and who are likely to repeat their present standard. The poor school performance can be attributed to the crisis in schooling that has been brought about by, amongst other things, factors such as pupil boycotts, teacher boycotts, the disruption of schooling, as well as other political problems facing the country (Wallace and Adams, 1987; Kaplan et al., 1994).

Looking at the politics of education during a crisis, we find that the commitment of students to school becomes a serious question. Pupils perform inadequately, schools become unmanageable as well as unproductive as students become difficult to discipline causing disorder and chaos in the learning environment. The schools, homes/families and the community, which are ideally the places in which the development of juveniles is secured, become emotionally powerless and often fail to cope in an adequate manner. As a result children lose their childlike qualities and in place of these we find apathetic behaviour such as lack of concern, insensibility, irresponsibility, and lack of co-operation. Children in such situations start questioning things, and the content of school knowledge becomes a pressing issue. If such students see their culture as being belittled or ignored, they tend to see school knowledge and curricula as racist and alien to their own

experience. They then start resenting what the teacher gives them as they see it as not being worthwhile (Sharp, ed., 1986). Consequently they lose interest in school learning, and hence their poor performance.

The education crisis may also bring with it feelings of worthlessness in pupils. This may lower their self-esteem which may influence their achievement negatively. Kaplan (1980) in his study of the relationship between self-esteem and achievement, argued that

> ... a history of context-specific devaluing experiences that individuals are unable to defend against will lead to their association of that context with their negative self-feelings...(in Kaplan et al., 1994:167).

Such persons, he says, will become increasingly inclined to deviate from what is normally expected of them by the society, in this case high academic achievement. This behaviour Kaplan et al. term `self-rejection' and define it as "... the subject's cognitive association between self-derogation and prior self-devaluing experiences in conventional membership groups" (ibid). This assertion is similar to Rautenbach's (1985) claim that children growing up under conditions of school boycotts and unrest tend to consider themselves as objects rather than subjects. Rautenbach further claims that their thinking skills are poorly developed. Thinking and feeling are not well differentiated and they tend to react to the environment instead of interacting with it, with the purpose of influencing it in specific ways. From this, one can reasonably infer that in crisis situations such as disrupted schooling, pupils may direct their thinking to issues other than those which require their use of scientific concepts to solve school related tasks (Rautenbach, 1985).

The school boycotts and unrest in South Africa have brought with them poor school conditions in the sense that schools in crisis conditions were severely damaged by fire. The Nationalist government took a long time to repair damaged schools, and consequently pupils were forced

to learn in unconducive school buildings. In this regard Chazan et al., (1976) argue that school factors, beside home background factors, may contribute to the pupils' poor response to schooling. According to them,

> conditions at school which amount to deprivation for the child include inadequate school buildings and amenities, a failure to provide appropriate stimulation, a lack of continuity in the teaching, and a lack of satisfactory relationships with other children (1976:15).

Chazan et al. also argue that unsatisfactory working conditions such as lack of green playing spaces, unconducive classrooms, and restrictions on activity tend to lead to a lowering of morale and of achievement among both teachers and pupils. They cite examples from Swift (1969), Douglas (1970) and the Coleman report (1966) which stress the importance of good school conditions in school achievement and later success in life. Chazan et al.'s argument and their examples concur with the recent findings by a Wits University research team (Paton, 1996) in Gauteng schools. The latter researchers found that the conditions of school buildings and facilities made huge differences to learning and teaching and influenced the morale of teachers and students. They also found that schools that have the worst facilities have a low pass rate. Only half the schools in the study had functioning toilets and a third had electricity, a telephone, a photocopier or glass in the window panes (Paton, 1996).

According to Hale-Benison (1986), one explanation for the difficulties children experience in school may be their participation in a culture that is very different from the culture that designed the school (in Berry and Iceman, 1989). In South Africa, for example, school disruptions such as demonstrations, sit-ins, marches, student and teacher boycotts, student rebellion and truancy have brought with them a lack of continuity in teaching. Paton (1996) detailed an alarming picture of school life in Gauteng. The research team's findings were of gangsters ruling schools, drug use

in schools, teacher drunkenness and absenteeism, and of broken relationships between teachers, students and principals. It was also found that teachers had lost their sense of duty and respect for the existing regulations, while principals were unable to provide the leadership needed to take schools out of these crises (Paton, 1996).

Having looked at how schooling affects cognition and considering the fact that South African schooling has had a series of disruptions, the questions one might ask, therefore, are 'To what extent have the schooling disruptions in South Africa affected the development of cognition, and more especially, the formal thought of pupils?' and 'Is schooling solely responsible for the development of formal thought?' To answer these questions I conducted research among high school pupils in which I attempted to establish their knowledge and use of systematised, schooled concepts. In the next section I will describe my research methods and findings.

RESEARCH METHODOLOGY

The research which will be reported here was conducted in two urban high schools which had been subjected to different levels of disruption. School A had been subjected to a high level of disruption and School B was mildly affected by the disruptions. Both schools were looked at from a ± 20 year history of disruption. The disruptions ranged from teachers and students not attending classes whilst on the school premises; students victimising, harassing and attacking teachers; to students deliberately disrupting the normal functioning of schools because of conflicts between them, teachers and principals.

The consequences of these disruptions led to students not doing their schoolwork, showing a lack of commitment and interest in their schoolwork and not caring at all about their future. In these situations teachers and students lost motivation as there was a lack of mutual support. The schools thus became places where teachers and students 'while away time' instead of engaging in teaching-learning activities. Most subjects included in this research indicated that they were trying to study, although it was difficult to do so without the guidance and support of the teachers. In School A, which had severe disruptions, students indicated that they had lost teachers through harassment and attacks by other students. As a result they had to study on their own for the final exam, which they found very demanding.

The two schools were selected in such a way that the pupil population in each were from a comparatively similar background, that is, similar socio-economic conditions, more or less the same age and school grade, that is, grade 12. The subjects were chosen on this basis because of the assumption that they would, at the time of research, at least have had a 5-year history of schooling in the given context. From each school a sample of 10 subjects was selected.

For each subject in the two groups qualitative data was sought in relation to:

- accounts of experiences and conception of schooling and school learning;
- accounts of the subject's personal school history;
- home conditions and parental professional background;
- performance on school-type tasks, and
- the forms of the subject's cognitive activity on classification tasks derived from Luria (1976) and adopted by Cole et al (1971) and Moll (1991).

The first task, task A, was a naming and classification task. It consisted of geometric figures which were shown to the subjects and each subject asked to do the following sub-tasks:

A1: name each geometric shape that was presented on a stiff card,

A2: grouping different geometric shapes according to common traits, and

A3: provide a reason for grouping particular shapes together.

Task B consisted of syllogisms which were presented to the subjects to ascertain their ability to reason syllogistically. The subjects were presented with school-type tasks and were supposed to provide answers to the questions on the basis of the given information (premises). An example of the task was done by both the subject and the researcher. The example was as follows:

If a = b and b = c then a = ?

The correct answer would then follow logically that a = c and the explanation would be that a = c because they are both equal to c. On the basis of this example the researcher was able to establish that the subjects understood what was required of them before they proceeded with the task.

Task C was Luria's (1976) abstraction and generalization task. The task was adapted to be familiar and meaningful to the subjects. This assumption was checked in an urban context by showing the tasks to the subjects before using them and establishing that the subjects were familiar with the tasks by asking them to name, identify and describe the use of items which are represented by the pictures on the stiff cards. On each stiff card there were four drawings. The subjects were asked to identify the item that did not fit with the three others on the same card, and further to provide a reason for picking a particular item as the odd one.

The interview method was used in order to enable the researcher to discover the subject's reasoning in relation to the tasks. This method was also used to determine how and why the subject arrived at a particular solution to a problem.

The tasks used were as follows:

TASK A

A.

