INHIBITORS TO CHANGE:

A CASE STUDY OF TEACHER CHANGE

IN A RURAL AFRICAN CONTEXT

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ABSTRACT

Environmental education is taught as part of the Primary School Environmental and Agricultural Science (EAS) curriculum in Zimbabwe. An attempt to improve the quality of learning in EAS resulted in a research project at the University of Zimbabwe that aimed to transpose innovative constructivist pedagogy from a western context to a rural African one.

This writer has used a definition of teacher change as social change and a belief that sustainable pedagogical change involves a transformative process. The research backs up previous findings that failure to recognise and deal with how people actually experience the change process, accounts for much failure of social change.

This qualitative research has attempted to provide some understanding of the complex interrelationships of factors that affected expected change in teaching style. By focusing on the process of teacher change within innovation, this researcher was able to identify inhibitors to change that were subsequently critically reflected on by the teachers themselves. The disappointing resistance to change first noted within the project has become a source of unexpected but potentially important illuminative understanding of teacher education and development in a non-western environment.

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The results of this study would not have been possible without the teachers. I thank all the individuals involved with the UZ Project, especially those teachers who were part of the collaborative group. Through them I began to understand the life and working environment of rural teachers in their own particular context. With them I learned to appreciate their individuality and enthusiasm for involvement. The teachers remain anonymous, while their words are used to express their understanding of the realities of pedagogy transposition from the North to the South.

Thanks are also due to those persons, especially Gill Bolt, who spent many days with me - reading and talking about teacher change. Thanks to World University Service of Canada for placing me with the UZ Project as an environmental education resource person, and to the UZ project staff for their patience with a novice to "constructivism".

I wish to thank my daughter, Marit, for her gift of two feminist participatory research books which facilitated my research with the collaborative teachers, showing me that there are alternative ways to do research with persons on the margin. Finally I express appreciation to my family and friends who believed in what the teachers and I were doing.

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INTRODUCTION

1.1 SUMMARY

The nature of environmental education, with its emphasis on diverse learning environments and approaches to teaching/learning often makes it receptive to new pedagogy that may involve problem-solving and action components. Environmental education goals involve human populations relating to the environment, not just to recognise environmental problems, but to involve themselves with the critical ingredient needed for a sustainable environment - action. Developing the ability of individuals to actively participate in problem-solving thus becomes an important aspect of environmental education.

The global involvement of environmental education allows for generalizations of theory and pedagogy that have been developed in entirely different contexts from southern Africa. Transposition of education practice implies an acceptance of need for change and the suitability of the transposed pedagogy within the new context or environment. What actually happens during the process of implementation, may question the underpinnings of the original assumptions and paradigms used to facilitate the change process. Educators may need to re-examine the suitability of a new pedagogy in response to research findings of the relationship of inhibitors to the process of teacher change.

This document was based on research into teacher change from traditional style to a problem-solving style using science process skills. This change was to occur within the primary Environmental and Agricultural Science curriculum in Zimbabwe. Qualitative, intersubjective and critically reflective research involving a group of collaborating teachers and this researcher, was done in response to a need to identify and understand both inhibitors to change and the change process as part of teacher development. In response to the research process this thesis attempts to provide a vehicle for the teacher's voice: to be accountable to those implementors of transposed pedagogy who are too often marginalized from decision making. Identified inhibitors are discussed

finally in relation to rural, marginalized teachers - their desire and need to change and what may be the best ways to help them, within the present socio-economic and environmental context.

1.2 HISTORICAL BACKGROUND TO THE RESEARCH

One of the goals of education in Zimbabwe is to improve education for the young people thus enabling them to develop themselves and their country in an environmentally sustainable way. After Independence in 1980 the curricula were changed from colonial British to ones more reflective of a Zimbabwean context, though still incorporating much of pre-colonial content and style (Lewin *et al* 1991). In 1981 a unified Environmental and Agricultural Science (EAS) course for primary schools was instituted. By 1984 EAS was being implemented in Zimbabwe schools. The syllabus took components from both the *white* and *black* pre-independence primary science or nature study curricula. Environmental education was incorporated in both the course name and in the inclusion of appropriate objectives and some environment issues such as pollution and agricultural land use. There was strong sentiment at the time that the colonial British science content from the *white* syllabus be maintained to keep up standards (Heberden 1993, pers. comm.). As Lewin *et al* (1991) and Kuiper (1994) have noted, the primary school Environmental and Agricultural Science (EAS) syllabus and its implementation are not at present providing what is needed to fulfil the stated goals and objectives of either the EAS syllabus or environmental education. As a result of Lewin *et al*'s evaluation report, researchers and curriculum developers have been encouraged to: 1) revise the EAS syllabus and 2) introduce teaching practice that will effectively help fulfil the goals of the EAS course. Lewin's summary report is provided in Appendix 1.1, p. 129.