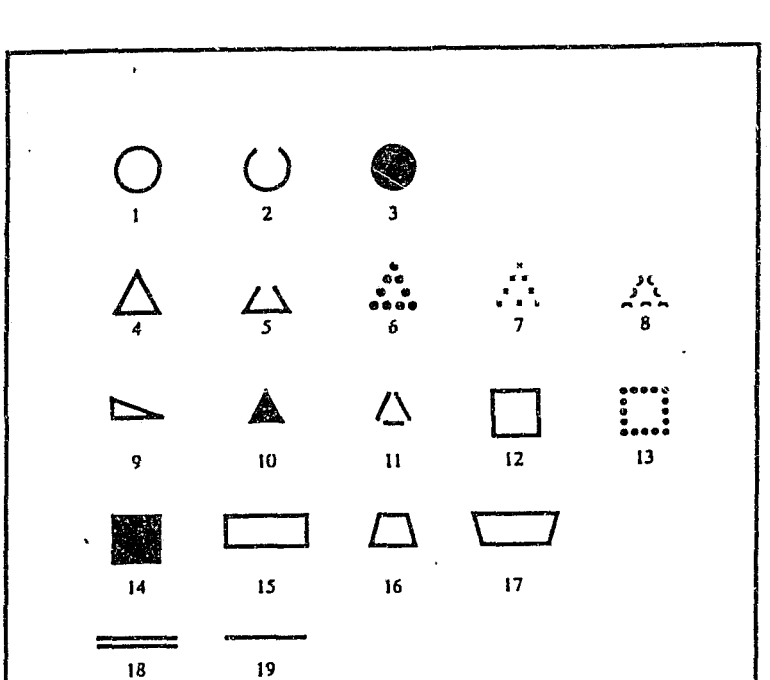


Figure 1 Naming and classification of geometric shapes, (Moll, 1994).

The figures above represent

1. Circle 2. Incomplete circle 3. Shaded circle 4. Triangle

5. Incomplete triangle 6. Dotted triangle 7. Crosses forming a triangle

8. Shapes forming a triangle 9. Right-angled triangle 10. Shaded triangle

11. Incomplete triangle 12. Square 13. Dotted square

14. Shaded square 15 Rectangle 16. Trapezium 17. Trapezium

18. Parallel/horizontal lines 19. A line

TASK B

SYLLOGISMS

B. Precious metals do not rust.
Gold is a precious metal.
Does it rust or not?

C. Monkeys live the forest and nowhere lese.
There are no forests in big cities.
Are there big cities that have monkeys living in them?

D. In the Okavango there are animals called Lechwe.
Lechwe live only in wet swamp areas.
Is the Okavango a swamp?

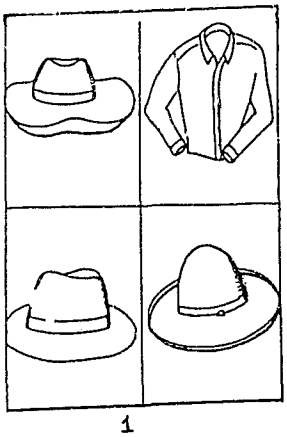
E. Maxalani grows only in hot and dry areas.
England is a cold and wet place.
Does Maxalani grow in England?

F. There are no snakes in Ireland.
Dublin is a place in Ireland.
Are there snakes in Dublin?

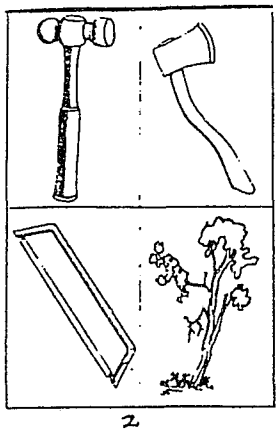
G. In India, all elephants have small ears.
Punjab is a place found in India.
Do elephants in Punjab have large ears?

TASK C

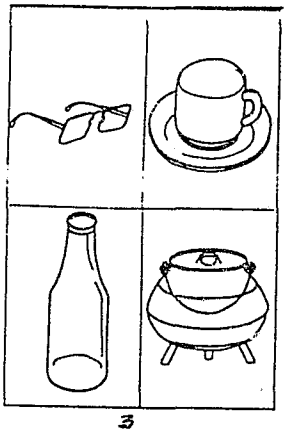
ABSTRACTION AND GENERALIZATION



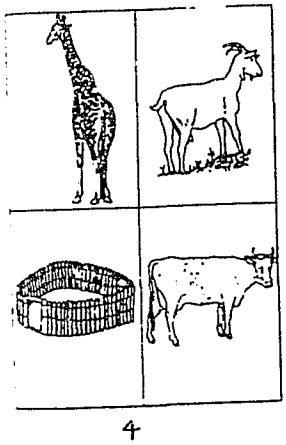
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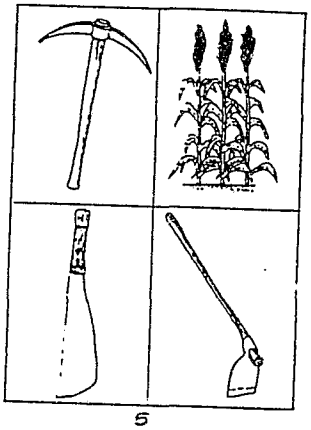
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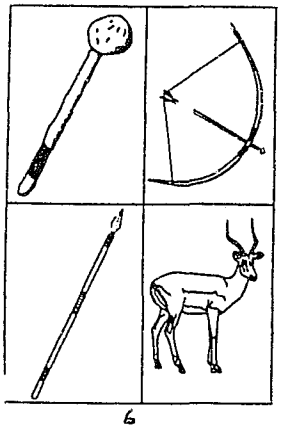
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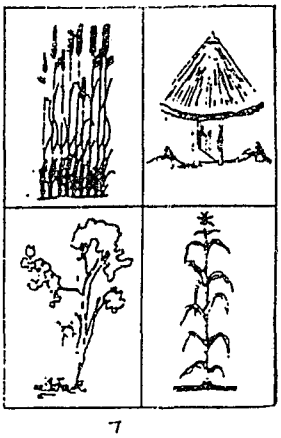
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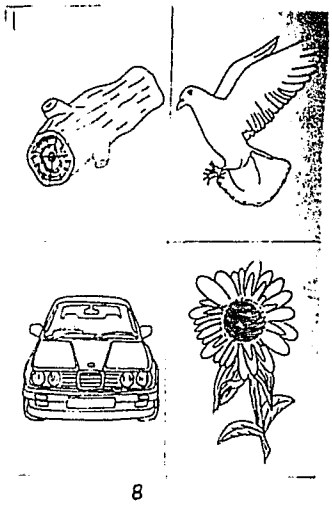
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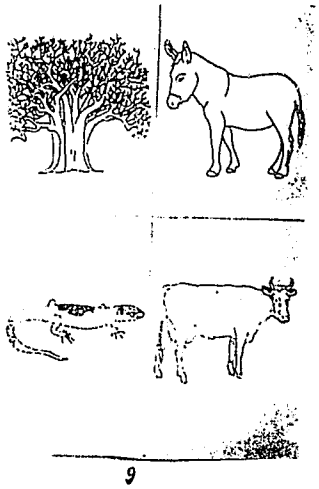
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7



8



9

RESEARCH FINDINGS

In this section I will present my research findings. The responses to each task will first be presented as a summary of the total responses and then discussed in detail. The detailed presentation of the responses will be accomplished by selecting three subjects per school, per task and their responses will then be outlined. I will highlight only the inappropriate responses as they form the basis of the discussion of the research findings and of the research question. Before the individual responses are discussed, background information on the subject will be provided. The subjects from School A will be designated 1A, 2A, ...9A and those from School B will similarly be designated 1B, 2B, ...9B, respectively.

More specifically, I will look at task A1 and the responses from school A, go on to detailed responses of the arbitrarily selected subjects (1A, 2A and 3A in this case) and conclude those responses with a general discussion. After that I will look at the same task (i.e. A1) with regard to school B which will be followed by its subjects' responses. The same procedure will be followed with the other tasks (i.e. A2, B and C). It should be noted that the numbering of the subtasks of each major task reflects the numbering that was outlined in the methodology section for each of the subtasks. This is important because only the inappropriate responses will be highlighted in the case of tasks A1, B and C, therefore the reader will need to refer back to the methodology section in order to keep track of what is happening.

Lastly this section will be concluded by a comparison of the two schools as well as a summary of all the responses from both schools. The subjects will be compared with the intention of establishing whether the disruption of schooling affects the conceptual development in a

significant way.

RESEARCH FINDINGS

TASK A1 - NAME OF GEOMETRIC FIGURES

SCHOOL A : (1) Summary of the total responses to task A1

N = 10

NAMING	APPROPRIATE	INAPPROPRIATE
1	10	00
2	09	01
3	07	03
4	10	00
5	09	01
6	10	00
7	09	01
8	10	00
9	03	07
10	08	02
11	07	03
12	10	00
13	10	00
14	08	02
15	10	00
16	03	07
17	00	10
18	10	00
19	10	00

The table above shows that most subjects could identify or name the geometric figures in the

'scientific way' used at school. There were, however, instances (e.g. number, 9, 16 and 17) where subjects experienced difficulty in naming the given figure in a scientific or abstract way. In these instances subjects tended to resort to their everyday thinking or concrete ways of thinking, that is, thinking in terms of the function of the item resembling the given geometric figure.

The following in-depth look at three arbitrarily selected subjects' responses to task A1 provided a sense of their ability to group and categorise shapes. A brief description and background information of each subject will be given before the responses are tabulated.

Responses to Task A1

Subject 1A

A 17-year old matriculant from a family of nine. The father, a widower, is a single parent. He is assisted by the two eldest children to support the family. The family is dedicated to schooling and is very supportive in this regard, and consequently the subject gets a lot of motivation from home. His schooling history, especially high school, has been characterised by disruptions. The disruptions, according to the subject, led to his under-achievement at school. This was so because, according to the subject, teaching and learning were not consistent: one day teachers would attend classes and teach effectively, and the next day teaching and learning would not be normal due to the disruptions caused by either the students not attending classes or by teachers not honouring their duties. As a result the subject pointed out that performing well in school subjects or performing according to one's potential and capability became difficult. The subject had been in school for five years without repeating any standard.

The subject responded appropriately to the given task, except in the following instances.

3. *Shape of the earth.*

10. *I don't know.*

14. *A square full of sand.*

16. *I don't know.*

17. *A bath.*

Subject 2A

A 19-year old from a family of thirteen comprising a mother, father and eleven children. The subject is the youngest and stays with the mother and two unmarried sisters. The father resides in Zimbabwe with the other children. There is a lot of motivation from home with regard to schooling and the mother provides for all the educational needs of the subject. The subject is also a hard worker who, despite the disruptions at school has managed to pass every standard well. At the time of the research the subject pointed out that there was no science teacher at school because COSAS (Congress of South African Students), a student organization well known for its disruptive activities at the school, was not on good terms with the teacher. COSAS had given the science teacher a hard time at school, harassing and intimidating the teacher because he was 'strict'. The teacher engaged in physical fights with COSAS members and ultimately decided to leave the school. The Department of Education did not provide a replacement teacher hence the subject and his colleagues had to study science on their own for their matriculation exam.

The inappropriate responses by the subject to task A1 were as follows:

3. *Ball, or moon, a round thing.*

10. *Triangle divided into two.*

11. *Three sides.*

17. *Looks like a basin*

Subject 3A

The subject is 18 years old, from a family of six consisting of both parents and three brothers, the subject being the fourth child. Although the parents did not have much education, they were positive about schooling, always encouraging their children to work hard at school so that they could be better people. The subject had enjoyed schooling because the family, friends and teachers were very supportive. She is a hardworker but due to the disruptions she claimed that she could not perform according to her potential, especially in Accounting because teachers were often on strike and could not attend the classes well.

The subject gave the following inappropriate responses to task A1.

2. *The letter c.*

5. *I don't know*

9. *An angle.*

16. *A rhombus.*

17. *I don't know.*

Having provided the responses to task A1 by subjects 1A, 2A ad 3A, I will now look more closely at their responses.

All the above subjects were able to use scientific concepts used at school to name the geometric figures except where indicated. In instances where they failed to remember the appropriate scientific names, there was a tendency to resort to familiar words, to common sense descriptions,

or to simply say 'I don't know'. For instance, a shaded circle (figure 3) is referred to as 'shape of the earth'; 'ball'; 'moon' or 'a round thing'. Figure number 10, a shaded triangle, is referred to as 'a triangle divided into two', although the subject does not explain or provide a reason for that response. Another interesting figure is number 17, a trapezium. The subjects refer to it as either a bath or a basin. Figure 14, a shaded square, is referred to as a 'square full of sand' by subject A1 and the trapezium is called a rhombus by subject 3A.

TASK A1 - NAME OF GEOMETRIC FIGURES

SCHOOL B : (1) Summary of the total responses to task A1

N = 10

NAMING	APPROPRIATE	INAPPROPRIATE
1	09	01
2	07	03
3	08	02
4	10	00
5	07	03
6	08	02
7	08	02
8	07	03
9	08	02
10	08	02
11	09	01
12	08	02
13	08	02
14	08	02
15	06	04

16	01	09
17	01	09
18	08	02
19	10	00

In the above task there were more appropriate than inappropriate responses. Thinking and reasoning tended to vacillate between the graphic functional and the scientific way of reasoning. Figures number 16 and 17 had the most inappropriate responses as the subjects tended to attach the name of a 'utensil' to the figures in order to explain them. Most subjects, as is evident from the table failed to use the appropriate scientific concept used at school.

Responses to Task A1

Subject 1B

A 19-year old from a family of seven consisting of two brothers, two uncles, the grandmother, the aunt and the subject himself. The subject's mother, although not staying with the family (relatives) , provides support and encouragement to the subject with regard to schooling. The subject is the first to reach matric within his family. The family members with whom the subject stays are unemployed and they while away time by drinking. In his schooling career the subject failed or repeated standard eight (grade 10) and attributes the failure to the vernacular which he said was too difficult for him because it was not his mother tongue. The mild disruptions in the subject's school were not associated with politics and gangsterism or violence but were due to disagreements between the students, teachers and school management over the wearing of school uniform by the students and the cleaning of the classes. The students would want to come to school in fancy clothes and also refuse to clean their classes. These kind of disruptions impacted

negatively on the subject in the sense that the wasted teaching days could not be made up for and soon it would be mid-year or end of the year, time for the examination and not much would hae been done.

The subject's inappropriate responses to task A1:

8. *Rectangle.*

16. *Rhombus.*

17. *Four-cornered square but not all sides equal.*

Subject 2B

A 17-year old matriculant who stays with both parents. The mother is unemployed and the father is working. Both of them are very supportive with regard to schooling and encourage their child to study hard so as to have a better future. The subject has enjoyed schooling because the teachers have been very supportive, although at the time of the research the subject indicated that schooling was no longer as interesting as it was in the previous years. The subject attributed lack of interest in schooling to teachers abandoning the classes that were regarded as 'boring'. During the times that the classes were abandoned, the subject felt demotivated and that affected his performance at school, which, even though he had not failed any standard, was not satisfactory. The subject felt that teachers lacked support and were themselves demotivated hence they did not even support their learners.

The subject's inappropriate responses to task A1

1. *The sun.*
2. *Moon.*
3. *Dark moon.*
6. *I don't know.*
7. *Bees.*
8. *Leaves*
10. *It is something like a scale.*
12. *A box.*
13. *Dotted box.*
14. *Box*
15. *Table top.*
16. *Dish*
17. *Bath or basin*
18. *Water pipes*

Subject 3B

A matriculant, 19 years of age and from a family of eight. Both parents are working, and provide a lot of motivation to their children to go to school. The subject has been at the school for five years and has repeated standard nine (grade 11). She attributed her failure to playfulness and lack of dedication to school work. She confessed that she "worshipped entertainment" like movies, picnics and 'bashes' or street parties. She also belonged to a student organization at school, which was another contributory factor to poor school performance. Most of the time she sat in meetings which sometimes ended up in arguments and fights as members from another student

organization within the school disagreed with their ideas. The subject had enjoyed her schooling which she said helped build up her confidence.

The inappropriate responses given by the subject to task A1:

2. *The letter c.*

5. *I don't know.*

9. *Rectangle.*

15. *I don't know*

16. *I don't know.*

17. *Looks like a basin.*

Discussion of the responses of subjects 1B, 2B and 3B to Task A1

Subject 1B responded inappropriately to figures numbered 8, 16 and 17. The geometric concepts were used inappropriately by the subject, that is, figure 8, a triangular shape, was referred to as a rectangle, figure 16, a trapezium, referred to as a rhombus, and another trapezium (figure 17), referred to as a 'four-cornered square but not all sides equal'. The responses are unlike those of subject 3B who appeared not to know the names of most of the geometric figures. Subject 2B provided very unusual responses to the task. The subject used mainly graphic-functional thinking to name the geometric figures. We see, for instance, responses like bees, leaves, table top, the sun, dish and water pipes, to name a few. It would be interesting in this regard to look at task A2 where the subject was required to group the geometric shapes according to common traits and to provide reasons for the groupings.