The EAS syllabus was revised during 1992-93 and is presently (1995-1998) being implemented into the school system . This researcher was present at the national workshop in 1992 when the major revision decisions based on Lewin *et al*'s recommendations were made. There was strong commitment to maintaining existing content by many teachers, teacher-educators and administrators. No current British primary environmental education or science syllabi were available at the workshop for

consideration. Although revisions were made, there was little content loss or new material added.

1.3 THE UNIVERSITY OF ZIMBABWE PROJECT

Concurrent with the EAS syllabus revision, a project that aimed to support learning and teaching change in primary mathematics and environmental science was designed as a collaborative effort between the Curriculum Development Unit (CDU) of the Ministry of Education and Culture (MEC) and the Education Faculty of University of Zimbabwe (UZ). This project, entitled *Children's Scientific and Mathematical Problem Solving Strategies and Teacher Support Models: An Action Research Project* (hereafter referred to as UZ Project), had the following basic objective:

> to explore the possibilities of children doing more than receiving information and teachers doing more than transmitting it... (Hodzi *et al* 1991:1).

The UZ Project as proposed involved two aspects: 1) research with children's ideas or conceptions before and after intervention and 2) an inservice or support program to be developed for classroom teachers and teacher colleges (refer to the UZ Project proposal in Appendix 1.2, p 143).

The project design was to introduce existing innovative teaching methods from outside Zimbabwe's context, and have teachers adapt them for local use. The environmental science component would follow the diagnostic/generative teaching style of the *Science, Processes, And Concept Exploration Project* (SPACE) in Britain (refer to explanation of SPACE in Appendix 1.3, p 156). These teaching strategies would then be used to encourage a change in children's learning strategies from passive to active, involving process skills including especially problem-solving. This process was based on a relatively new learning theory for Zimbabwe - constructivism. The research strategy included having UZ researchers and participant teachers gather data on childrens' ideas and problem-solving strategies, during the implementation of innovative teaching. There was never another document to explain the research

strategy. The workplan that evolved is included in Appendix 1.4, p163. The project began in April of 1992.

The inservice support for teachers was to include a combination of workshops, close liaison with research staff, and resources as needed. As can be seen from the schedule (Appendix 1.4, p 163) there was regular workshop activity offered to the teachers. The research team which was to include principal researchers from UZ, Curriculum Development Unit of MEC, and lecturers from the two involved teacher colleges, in reality got minimal involvement from these proposed researchers, due to other commitments. During 1993 only one of the two principal researchers was involved at a time, with some UZ faculty acting as resource persons at workshops or attending an occasional cluster meeting. Persons from CDU were available only for occasional appearances at workshops due to a heavy workload, thereby acting mostly as resource persons for specific interest areas. The teacher college lecturers as is explained in chapter 4, had their own difficulties with the unfamiliar pedagogy.

A sudden increase in numbers of participating teachers in January 1993 from 20 to 80, with need to introduce the pedagogy all over again, complicated the project's operation. The project became mostly involved with teacher education (inservice), while lacking the personnel to supervise classroom trials of the pedagogy. Many teachers were never observed teaching in their classrooms or during demonstration lessons. Others were observed infrequently, mostly during demonstration lessons.

As will be further explained in chapter 2 the role of the teacher and the classroom environment are critical factors in a child's learning (Benedict 1991a). In the participant schools most of the immediate learning environment was controlled by the teacher, with various factors affecting his/her teaching strategy. Through involvement with the UZ research project teachers were under pressure to change from their own traditional rote learning style to an external imported generative or diagnostic style as described by Harlen and Osborne (1985). This pedagogical change involved

1) an acceptance of the *constructivist* view of learning;
2) a change in classroom organization;

3) a change in time organization/utilization;
4) an increase in use of resources or manipulatives;
5) a change in the style of teacher interaction with students.

No analysis of the teachers' initial understanding or beliefs concerning the proposed innovative teaching style was done by the UZ research team. The time needed for development of teachers as participant and collaborative researchers, was not known by the researchers. The time limit on the initial stage of the project was set as one year during which time classroom implementation and inservicing were to occur (refer to Appendices 1.2 and 1.4). The research on change in children's ideas was to run concurrent with the development of the teachers. The teachers were given a role in this aspect of the research which included teaching in the advocated manner and gathering data on children's ideas.

Testing of children's conceptual ideas was done by principal researchers and teachers at the beginning of the project, and again after three terms. Teachers were to use a generative style of teaching in all environmental science lessons, with special emphasis on problem solving. In May 1993 the post-testing indicated some change in children's ideas (Hodzi 1994, pers. comm.). There has, however, been no research data to prove that there is any relationship between the children's increased knowledge and either teaching style or children's problem solving ability.

In May 1993 the principal UZ researchers acknowledged to this researcher that they had observed a lack of change in pedagogy used by the participant teachers. The evidence for this conclusion was based on both observation of peer teaching and teacher journals in 1993. The innovative teaching style was simply not being used except in isolated lessons. The conclusions drawn by senior researchers was that most of the teachers either did not understand or did not attempt to use the prescribed methodology. Support structures in the form of workshops and critiques of the demonstration lessons did not seem to have produced the desired change.

The inability of the teachers to use the advocated pedagogy "correctly" or regularly aggravated the frustration of the UZ researchers whose empirical data on children's

change could not be analysed as intended. Project researchers maintained in interviews that the inability of the teachers to implement the new pedagogy was the reason for children's failure to change. Teachers had been questioned after inservice support programs such as workshops and cluster meetings and continually wrote that these *change facilitators* were useful. Observations of peer teaching, teacher diaries, and children's work suggested that there was actually a strong resistance to change on the part of teachers.

1.4 RESEARCH PROCESS CHANGE

This researcher was working in 1993 as a WUSC (World University Service of Canada) Associate to provide the project with an additional environmental education and science resource person. Separate from this project role she was to observe and evaluate the change in teaching style of the classroom teachers. From June 1993, this researcher began a process of trying to find out what was *inhibiting* the change in pedagogy of the teachers. This focus of research was discussed with the two senior researchers who agreed that it would be useful to know why the teachers were having so much difficulty changing pedagogy. The senior researchers wanted a questionnaire to investigate teacher professional background in case the participants assigned by Heads were not fully qualified teachers. The questionnaire showed participant teachers had paper qualifications but little inservice experience.

At this point this researcher drew up a list of "inhibitors" which were shown to the senior researchers in July, 1993 (original list is included in Appendix 4.3, p 211). This list was based on the critical reflection of observations and conversations with teachers. This research process is described in chapter 3. The response of the UZ senior researchers was one of interest, however, in July one researcher left for a two year sabbatical and the other became involved with international commitments. The question of inhibitors to change was left alone for the time being.

Meanwhile the project entered another phase: that of producing model lessons based on the constructivist framework. A new senior researcher took over this aspect, while this researcher finished her contract. In 1994 this researcher returned to work with a

group of collaborative teachers, continuing to visit them at their *writer workshops* and at their schools. The focus of the research was the same but the approach changed. This time the teachers were asked to become involved directly in critical reflection on their difficulties with the project. The thesis is largely a result of this later collaboration between this researcher and a group of ten teachers who committed time and a lot of reflection to this research.

1.5 THESIS FOCUS: INHIBITORS TO PEDAGOGICAL CHANGE

> Educational change depends on what teachers do and think - its as simple and complex as that (Fullan and Stiegelbauer 1991:117).

The focus of this thesis is on rural Zimbabwean teachers and the factors that help maintain traditional teaching style, during a time when teachers were involved in trying out imported, innovative teaching strategies for a research project. The primary objective was to identify inhibiting factors to change in their teaching during the 18 months of the project. The second objective was for teachers to reflect critically on these factors and their importance to their personal and professional development. Teachers considered it important to document their difficulties before they continued with their careers. Project support structures such as *cluster meetings* have been critically reviewed by the same teachers.From this critical reflection has come both an analysis of the change process, and a discussion of questions which need to be addressed when anticipating the transfer and/or design of pedagogical change, especially if directed toward Zimbabwe rural teachers.

The thesis introduces the reader to literature on a variety of topics involved in the research. This is important in understanding the relationship of environmental education to both problem-solving and transposition of pedagogy from one context to another. The resistance to change and difficulties encountered by classroom teachers is looked at in chapters 4 and 5. Here the reader finds the voice of teachers and the reflection of this researcher. To further enhance the understanding of the context and the *whole teacher* Appendix 4.1, p 188 includes a specially written section of ethnography and autobiographical accounts of five of the participant teachers. Finally

a discussion is given in chapter 6, that tries to relate inhibitors to change to inservice processes and decision making about transposition of pedagogy from outside contexts.

CHAPTER 2

LITERATURE REVIEW

The literature review will show the historical involvement of Environmental education in educational epistemology and pedagogy that is constructivist and involved in problem-solving. A look at the British-based constructivism for science teaching is coupled with discussion of the transference of Northern developed innovation and epistemology to African contexts. The problems that arise as inhibitors to change when such transference is attempted is discussed involving research from both Western and African examples. A further discussion involving some current research involving teacher pre and in-service education is to be found in Chapter 6 "Discussion and Recommendations".