TASK A2 : CLASSIFICATION OF GEOMETRIC FIGURES

School A N= 10 Summary of the total responses

CLASSIFICATION/GROUPING	APPROPRIATE	INAPPROPRIATE
Figures		
1. 1+2+3[1]	09	01
2. 4+5+6+7+8+9+10+11	02	08
3. 12+13+14	04	06
4. 15	02	08
5. 16+17	03	07
6. 18+19	08	02
7. 2+5+11	03	07
8. 3+10+14	04	06
9. 6+7+8	08	02
10. 6+7+8+13	02	08
11. 1+4+9+12+15+16+17	02	08
12 12+13+14+15+16+17	01	09

In task A2 the subjects were required to group the geometric figures according to common traits such as shapes or sides. From the above table it will be evident that most subjects responded inappropriately. It is interesting to note that some figures were scarcely placed in any group, especially the figure numbered 9, a right-angle triangle. Subjects felt it belonged on its own because it was not like other triangles. What follows are the responses from the same subjects who were looked at in task A1. It is important and necessary (unlike in task A1) to provide all the responses to task A2 from all the selected subjects because of the importance of the reasons provided by the subjects for the groupings that they made.

[1] The "+" sign stands for "and". In grouping number 1, for instance, figures 1 and 2 and 3 have been grouped together.

There are two groupings per subject, that is, first the subject does the grouping on his/her own and provides reasons for the groupings he/she has made. Secondly the researcher groups the figures according to relevant common traits. The purpose of the grouping by the researcher is to highlight to the subjects the groupings that the subject might have failed to consider, and thus to find out how the subject would respond to the different kinds of groupings.

Subjects 1A's Responses to Task A2

(i) Grouping by the subject

	Groupings	Reasons
a)	1+2+3	*These belong together because they are all circles.*
b)	5+7+8+11	*They are all triangles*
c)	4+6+9+10	*They are also triangles*
d)	12+13+14	*These are squares*
e)	16+17	*They are rectangles*
f)	18+19	*These are lines*

After this grouping the researcher asked the subject if there was any difference between groups b and c because the reason given was the same. The subject then regrouped b and c by combining them (that is, figures 4-11), saying that they should belong together because they were all triangles.

(ii) Groupings by the researcher and the subject's responses

g)	12+15+16	*Only 12 and 15 belong together, 16 is unlike the two of them.*
h)	13+14+17	*They all have four corners and therefore belong together.*

i) 5+9+10+11 *9 does not belong here because it is a right-angled triangle. 5 has two sides only. I don't know whether it was going to be a tingle or something else. It does not belong here either because I don't know whether these lines will cross each other or not. 10 is okay. They all do not match.*

Subject's 2A's responses to Task A2

(i) Groupings by the subject and the reasons provided

a) 4+5+6+7+8+10+11 *I think 7 and 8 are similar, 5 was just being started, together with 11. 4 was completed and 10 is solid. They all belong together.*

b) 9+15+19 *19 is a straight line. It was added to become a right-angled triangle (9) and then further added to become a rectangle (15), hence they form a group.*

c) 16+17+18 *Number 18 explains 16 and 17. They are similar but differ only in size.*

d) 1+2+3 *Number 2 is a circle that was not completed, 1 is complete and 3 is also complete and solid. They all belong together.*

e) 12+13+14 *I will start with 13. In this shape (13) a square was being traced, and in 12 it was drawn and finally in 14 the square was made solid.*

The next grouping was made by the researcher and the subject responded.

f) 12+15+16 *They are all the same. They are four-sided figures*

		although shapes differ.
g)	5+9+10+11	*Number 9 is different in the sense that it is right-angled. It does not fit in with the others.*
h)	13+14+17	*Number 17 does not form part of the group because of its shape. 13 and 14 are the same.*
i)	18+19	*These are lines and they belong together.*

Subject 3A

Grouping by the subject

a)	2+5+11	*They are incomplete, they have spaces.*
b)	6+7+8+13	*They are not solid.*
c)	3+10+14	*All shaded*
d)	1+4+12+15	*Complete or solid figures.*
e)	9+16+17+18+19	*All incomplete or unfinished.*
f)	1+3	*These are circles.*
g)	4+6+7+8+10	*They all have 3 sides.*
h)	12+13+14	*These are squares.*
i)	9+16+17	*They have similar shapes.*
j)	15	*It is the only rectangle.*
k)	18+19	*These are lines.*

(ii) Groupings by the researcher and the subject's responses

l)	1+2+3	*They do not belong together because 2 is incomplete.*
m)	5+9+10+11	*I don't agree with this group. The figures are not related*

		because 10 is shaded and 9 has a 90 ° angle.
n)	12+15+16	*I still do not agree with you. They do not belong together because 12 is a square, 15 has two opposite sides equal and 16 has sides which are not equal.*
o)	4+11	*They do belong together because if you complete number 11 you will get number 4.*
p)	13+14+17	*No, I don't think they belong together because 13 is incomplete and 17 is something else.*

Discussion of the responses to Task A2

Subject 1A seems to apply scientific methods to group the geometric figures together. Shapes are grouped according to common traits like squares, triangles, circles, etc. There are, however, instances where the subject's reasoning vacillates between scientific and concrete ways of reasoning. For example, the grouping numbered (g) (four-cornered figures) is not acceptable to the subject because 16 is unlike 12 and 15, but in grouping (h) all the quadrilaterals belong together because 'they all have four corners', even though 17 is not like 13 and 14. Grouping number (i) also raises some questions as the subject singles out figure 9 (a right-angled triangle) from other triangular shapes and claims that the grouping does not qualify to be one because all of the shapes do not match. This contradicts the grouping that the subject initially made where all the figures from 4 to 11 were grouped together because they were, according to the subject, all triangles.

Subject 2A provides an interesting way of grouping and reasoning. In grouping (a) the figure 9 was left out when all other triangular shapes were grouped together. In grouping (g) the subject

still insists that figure 9 does not belong with other triangles because it is different. This is the same kind of reasoning provided by subject 1A above. In grouping (b) subject 2A sees the different shapes coming together to form a bigger and a more complicated shape, that is, from a line (19) to a right-angled triangle (9) and finally to a rectangle (15). This kind of reasoning also goes for grouping (e) where a dotted square(13) formed the basis of a solid square (14). Furthermore, the reason provided for grouping (c), that "number 18 explains 16 and 17", shows the subject's 'peculiar' way of thinking. The geometric shapes are not classified, as seems to be the norm, according to the number of sides or corners, or according to their shapes, but according to a 'building-up' process, where one shape leads to another and finally to a bigger, complete figure. We note in groupings (f) and (i) that the subject is capable of classifying shapes according to a common trait like the shape and the number of sides. In (h), however, the subject's idea of four sides dies away as the shape dominates the grouping. The trapezium (17) no longer forms part of the group of four-sided figures because its shape is different from that of the two squares.

Subject 3A's responses in groupings numbered (a) to (e) shows that the shapes did not matter nor the number of sides. What dominated the subject's reasoning were traits such as complete, incomplete, solid or shaded. These responses, as compared to the responses of the subjects discussed thus far, are not familiar, that is, the other subjects were not able to identify these traits at their first attempt to group the shapes. In this subject's groupings (f) to (k), the familiar traits are seen once more. It is interesting to note that the triangular shapes were grouped together in (g) except figures number 5 and 9. Although figure 5 represented a triangle, it was incomplete and this led to the subject's inability to name and to classify it under triangles. Figure 9 was referred to as "an angle" in task A1, and not as a right-angled triangle, hence it was also not classified with other triangles. It was instead classified with quads 16 and 17, in grouping (i),

because the subject sees the three figures as having similar shapes. Further more the subject's grouping number (e) is justified as "all complete or unfinished". A look at this grouping raises questions because a triangle (9) is grouped with the trapezium (16+17) and again with lines (18+19) and they are all said to be incomplete. The other observation is that the subject was not able to group all the four-sided figures together except the squares only. This inability was also noticed in groupings (n) and (p). The fact that the subject referred to figure number 2 as "the letter c" made it impossible for the subject to classify it under circles, as was the case with other subjects.