2.1 ENVIRONMENTAL EDUCATION AND PROBLEM-SOLVING

Problem solving in relation to various areas of curriculum has been discussed by many educationalists since the 1970's. As Gayford pointed out "Problem solving has become fashionable ...especially in science education." (Gayford 1989:193). Harlen (1985) and Gil-Perez and Carrascosa (1990) have brought to the readers' attention the important aspect of a problem - that a problem is really a question that has no obvious solution at the beginning. It has an open quality that allows and even encourages the investigator to come up with more than one solution, using alternative strategies. According to Russell and Harlen (1990) of the Science Teacher Action Research Project (STAR) followed by the UZ Project, problem solving is one of the process skills which are critical to concept development and change. Hodzi, Jaji and Heberden used these ideas of problem-solving as the basis for their project proposal "Children's Problem-Solving Strategies and Support Structure Model" (Hodzi *et al* 1991).

The importance of developing skills for environmental problem identification and problem solving has been expressed in the goals and principles of environmental education since the TBILISI Declaration , 1977. The focus of the TBILISI Declaration was on "learners working individually and collectively towards the resolution of

current environmental problems" (Stevenson 1987:74-75). The guiding principles for environmental education as adopted in 1977 at Tbilisi included the following statements

> Environmental education should:
> ...enable learners to have a role in planning their learning experiences...
> ...relate environmental sensitivity, knowledge, *problem solving skills* (own emphasis),and values clarification to every age, but with special emphasis on environmental sensitivity to the learner's own community in early years...
> ...emphasize the complexity of environmental problems and thus the need to develop critical thinking and problem solving skills...
> ...utilize diverse learning environments and a broad array of educational approaches to teaching/learning about and from the environment with due stress on practical activities and first-hand experience. (Irwin 1991:23)

In 1991 UNESCO-UNEP reissued a compilation of articles about environmental education including an article on the problem-solving approach. Here the problem-solving approach which is characteristic of environmental education was shown as the principal way of achieving the Environmental education goal of developing skills to solve environmental problems, in groups and individuals. A variety of pedagogical approaches were advocated to teach these skills (UNESCO-UNEP, 1991:35). Earlier in 1989 Meadows had advocated that the problem orientation of environmental education could best be taught through pedagogy that involved *action*, that is "...participatory and experimental, problem-oriented...integrated into the nearby surroundings,... (and) group oriented..." (Meadows 1989:37).

Benedict, in 1991 in a retrospective account of environmental education development not only reinforced environmental education'ss problem orientation, but drew attention to the fact that this orientation thrust environmental education beyond other areas of academic study.

> These two aspects of EE - - the need to go to the root causes of the problems and the need to teach pupils to actively participate in society - are what give EE its special character... What separates Environmental education from natural sciences, environmental science and environmental management is that it has...more to do with solving

problems than finding problems and describing them. (Benedict 1991a:14,19)

Environmental Science, which includes how man impacts on nature as well as the knowledge of ecology and geography, in Benedict's view, could in its teaching become environmental education when it incorporated the problem solving steps that go beyond analyzing problems - to taking action. The fact that in environmental education there has been a call for problem-solving strategies as a focus in teaching style was also reinforced by educators in other content areas such as mathematics and science. UNESCO in many of its documents advocates problem-solving strategies - for example Lynch in 1977 linked recent changes in science and technology as the agent of pressure on educators to teach for "problem-solving abilities" (Lynch 1977:19).

Teachers as the primary implementers of environmental education were recommended by educators writing for UNESCO to develop a competency to "...utilize current theories of learning... in selecting, developing, and/or implementing curricular materials and teaching strategies to effectively achieve EE goals with selected receiver groups." (Wilke *et al* 1987:31). These writers based their recommendation on the problem-solving goal of environmental education and their premise that " learning theory has much to offer in guiding the selection of materials and strategies to develop problem-solving abilities." (Wilke *et al* 1987:31). The fact that their reference to learning theory was the stage theory of Piaget rather than the constructivist theory used by Driver and Bell (1986) should be noted though their comments allowed for a choice by the teacher as to which theory to use in adopting pedagogy. The environmental educators were in accord again with the mathematics and science advocates of problem-solving teaching who also saw the role of teachers as changing to meet the needs of this new learning and teaching style (Lynch 1977:21). Benedict went a step further to say that the learning process must be restructured to allow for the action component of environmental education to be fulfilled. She proposed that the teacher must take on a role of facilitator rather than the source of knowledge (Benedict 1991a).

The recommendation of the United Nations Conference on Environment and Development (UNCED) in 1992 put a heavy emphasis on education throughout its

chapters, especially in Chapter 36 where the principles of the 1977 Tibilisi Inter-governmental Conference on environmental education, were used as the basis for the 1992 proposals. As in 1977 environmental education is seen as critical for " promoting sustainable development and improving the capacity of the people to address environment and development issues." (Agenda 21, Chapter 36 1992: 3.1). Further in the chapter it is proposed that the educational component of implementing Agenda 21 should " promote proven educational methods and the development of innovative teaching methods for educational settings. " (Agenda 21, Chapter 36.5 (f);3)

The question of just what were the *proven methods* mentioned in Agenda 21 and in what context they should be used seemed to be overlooked by most UNESCO documents. UNESCO handbooks such as the one prepared for European teachers Environmental education for Our Common Future, (Benedict, 1991b) explored and recommended problem-solving teaching. Some examples of problem-solving activities such as simulation exercises had been prepared by UNESCO (Taylor 1985) but were not being used in EAS in Zimbabwe classrooms as evidenced by Lewin in his EAS evaluation (Lewin *et al* 1991).

Difficulties with the use of problem solving pedagogy has been documented as relating to the teacher's lack of understanding of the process, such that the process becomes more of a linear exercise that true problem solving (Gil-Perez and Martinez-Toregrosa as cited in Gil-Perez and Carrascosa 1990:537). Difficulties of pedagogical misunderstanding are looked at in the section "Constraints in teacher change" in the literature review.

2.2 TRANSPOSITION OF *PROVEN METHODS* TO NEW CONTEXTS

The transposition of education practices involves moving something from one *context* to another. The meaning of context that is accepted by the writers researched here is that of Hawes which included the context of the school as being "part of a wider education system. An education system is part of a political, social, and economic framework...(also) individuals (children and teachers)...are responsible to other individuals (parents) within the framework of a community" (Hawes 1979:10).

Maddock, from his anthropological viewpoint explained the same concept of context but refered to it as *culture* (Maddock 1981:4). Since many other writers used the term context this writer shall use the term "context" though acknowledging that it can at times be interchanged with the term "culture". Terms such as North/South, East/West, developed/underdeveloped, first/third world - have debatable meanings but for this document the writer has decided to use the term *North* when referring to the origin of the transposed pedagogy.

Vulliamy (1987) warned that the transposition of environmental education teaching approaches from the North to the South, would encounter "major constraints". He based his argument on previous attempts to transpose programs and pedagogy from Europe, and the documented difficulties these attempts encountered. Earlier Maddock (1981) had given the same warning, again based on acknowledged difficulties and failures. Some of these difficulties stemmed from what Vulliamy considered difficulties associated with transposing methods and materials from one context to another. Maddock emphasized the change in cultural setting as creating difficulties since he saw science, as well as other subjects, as a cultural enterprise. Further Maddock argued, there is an unfortunate tendency for proponents of particular materials and methods to refuse to accept the failure of their transposed approach or materials (Maddock 1981:22). This he believed was based on their positivist belief that *their* approach is best and that any encountered difficulties may be blamed on the recipient. Crossley (1984) in his research on transposition of the Nuffield Science programs of the 1970's pointed out the difficulties that arose not just in terms of content, but of teaching style. King argued that in fact there was a lot of "muddled thinking about responsiveness and interventionism when it comes to transferring 'technology' in education whether software or hardware" (King 1986:127). As Robottom explained the underlying assumption in transfer is that

> the value differences between the setting in which the innovation is formulated...and the setting in which the innovation is implemented will not affect the reform effect. This assumption fails to take into account the educational problems that arise in particular settings, and therefore the institutional constraints which shape educational practices remain unaddressed and persist" (Robottom 1987:100).

Colonial transposition of education systems and styles

> The reality is that much of the present...educational ethos...attempt to replicate those of the former imperial powers...the educational systems... have been largely derived from the colonial era. (W'O Okut-Uma and Wereko-Brobby 1985:137)

Ogunniyi (1986) continued the argument as he explained that one of the problems over the last two decades of African science education has been

> that the type of science being taught in our institutions provides at best ready-made knowledge isolated from our cultural background...All over Africa there is a great drive to import western science and technology like one purchases merchandise from the market (Ogunniyi 1986:118).

As Lewin *et al* (1991) explained, the EAS course in Zimbabwe developed from the colonial Nature Study of the *white* schools and the environmental primary science designed for African schools just prior to Independence. These two streams were similar to the pattern of colonial education described by Hawes (1979). Not only did the system stem from colonial times but there was a "conscious borrowing of contents, practices and methods from metropolitan education systems" (Hawes 1979:25). In the case of Zimbabwe the borrowing was and continues to be from Britain. The UZ project design was based on the research and pedagogy of the SPACE project in Britain (Russell and Watt 1990). The uncritical borrowing which is still continuing as exemplified by the use of Cambridge 'O' and 'A' level syllabi and examinations in Zimbabwe has come under criticism (Hungwe 1994). Hungwe was in agreement with Ogunniyi and others that science curriculum development has continued to conform to the traditional British curriculum due to its "access to a socially valued qualification in science", and a "maintenance of standards... (giving Africans now) comparable access and quality " (Hungwe 1994:87). Hungwe's main criticism was that while revising and supposedly "contextualizing" the science curriculum, in reality the new was like "new wine in old wineskins". Secondly, he maintained that the effect of "teacher-proof technology of instruction, capable of succeeding with limited teacher

skill and input" only increased the marginalization of the rural teacher (Hungwe 1994:88-89).