TASK A2 : CLASSIFICATION OF GEOMETRIC FIGURES

School B N= 10 Summary of the total responses

CLASSIFICATION/GROUPING	APPROPRIATE	INAPPROPRIATE
Figures		
1. 1+2+3	08	02
2. 4+5+6+7+8+9+10+11	02	08
3. 12+13+14	05	05
4. 15	02	08
5. 16+17	07	03
6. 18+19	09	01
7. 2+5+11	02	08
8. 3+10+14	02	08
9. 6+7+8	04	06
10. 6+7+8+13	01	09
11. 1+4+9+12+15+16+17	00	10
12 12+13+14+15+16+17	01	09

Most of the responses to task A2 fall within the inappropriate category. Subjects failed in most cases to group the figures according to common traits such as incomplete, solid, dotted and shaded shapes. While subjects could not name figures numbered 16 and 17 in Task A1, they managed to group them together according to similar shapes. The following in-depth look at the selected subjects' responses will illustrate the responses in detail.

Subject 1B's responses to Task A2

(i) Groupings by the subject and the reasons provided

a)	1+2+3	*These shapes belong together because they are the same. Number 2 is about to become a circle.*
b)	4+6+7+8	*These also have same shapes and equal angles.*
c)	5+11	*All these are incomplete triangles*
d)	9	*It is only right-angled triangle.*
e)	10	*It is a triangle whose sides are not equal.*
f)	12+13+14	*All these are squares.*
g)	15	*It is the only rectangle.*
h)	16+17	*These two shapes are the same even if one is upside down.*
i)	18+19	*They are both lines.*
j)	1+3	*Number 2 is out because it is incomplete.*
k)	15+18	*They both have parallel lines.*

ii) Groupings by the researcher and the subject's response

l)	5+9+10+11	*I don't agree. The figures do not match.*
m)	12+15+16	*They are different. They don't need to be together.*

n)	13+14+17	*17 should be out of the group. It is not like 13 and 14.*
o)	4+11	*11 is incomplete therefore it does not belong with 4.*

Task A2 - responses by subject 2B

(i) Grouping by the subject and reasons provided

a)	1+2+3	*Similar shapes which belong together.*
b)	7+8	*Number 7 represents bees and 8 represents leaves, therefore bees prefer to sit on leaves.*
c)	12+14	*These are same boxes.*
d)	13+15	*One is the main table (15) and the other (13), because it is small is a corner table.*
e)	16+17	*Small and big basins belong together.*
f)	5+9	*They are the same shapes.*
g)	4+11	*Similar shapes.*
h)	18+19	*All of them are pipes.*
i)	6+10	*These are similar.*

(ii) Grouping by the researcher and the subject's responses

j)	4+6	*Yes, I agree because the shapes are similar.*
k)	6+7+8	*They do belong together because they are also similar.*
l)	12+15+16	*Because of their different shapes, they do not belong together.*
m)	5+9+10+11	*These do not match. Number 11 has to be alone. 9 and 10 can be together.*
n)	13+14+17	*17 does not belong here, it is not like the others.*

Task A2 - responses by subject 3B

(i) Groupings by the subject and reasons provided

a)	1+2+3	*They are all circles.*
b)	9+15	*Number 9 was a square and it was cut in half. 15 is like a square.*
c)	4+5+6+7+8+10+11	*These are all triangles.*
d)	12+13+14	*All squares.*
e)	18+19	*They are lines.*
f)	16+17	*They both look like basins.*

(ii) Grouping by the researcher and the subject's response

g)	5+9+10+11	*They do not all belong together. If you remove 9 you will be left with triangles only.*
h)	12+15+16	*12 and 15 belong together but 16 does not because it is different from them. It does not look like a square.*
i)	13+14+17	*I can agree with 13 and 14, but not to number 17 because it is not like them.*

Discussion of the responses to Task A2

The groupings provided by subject 1B reflect the subject's inability to classify, for example, all the triangular shapes and all the four-sided shapes together. This is seen in groupings (c); (d) and (e) as well as (f) to (h). The responses to groupings (l) to (n) also justify the subject's failure to notice the common traits amongst the given figures. The subject also starts by grouping figures 1, 2 and 3 together but goes further on to separate them [grouping (j)], leaving 2 out because "it is incomplete".

Subject 2B's way of thinking and responding to the classification task is mainly graphic-functional. There is a tendency by the subject to classify the geometric figures according to the functions of the items that are resembled by those geometric shapes. Because of the subject's reliance on the concrete, the subject is unable to abstract. The reasons for grouping (b) and (d) are very interesting in the sense that although figures 7 and 8 represent triangles, they are seen as bees and leaves respectively and hence should, according to the subject, belong together because bees like to rest on leaves. Figures 13 and 15 are grouped together as well, not because they are four-sided figures, but because one (i.e. figure 15) is the main table and the other (i.e figure 13) is a small corner table. This kind of reasoning reflects the everyday environment form which the subject comes, which dominates his way of looking and assessing things. Other groupings of interest are (e) and (h) where (e) is a group of basins and (h) is a group of pipes. It is thus clear from subject 2B's responses to the groupings that the schooled (scientific) concepts that are learnt at school played no role in influencing the way in which the geometric shapes were looked at.

The third subject, subject 3B, provided similar responses to those of the other subjects. The response number (f) of this subject was common among all subjects. An interesting response is that of grouping (b). According to the subject, the two belong together because figure 9 is half of figure 15. Figure 9 has posed a problem in a number of subjects when it was not grouped with other triangular shapes only because of its slightly different shape. The subject was unable to name figure 5 in task A1 but was able to classify it with other triangles. This was also the case with figures 15 and 126. Figure 15 (a rectangle) is said to be a square in task A1 but is it not grouped with other squares, it is instead paired with figure 9.

TASK B **SYLLOGISMS**

SCHOOL A SUMMARY OF THE TOTAL RESPONSES N = 10

Syllogism	Appropriate	Inappropriate
a	10	00
b	08	02
c	08	02
d	10	00
e	10	00
f	10	00
g	10	00

The above table shows that most syllogisms were successfully completed. In syllogisms labelled (b) and (c) subjects tended to use graphic-functional thinking because of their failure to realize that in syllogistic problem solving the solution lies in the premises. Once they established what was required, they responded in the appropriate way, as is seen in the responses labelled (d) to (g). A different group of subjects, designated 4A, 5A and 6A was involved in this task and the responses were generally the same, such that it would be futile to deal with each subject separately, as was done in tasks A1 and A2. I will thus provide a general discussion of the task on syllogisms.

Subject 4A responded to syllogism number (b) by saying "gold does not rust because it does not change its colour, it stays as it is". This response shows that the subject failed to consider the given premise and instead focussed only on what he knew about the metal gold. In syllogism number (c) subject 6A insisted that monkeys were found in big cities in the zoo. Even on further

prompting by the researcher, to make the subject realize that the appropriate response lies in the premises, the subject still insisted that there were monkeys in big cities. This kind of reasoning shows us the influence of the everyday, concrete environment in the thinking of the subjects.

TASK B **SYLLOGISMS**

SCHOOL B SUMMARY OF THE TOTAL RESPONSES N = 10

Syllogism	Appropriate	Inappropriate
a	10	00
b	03	07
c	06	04
d	10	00
e	10	00
f	10	00
g	10	00

The above table shows that syllogisms seemed easy to understand and to follow, except (b) and (c) where there were inappropriate responses. School B subjects as opposed to those of school A, provided more inappropriate responses for the two tasks. Similar reasons as that of school A subjects were provided by school B subjects. For example, subject 4B responded to syllogism (b) by saying that "gold does not rust because it is 'genuine'", and subject 5B said, "... even if you put it or immerse it in water it will come out as gold, so it does not rust". Subject 6B went further and said, "if someone has gold and is taking good care of it, it cannot rust. It can only rust whilst it is in the soil". Even when this subject was referred back to the premises he still

maintained that gold is very valuable and therefore does not rust easily. The inappropriate responses to task (c) resembled those of school A where the subjects claimed and insisted that even if the given premises leads them in the 'wrong' direction, there still are monkeys in big cities because zoos are found in big cities.