The difficulties that children have with transposed knowledge and pedagogy was discussed in research by Prophet (1990) and Jegede and Okebukola (1991). Their examples pointed out the problems that arose from differences in the contexts within which the pedagogy was developed and that to which it was transposed. Furthermore that much of the "knowledge" which was from another environment was meaningless to the non-western child. The material culture needed for the transposed pedagogy was often missing in the new community, while the socio-political culture was at variance with the underlying principles of the new pedagogy. This final difficulty was upheld by the research of Hawes (1979) and Vulliamy *et al* (1990). Further discussion of children's difficulties accepting and internalising transposed education is found in section 2.6 entitled "Model of Constructivism and the UZ Project".

2.3 EDUCATIONAL CHANGE - PROFESSIONAL DEVELOPMENT INNOVATION AND INHIBITORS TO CHANGE

Education in classrooms is usually undergoing small changes which are not disruptive and involve little threat to the status quo of the beliefs and pedagogy of the classroom. An "innovation" on the other hand, said Rudduck "is different: it is conscious, planned and involves some fundamental breaks with the known past" (Rudduck 1991:56). Change which involved innovation was the concern of research by Rudduck. Educational change involves change in "practice" as Fullan and Stiegelbauer (1991) explained. Hargreaves (1994) looked at three aspects of change in what he considered a postmodern age; 1)substance, 2) context and 3) the process of change. Innovative change needed to be looked at in terms of substance and context while how teachers responded to the change was part of the process. The process involved "the practices and procedures, the rules and relationships, the sociological and psychological mechanisms which shape the destiny of any change" (Hargreaves 1994:10). The question of resistance to change had to do then with the process as much as the substance and context of the change. Hargreaves agreed with other researchers that

teachers are the key to educational change, so that change advocates must be cognisant not only of their capacity to change but also their desire to change.

The complexity of change is often not noted and therein Fullan and Stiegelbauer saw the first problem for a change process. In their description of the "multi-dimensions" of innovation Fullan and Stiegelbauer (1991) argued that three dimensions must be included when considering implementing innovative change: 1) change in resources or curriculum; 2) change in teaching approaches; 3) and changes or alterations in beliefs (eg pedagogical) held by persons involved in the change. Fullan and Stiegelbauer further identified three problem areas that are important to acknowledge before implementation of any or all of the change dimensions. These were 1) the developer of the innovation; 2) that there could be a problem of 'fidelity' or belief that an already existing innovation should be used and that it should be implemented such that it is used as the developer intended. The opposing view is an evolutionary one in which change is "often (and should be) a result of adaptations and decisions made by the users" (Fullan and Stiegelbauer 1991). The third problem centred around the difficulty in identifying objective dimensions in terms of resources since they change constantly during the change process.

Fullan emphasized that change in teaching or other educational change must consider the one most "crucial factor", that of the professional development of the teachers involved. The "educator as life-long learner is the key to reform" (Fullan and Stiegelbauer 1991:289). The nature of the change that is being implemented determines some of the response from teachers during implementation stages. With hindsight, said Fullen and Steigelbauer, researchers have noted that features such as "complexity, prescriptiveness, and practicality" (Fullan and Stiegelbauer 1991:68) affected the response from teachers, ie the degree of resistance depended somewhat on the change itself.

2.3.1 Teacher resistance to change

The past few decades have seen a number of "educational changes" but Rudduck (1991) argued that there had been remarkably little real or sustainable change in school

culture and practices. As Fullan said "We may have learned how to introduce new content and new materials into the curriculum, but it seems that we are not so adept at changing the process of teaching and learning" (Fullan 1982:28 as quoted in Rudduck 1991:27). There was a definite resistance to changing conventional teaching and beliefs by schools, teachers as well as the education system (Rudduck 1991). Researchers such as Diamond (1991), Rudduck (1991), and Hargreaves (1994) have tried to explain the inhibitors to the acceptance of change. The next sections include references to inhibitors found and noted by researchers.