TASK C **ABSTRACTION AND GENERALIZATION**

SCHOOL A SUMMARY OF THE RESPONSES N = 10

	APPROPRIATE	INAPPROPRIATE
1	10	00
2	08	02
3	01	09
4	02	08
5	05	05
6	05	05
7	08	02
8	07	03
9	07	03

The table indicates that subjects tended to fluctuate between appropriate and inappropriate responses. A lot of graphic-functional reasoning was evident in the inappropriate responses, as will be seen in the following in-depth look at individual responses for selected subjects.

Subject 7A

The subject is 17 years old and has been in the school for five years. She is from a family of nine. The mother, who has separated with the father, is very supportive even though she is an unemployed pensioner. She encourages the subject to go to school and makes her to feel

responsible for her own education. The subject pointed out that schooling was not 'normal' in the sense that now and then there would be disruptions caused by a number of reasons such as lack of mutual respect between students and teachers, laziness of students, and the presence of the police in the school, which excites the students. The subject also pointed out that she had not enjoyed her schooling because of the disruptions. Some years were good and some were boring, as she said: "My standard 7 was not good because the police were after us all the time ... we lived with fear. When you saw a policeman in uniform you felt like you could die". The subject was, however, optimistic about schooling because she saw education as a way of liberating one's mind and of making one to have a brighter future.

The subject's responses to Task C

3. **Cup and saucer, pot, bottle, spectacles**

The spectacles are out because if I am a cook I will use the bottle to store water which I will use to make tea and cook porridge in the pot.

Would the three items belong together if the pot is removed?

Yes, if for instance you make tea with water from the bottle, you can still read a newspaper wearing spectacles.

4. **Cow, goat, kraal, giraffe**

A giraffe does not belong here because it is a wild animal. The others are domestic animals which could be put inside the kraal. A giraffe is found in game reserves.

If I remove the kraal would you agree with the grouping?

Oh no I wouldn't! The cow and the goat will get lost and they will be eaten by wild animals. The giraffe does not have a problem because it knows its way through the jungle.

Would you group any three and give them one name?

Okay, a cow, a goat and a kraal are domestic things.

5. **Hoe, pick, panga, mealies**

I would remove a pick because its work can be substituted by a hoe. I plough with a hoe and plant seeds. The mealies will then grow and I can use a panga to cut them off.

What if I remove the mealies?

The tools will remain but they will be of no use without plants.

8. **Car, wood, sunflower, bird**

The odd one is the sunflower. If I want to send a message somewhere I could use a car or the bird. I could also put the message on the wood and put the wood into a flowing river and then the message would be carried across. The sunflower does not belong to the group because it cannot move. I can also put the dove with the sunflower. The flower represents love and the dove represents peace. Love and peace go together because they are valuable.

Subject 8A

An 18-year old who lives with a single mother, a brother who is a teacher and a sister who is studying to become a dietician. The mother, although unemployed, is very supportive and encourages the subject to study hard so as to make it in the exams. The subject pointed out that there were disruptions at school, a lot of which were caused by fights between the students within the school and outside the school, that is, a group from one school would gang up against another group from the other school. The fights became disruptive when the groups either shot at each other or stabbed each other, sometimes leading to deaths. The subject saw teaching as not being effective at school due to what she said was laziness from both students and teachers. She

pointed out that the exams were just around the corner but there was not much done on teaching, especially in biology, because they were still far behind. The subject has enjoyed schooling because, as she said, she has learnt a lot of things and has also learnt how to deal with different people.

The subject's responses to Task C

2. **Axe, saw, tree, hammer**

I would remove the hammer because I can use the axe and the saw to chop down the tree, but not the hammer.

What if the tree is removed

The remaining three can still belong together because the plumbers sometimes us them.

Is there one word you can use to refer to any three items?

(A long pause), then ... I don't know, I can't think of any word.

Okay we call these tools (pointing to the picture).

Oh, I see.

3. **Cup and saucer, pot, bottle, spectacles**

The spectacles do not belong to the group because you can use either the cup or the bottle to pour some water into the pot.

Would you agree if the pot is removed from the group?

No, I wouldn't agree. I don't see any way in which the remaining three items can be together.

4. **Cow, goat, giraffe, kraal**

There is no odd one here, they all belong together. The three animals belong together and the kraal can be used to keep the cow and the goat inside.

6. **Spear, bow and arrow, knobkerrie, impala**

The knobkerrie does not form part of the group because if you try to use it to kill the impala, it would not die, but if you use a spear or bow and arrow it will definitely die.

If the impala is removed would the remaining three form a group?

Yes, because they can be used to fight.

What do we call them?

They are weapons.

8. **Bird, car, wood, sunflower**

I think the car does not belong here because the bird can roost on the wood next to the sunflower.

Is there any other way in which you can regroup them?

No, I don't think so.

9. **Cow, donkey, lizard, tree**

They all belong together because the donkey can rest under the tree and the cow can eat leaves from the tree. The lizard can also be found on the tree branches.

Is there one word you can use for any three?

Yes, the cow, donkey and lizard are animals.

Subject 9A

The subject is an 18 year old male who, together with two other brothers, live with their grandmother who is a pensioner. The parents have divorced and each is involved in a marriage. The grandmother provides a lot of motivation for the children to go to school. The subject pointed out the nature of the disruptions at school which were, amongst others, car hijacks (i.e, the taking of goods from the delivery vans), stone throwing at the police and fights between the

different student organizations and gangsters at school. Schooling would, most of the time, not last for a week. If, for instance, as the subject pointed out, the disruptions started on Monday, there wouldn't be schooling on Tuesday. If one came to school on Wednesday one would find that there still wasn't any normal schooling. This situation would sometimes carry on for the whole week. The subject also pointed out that a month before this research was carried out they had the MEC for Education in Gauteng, Mrs Mary Metcalfe, visiting them. The MEC motivated the students to stop the disruptions and the violence and to learn. She told them about the importance of education in the new South Africa. The subject thus felt motivated to study harder, especially because they were heading for the exams soon.

The subject's responses to Task C

4. **Cow, goat, giraffe, kraal.**

   The giraffe does not belong with the other three because it is isolated from them.

   Can you group any three and give them a name?

   I can't think of a name.

   If I remove the kraal what would you be left with?

   If you take the kraal away I would group the cow and the goat together. I don't think there is any way in which the giraffe can form part of the group.

   Okay, the name I asked you for is animals. If you take the kraal away you will be left with animals.

   I see.

5. **Hoe, pick, panga, mealies**

   I would group the hoe, panga and mealies together and leave the pick out because without a hoe the mealies would not be planted. You use a panga to harvest the mealies

when they are ripe.

Is there one word you can for any three?

Yes, I would call a hoe, pick and panga agricultural tools.

7. **Hut, maize, tree grass**

Here I can remove the grass and be left with the other three because they can found in the same place.

Would you agree with the grouping if the tree is left out?

Again I would group the hut and maize only, but the grass comes in where the roofing of the house is concerned, therefore it can fit into the group.

Can you use one word for any three?

Yes, we have plants and a hut.

Discussions of the responses from school A

For school A, task C seemed to be a bit problematic in the sense that subjects tended to ignore the common characteristics of the given drawings and instead focussed on the way in which objects were used. Almost all subjects responded inappropriately to tasks number 3 and 4. The reasons given for the responses to task number 3 were that spectacles are only worn when one has an eyesight problem. The other three items were grouped together because they are used in the home. These subjects failed to group the spectacles, cup and saucer and the bottle together. The fact that they are all made of glass, hence they can form a group of glass was not evident to them. Task number 4 also generated more or less the same type of reasoning as that of task number 3. A giraffe was considered the odd member of the group because 'it is a wild animal' and the others are 'domestic animals which can be kept inside the kraal'. One interesting reason is that of subject number 7A who, when asked if it would be possible to remove the kraal instead

of the giraffe from the group, answered "Oh no, I wouldn't! The cow and the goat will get lost and ...y will be eaten by wild animals. The giraffe does not have a problem because it knows its way through the jungle". Looking at this kind of thinking one sees a concrete way of reasoning. The subject also failed to name the animals, i.e. to identify the cow, goat and giraffe as animals. She instead referred to the cow, goat and kraal as 'domestic things'.