What are some of the inhibiting factors that influence the change process described by Hargreaves (1991)? How do they affect change? The personal, teacher-involved inhibitors will be looked at first, followed by those from the environmental context, including that of a research project.

a) ***Teachers existing ideas about Education.*** Researchers involved with classroom practice and curriculum change have noted the importance of the teacher's existing ideas both in terms of content, and pedagogy. For example Osborne and Wittrock (1985) commented on the importance of teachers' existing ideas as influencing how they used resource materials and how they interpreted curriculum written by others. Osborne and Symington (as cited in Osborne and Wittrock 1985) found that "Teachers' existing ideas about how children learn, about the nature of desirable science teaching, and the constraints they see in their role in the classroom all influenced their construction of meaning from curriculum materials and their subsequent classroom practice" (Osborne and Wittrock 1985:81). This acknowledgement of the possible misuse or misunderstanding of the generative model of learning and teaching of Osborne and Wittrock (1985), and Harlen and Osborne (1985), was continued in the warning by Harlen and Osborne that in proposing a new model for teaching the designers must be careful to explain changes in all aspects of the model that may be affected by the existing ideas of the teachers. They acknowledge that existing teaching style is related to "a certain view of education, of children's learning and the sorts of experiences schools should provide for pupils" (Harlen and Osborne 1985:136). Constructivist researchers have also noted the importance of teacher views or existing ideas to the successful implementation of what he called a "paradigm shift in

education" (Prawat 1992:354). Cohen (1988) saw current teachers' beliefs as coming from a "transmission" and "absorption" approach where teachers are "tellers of truth who inculcate knowledge in students... (and students are) accumulators of material who listen, read,and perform prescribed exercises" (Cohen 1988:15 as quoted in Prawat 1992:356). Prawat looked into research findings to illustrate the complexity of the *interaction* of epistemology, content knowledge, and views of learners, as another complicating dimension in the effect of teachers existing ideas. "In moving toward a constructivist approach to teaching, teachers will need to attend to their own conceptual change at least as much as they attend to this process in their students" (Prawat 1992:389).

b) ***Teachers Existing Ideas About Environmental education/Science.***

Primary teachers trained in Britain and other Northern countries have often:

> little or no background of science experience... teachers venturing into experimental science with real objects were entering an unknown world full of risk and disappointment...(they) felt little confidence in their science teaching... had poor experiences with classroom control, and taught the subject poorly or not at all (Raper 1987:42).

This comment about western primary teachers was a reminder to the researcher that comments about African teachers have some similarity to comments about the science background of primary teachers in the North. Teachers' views about science and science education when they are rooted

> in an absolutist view of truth and knowledge tend to place little or no emphasis on the students' own conceptions during instruction...(they) are more traditional in their approach to instruction because they see no reason not to transmit directly what is perceived to be a collection of substantiated facts (Prawat 1992:366).

What Prawat and others (Thompson 1985, and Hasweh 1985, as cited in Prawat 1992:367) have emphasized is that teachers' views on both content and knowledge of the discipline often constitute major impediments to a change to interactive teaching (Prawat 1992:367). As Stevenson noted teachers' ideological beliefs, their views about

knowledge and learning, influenced how knowledge is transmitted. For environmental education this became a conflict (inhibitor) when both transmission and knowledge were seen as problematic (Stevenson 1987:79).

Rollnick and Rutherford wrote in 1990 that in spite of a growing body of research on children's conceptual framework, there was still little reported information on teachers' possible misconceptions. Their research on teacher-held concepts of air and pressure brought her to the conclusion that teachers held misconceptions and that these might influence the conceptions of children in their classrooms (Rollnick and Rutherford 1990). The importance of primary teachers' existing ideas re science or environmental science content areas has become an issue in Britain since the introduction there of a National Curriculum for Primary Education, including science. With a weighting of 50% on both processes and concepts of science there was now interest in "whether primary teachers themselves understand the concepts well enough to introduce them effectively to children" (Kruger *et al* 1992:340). Recent research into teacher understanding of science concepts needed in primary teaching has shown "a severe mismatch" between the reality and the needs of the curriculum (Kruger *et al* 1992:348).

2.3.2 Lack of self confidence as inhibitor

Ashton (1984), Leiberman and Miller (1984), and Sparks (1988) were concerned with an area of teacher resistance to change that they said comes from a failure of " teacher's *self efficacy*, confidence in their own ability to handle things in their classrooms...when teachers have stronger self-efficacy they are more likely to take risks" (Sparks 1988:112). Walberg emphasised that teachers who are knowledgeable of their subject "have more confidence in imparting information..."(Walberg 1991:48). Fullan and Steigelbauer (1991) and Rosenholtz (1989) supported these findings and further emphasised the interrelationship between teacher commitment and teacher certainty (efficacy) - that they "feed on each other" (Fullan and Steigelbauer 1991:134).

2.3.3 The desire to change or not to change

Some of the resistance to change that Hargreaves (1994) discussed comes from the desire of the teacher for stability and conservation of their owned and understood practice. Although not exclusive to teachers from third world contexts, there can be a "doublethink/doublespeak" by teachers in order to be acceptable to those in authority or to researchers (Kirby and McKenna 1989:33). This would be done to hide the teachers' real desire to remain in the traditional pedagogy. Hargreaves has argued that is important to understand both a teacher's desire for change and for conservation,"along with the conditions that strengthen or weaken such desires" (Hargreaves 1994:11).