Task numbers 5 and 6 generated an equal number of appropriate and inappropriate responses. The same type of graphic functional reasoning was evident as the subjects thought only of the way in which the mealies are planted, in case of task 5 (for example subject 9A's response) and also of how the antelope (impala) is killed in the case of task 6. For example, subject 8A responded that the knobkerrie is the odd one in the group because it won't kill the impala, as opposed to the bow and arrow and the spear which would definitely kill the impala. The subject further agreed that the animal may be excluded from the group because the others are weapons, but the fact that there are weapons does not mean that they need to be grouped together. This kind of reasoning shows that the subject thinks only of how the weapons are used in relation to the animal. On their own they are not important, they only matter when they are used for a collective function.

TASK C ABSTRACTION AND GENERALIZATION

SCHOOL B SUMMARY OF THE RESPONSES N = 10

	APPROPRIATE	INAPPROPRIATE
1	10	00
2	06	04
3	00	10
4	02	08
5	03	07
6	07	03
7	04	06
8	04	06
9	04	06

This task elicited more inappropriate responses. Subjects from school B tended to display graphic functional reasoning, that is, reasoning was based mostly on what they knew and saw happening around them and not on their schooled knowledge. The following in-depth look at the subjects' responses will illustrate this contention.

Subject 7B

A 17-year old from a family of eight consisting of both parents and six children who were still at school, the eldest in her second year at the technikon. The subject has enjoyed her schooling because of a supportive family and friends at school. The disruptions at the school that the subject pointed out were minor and some were those of students refusing to wear school uniform and wanting to prescribe to the teachers what to wear to school. These disruptions would, however, not last for long periods but could only last for a day or two. The subject felt that teaching was effective at the school and through supportive teachers she felt she would make it in the exams.

The subject's responses to Task C

4. **Cow, goat, giraffe, kraal**

The giraffe does not belong to the group because it lives in the wilds and the others are domestic things.

Can you group any three and give them one name?

Yes, the giraffe, cow and goat are animals.

7. **Hut, maize, tree, grass**

The grass does not belong to the group because when you stay in the hut you will plant a tree for shade and maize to eat.

Is there a common name for any three items?

No. I cannot think of a name.

8. **Bird, car, wood, sunflower**

The wood is the odd one because one can have a bird, a car and a flower together. The wood is dead and it has no use.

9. **Cow, donkey, lizard, tree**

The lizard is out because it is not associated with the cow and the donkey which are animals.

Subject 8B

A 19-year old who lives with both parents who are very supportive with regard to schooling. The subject has enjoyed schooling which he sees as very important in shaping one's future. Although there haven't been major disruptions at school, the subject pointed out that there was a lack of textbooks at school and that hampered badly on his performance. The subject pointed out furthermore that the school was frequented by gangsters who harassed and intimidated the

students, especially the girls. The presence of gangsters within the school disturbed the normal functioning of the school because the teachers seemed helpless and afraid of those gangsters, hence nothing was done, like calling the police to the school.

The subject's responses to Task C

3. **Cup and saucer, pot, bottle, spectacles**

I may take the spectacles out because the other three are used in the house. The cup and pot have been used for a long time. The spectacles can be used only if one has an eye problem. If you don't have a problem with your eyes then there is no need for these glasses.

What if the pot does not form part of the group but the spectacles do?

You can remove the pot but only if you also remove the spectacles because I don't need them. I don't have an eye problem.

4. **Giraffe, goat, cow, kraal**

I would exclude the giraffe because it does not fit in the kraal. The others live in the kraal.

What if the kraal instead of the giraffe is removed?

Only the cow and the goat will remain because we can slaughter the goat and eat the meat. We can also drink milk from the cow. There is nothing we can do with the giraffe.

Is there one word for any three?

Yes, these are animals.

And they still do not belong together?

Yes, they do not belong together.

5. **Pick, panga, hoe, mealies**

A panga does not belong here because we may plough using a pick or a hoe to get mealies. You cannot plough with a panga.

What happens when the mealie is ripe?

Oh yes, you can cut the maize off with a panga, which means that they all belong together.

What if the mealie is removed, would you agree with the grouping?

No, I wouldn't agree, but all of them can be together because the panga is only used when the mealie is ripe.

Is there one name for any three?

These, excluding mealies, are implements.

6. **Spear, bow and arrow, knobkerrie, impala**

They all fall under one group because I may use any one of them to kill the impala.

Are you saying that you can't take anything out?

I can take the impala out because the other three are weapons.

7. **Hut, tree, maize, grass**

The tree is out because ... no, it is not out. They all belong here because the tree, maize and grass all need water to grow. To build the house we still need water. They therefore all belong together because they all use water and the soil.

Does this mean that there is nothing you can remove?

I can remove the hut because all others are plants, but all of them do belong together.

8. **Car, wood, bird, sunflower**

The car is out because it does not use energy from the sun like the others. It uses fuel to run.

9. **Tree, donkey, cow, lizard**

The lizard is odd because it has nothing in common with the other three. The donkey will use the tree to feed itself as well as the cow but the lizard cannot.

Is there one word for any three?

The donkey, cow and lizard are mammals.

Subject 9B

A 19-year old from a family of six comprising both parents who are working and four children. The subject feels good about schooling which she said helps one to focus one's life and goals. She does not see any disruptions at school because according to her everything that happens at school is part of schooling. The subject's parents are supportive in educational matters and encourage all their children to work hard so as to succeed.

The subject's responses to Task C

4. **Giraffe, goat, cow, kraal**

The giraffe lives in the forest. The cow and the goat can be put inside the kraal.

Is there one word for any three members of the group?

Yes, the giraffe, goat and cow are animals.

5. **Pick, panga, mealies, hoe**

A panga is odd because it can be used only inside the house. The pick and hoe can be used to plant the mealies.

7. **Hut, tree, maize, grass**

A hut does not belong ... no, a tree does not belong because it cannot build a house whereas grass and maize stalks can be used for building the hut.

Can you use one word for any three things here?

I can't think of a word.

Okay, we have plants, that is, the tree, maize and grass are plants.

I did not notice that.

8. **Bird, car, wood, sunflower**

Wood is dead, it can be taken out. A car is a precious thing, as well as a sunflower. The bird shows peace.

9. **Tree, lizard, cow, donkey**

The lizard does not belong to the group because the cow and the donkey feed on leaves from the tree.

Discussion of the responses to Task C from School B

The responses to task C from school B were more inappropriate than appropriate. Thinking and reasoning tended to be dominated by the graphic-functional way as opposed to the scientific (decontextualized) way of thinking. All subjects responded to task 3 in the same way, that is, that the spectacles could not form part of the group because, as subject 8 said, "... I don't need them. I don't have an eye problem". This shows that the subject has personalised the way in which he thinks about the objects in the drawing. All of the subjects failed to classify items made of glass together. The only focus was on how the items were used 'in the house'. Task nu[illegible] also elicited the most inappropriate responses where subjects felt that the giraffe [illegible] other animals because it is wild and they are domestic animals. Altho[illegible]cts

acknowledged that there was a group of animals, they however failed to classify them as one group because, as subject 8 said, "... we can slaughter the goat and eat the meat. We can also drink milk from the cow. There is nothing we can do with the giraffe". This kind of reasoning reflects the subject's context and an inability to use schooled knowledge. A similar way of thinking is seen in subject 7's response to task number 7 where grass is seen as odd because the tree serves as the shade and maize as food for the person staying inside the hut. This subject also failed to refer to grass, maize and the tree as plants. The kind of thinking reflected here clearly shows the influence of the context from which the subject comes. Subject 8 felt that all items belonged to the group because 'they all use water and soil'. This subject could also tell that others were plants but they could not be grouped on their own because when you build the hut you use water and soil, just like the plants. Two subjects (7B and 9B) felt that the wood should be excluded from group 8 because it is dead and therefore has no use. Although subject 8 could see that the car does not belong to the group, the reason given for the groupings is unusual because the subject feels that the three belong together because they use energy from the sun. One would therefore ask a question, why/how does a dead log of wood use energy from the sun? Most subjects saw the lizard in task number 9 as odd because it does not feed on leaves from the tree, like the cow and the donkey.

A summary of the research findings and the responses from both schools

The qualitative information of the subjects gave us an idea on the environments from which the subjects came. The family backgrounds of the subjects were found to be similar, where there was either one or both parents in the family. Almost all the subjects indicated that they received support and motivation either from the family, teachers or friends, with regard to education. There were, however, exceptional cases where some subjects, for example 6B, did not get the

support that was required to continue schooling. These subjects felt that they could not wait to pass their matriculation examinations so as to go and work because they could not stand the poor family conditions from which they came. The only major difference between the two schools, as was evident in the accounts of their schooling history, was the level of disruptions of each school and the extent to which it affected the teaching and learning process. School A has indeed experienced a high level of disruptions which, one could say, could easily lead the learners to giving upon on education, as some have pointed out. Some of the subjects managed to rise above the schools' problems and against all odds, were able to do very well academically. School B on the other hand experienced mild disruptions that would in fact not render the school non-functional, as was sometimes the case in school A. Because of the support from home most of school A's subjects also were keen to go on with their education.

A look at the responses from both schools shows that the difference in reasoning is very minimal. Subjects from both schools tended to use the same forms of thinking and reasoning.

In task A1, for instance, subjects experienced problems with figures number 16 and 17. It was difficult for the subjects to provide the geometrical names for those figures, they instead referred to them as baths or basins. Task A2 also generated more or less the same responses although there were differences in some instance like grouping number 11 where two subjects from school A were able to provide appropriate responses and none from school B could respond the same way. Groups number 2, 4, 10, 11 and 12 had the least number of responses from both schools. It is evident from the responses that subjects found it difficult to group the geometric figures according to factors that were common to them. The four-sided figures were the ones mostly scattered in their groupings. Other figures/groupings which proved to be difficult were solid figures. None of the subjects from school B could identify this type of grouping and only two

from school A could identify the solid figures.

The responses to task B on syllogistic reasoning also reflected the same type of thinking from both schools. In syllogisms (b) and (c) in particular, subjects tended to restrict their thinking and reasoning to the graphic-functional way, but as soon as they could establish that the answer to the syllogism lies in the premises, they found no difficulty whatsoever in giving the appropriate responses, as seen in all other syllogisms. In the responses to (b) and (c) it was clear that the subjects had ignored the premises and depended on their 'everyday' knowledge and not on scientific knowledge gained at school.

Task number C elicited responses that fluctuated between the two modes of reasoning; that is, a scientific or abstract way and a graphic functional way of thinking. Although there were more or less the same responses from both schools' it is interesting to note that there were more appropriate responses to the tasks from school A subjects as opposed to the responses from school B subjects. Subjects reflected, in their reasoning, the contextualized way of thinking where their backgrounds played a major role in their attempts to solve the tasks given to them. The overall observation of all the responses to tasks shows that group A subjects performed better on the tasks than group B subjects.

SCHOOLING AND COGNITION: A RE-EVALUATION

In the light of the research findings I have presented above, this section will address the question whether schooling is solely responsible for the development of formal operational thought.

Looking at our research subjects, each one of them had had at least 12 years of schooling, that is, most of them were in their twelfth year of schooling and some, who had repeated some standards, had more than 12 years of schooling. This means they had 12 years of mediated instruction and exposure to scientific concepts, which presumably had transformed their everyday, spontaneous concepts into a new cognitive relationship with the world, (Vygotsky, 1978; Luria, 1976). Disrupted schooling would therefore be expected to have delayed the development of scientific concepts especially in the subjects from school A, which had experienced severe disruptions that sometimes rendered the school non-functional. This means that we would expect a significant difference in the way in which the subjects from school A as opposed to subjects from School B, would respond to the tasks. The research findings, however, reflect the fact that subjects from school A had more appropriate responses than the subjects from school B which was mildly affected by the disruptions. The responses from all the subjects pose challenges to the Vygotskian ideas because, as we have observed, the level of disruptions does not seem to impact significantly on conceptual development. This raises questions such as:

- what is it in schooling or in school instruction that enables the child to think in a formal operational way?
- is it only schooling that develops the formal operational thought or are there other factors involved, and if so what are those factors?
- what is it that makes children from a highly disrupted school to reason better

scientifically as opposed to children from a 'normal' school.

All of the subjects, despite their 12 years of schooling, still based most of their responses to scientific problems on their concrete thinking, using everyday concepts instead of abstract, scientific concepts. For example, some subjects like subject 10B tended to remove a hammer from a group of tools in task C number 2. The subject reasoned that the hammer could not chop the tree down like the axe and the saw would. This task (c) revealed the 'unscientific' way in which the schooled subjects in an urban context thought. Another example is the response given by subject 7A who grouped the vessels together not because they were vessels but because of how they could be used in a home situation (Task C number 3). The subject also introduced a fourth item in his grouping, a newspaper, because of how the spectacles would be used: only when reading a newspaper.

An interesting observation is that of the responses of some subjects to task A1, called the naming of geometric figures. For example, subject 2B's responses to this task were generally similar to those of an old Mozambican peasant farmer who had never gone to a formal school. The peasant farmer was a subject of research on schooling and cognitive development conducted by Moll (1994). Moll (1994) argued that schooling was the only social domain in which abstract thought was the dominant mode of cognitive activity and sustained over a significantly long period of time. Looking at Moll's assertion in relation to the responses provided by subject 2B, it is questionable that an exposure to schooling necessarily leads to conceptual development. The subjects, instead of transcending their everyday experiences as well as the context-bound thinking strategies, still resorted to concrete thinking that focuses on commonsense reasoning or reasoning in everyday concepts, especially in task C. Vygotsky's theory of cognitive development could be read as

making the strong claim that schooling will lead to conceptual development, i.e., that schooling is necessary in the conceptual development of the child, or as a weaker claim that schooling may lead to conceptual development. According to this latter claim schooling is a necessary but not a sufficient factor in the development of scientific concepts. On the basis of this latter claim questions may be asked, such as:

- 'how long does it take for a child to assimilate the school concepts ?' and
- 'how do we make sure that students learn scientific concepts at school?'

These kinds of questions seem to be far from being answered because the theories that we currently have do not shed much light on such questions.

It is interesting to note that despite their attendance at school the subjects rarely used scientific concepts. The common traits between the items/objects (especially in TASK C) have been generally ignored. Let us, for instance, look at the following responses provided by subject 10A to task c number 8 and 3. In number 8 the subject said,

> The car does not belong in this group. The bird, the sunflower and the wood belong together because the bird can come and feed itself on the sunflower. But you can also put the car into the group. It can be used to carry wood from far away places for those people who use coal stoves. It can also be used to go and buy flowers from the shop.

The subject also saw no connection at all between the items in Task C number 3 and said,

> They all do not belong together. You use the spectacles to read or when you are blind. The cup and saucer are for drinking tea and the bottle can store water. The three-legged pot is for cooking and you can't put in on an electric stove.

The nature of these responses immediately betray the context from which the subject comes. The nature of these research findings also suggests that Vygotsky's stronger claim cannot be sustained

and that the weaker claim is more appropriate in the explanation of cognitive development.

CONCLUSION

This research report was an attempt to establish the effects of schooling on the development of cognition and more specifically to establish whether schooling is solely responsible for the development of formal thought. The research reported challenges the uncritical acceptance of Vygotsky's strong claim uncritically and calls for more consideration of the weaker claim.

The research has, to some extent, shown that schooling is not solely responsible for conceptual development in children. This means that interpreting Vygotsky's strong claim that schooling leads to conceptual development is insufficient to explain the development of formal operational thought. One can thus say that more research needs to be conducted on the issues raised by Vygotsky's theory and the neo-Vygotskian ideas. The questions raised in the previous section, if they are to be answered, need to be looked at in detail in future research. One has to, however, acknowledge Vygotsky for providing a base on which to expand or to base future research. There seems to be fundamental issues over the concepts "schooling" and "conceptual development" that need to be unearthed so that it could be better understood, for instance, 'at what point in the children's thinking and reasoning do they use scientific concepts and why'? And 'at what point do we say that a child has reached his/her optimal level of conceptual development that will enable him/her to solve scientific problems in a scientific way and not in the way that we have seen in this research? Future research needs to address the question 'what else, besides schooling, contributes to the development of scientific concepts?'

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Author Makoe P
Name of thesis The Cognitive Consequences Of The Disruption Of Schooling Makoe P 1999

PUBLISHER:
University of the Witwatersrand, Johannesburg
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