Why will teachers embrace a new model of learning and teaching; especially one that as Cohen (1988) cited in Prawat (1992) explained is more time consuming, and pedagogically demanding than the traditional teacher role? Prawat (1992) and Posner (1982 cited in Prawat 1992) put forward the theory that teachers will change their firmly held beliefs when three criteria are met:

> First, individuals must be dissatisfied with their existing beliefs in some way; second, they must find the alternatives both intelligible and useful in extending their understanding to new situations; third, they must figure out some way to connect the new beliefs with their earlier conceptions (Posner as cited in Prawat 1992:357).

Sparks (1988) in her research on teacher change after in-service training found that there was a correlation between teacher's use of a new practice and the teacher's perception of the importance and ease of use of the new practice. Fullan and Steigelbauer stated that whether a proposed change was external or internal to a school, teachers must be treated "as interacting professionals who should be in a position to decide *finally* whether the change is for them" (Fullan and Steigelbauer 1991:132). They agreed with Sparks that teachers' commitment to the change was necessary otherwise the lack of commitment or seen value, becomes an inhibitor.

2.3.4 Ownership of meaning or innovation

Ruddock (1991), Hungwe (1994) and others have noted an inhibitor to adoption of innovation by the teacher when the ownership of the innovation or change process remains with the designer - who is not the teacher. "Ownership" which has become a key word in literature around change, can mean more than the individual or group being the originator of the idea. It can also imply a shared understanding and direct decision-making involvement with the change (Rudduck 1991). Teachers need some sense of ownership of the agenda for change in order to really get involved in the change as self development (Rudduck 1991).

2.4 INHIBITORS THAT ARE CONTEXTUAL

This section looks at the literature supporting the view that environment or context may provide strong inhibitors to change in education practice. Ogunniyi (1986) described the following problems as relevant to difficulties teachers have in changing to instructional practices that are inquiry based rather than traditional:

> ...lack of adequate textbooks, lack of funds to purchase equipment, overcrowded classrooms and time tables, lack of cooperation by school administrators, pressure of external certificate exams...poor preparation of teachers...lack of motivation among teachers...use of archaic teaching methods, poor implementation methods, overwhelming number of activities demanded by the new curricula...general lack of reinforcing home environment...(Ogunniyi 1986:118)

Adeniyi (1987) backed up Ogunniyi in describing difficulties of implementing science teaching change and also included foreign language barriers to the list of inhibitors. Various researchers such as Vulliamy (1987), Prophet (1990), Lewin *et al* (1991) and Bhunhu (1992) have attested to the fact that severe shortages of teaching resources can be constraining factors to active teaching methods. Harber's (1990) research in Southern Africa with constraints to change in social science teaching was similar to findings of other researchers. For instance he noted the following constraints: 1) lack of much relevant teacher training either preservice or inservice; 2) personal resistance from teachers who come from traditional cultural patterns that do not encourage

questioning (this is backed up by Prophet 1990); 3) teachers' learning experiences are not similar to the one they are trying to use; 4) underpaid and poorly rewarded teachers do not wish to do extra work; 5) authoritarian and rigid administration within the education system that is not supportive of the new teaching change (Harber 1990). Vulliamy's (1987) findings agreed with Harber's results that many constraints to change are contextual. Vulliamy emphasized that the community belief in the colonial system of education was strongly based in economic belief that the traditional colonial system brings success. The colonial education system, nationally and locally provided a whole set of constraints as did the exam system. These constraints were seen by Vulliamy as mitigating "against any deviations from inherited conceptions of teaching and learning." (Vulliamy 1987:14). Vulliamy continued with an explanation of students' resistance to innovation. Students resisted change due to their preconceived belief that school was not relevant to the reality of their lives, and not fitting into their indigenous beliefs. Cole (1975) emphasized the indigenous culture as being an important factor to be considered when teaching science. He further argued that indigenous culture can be utilized in a positive way or can be seen as part of a child and community's resistance to change in teaching style (Cole 1975).

Importance of language. Prophet (1990) saw language as a key factor in failure of transposed pedagogy. Language as an inhibitor was seen by him as more than second language difficulties for child and teacher. He agreed with Arca *et al* (1983 as cited in Prophet 1990:14) that it was the aspect of language as a basic and integral part of culture that makes change difficult. The resistance was in the cultural differences between the African and western originator of the teaching language. Maddock (1981) in looking at difficulties in "transplanting science curricula from one culture to another" (Maddock 1981:4) explained that there were two aspects to the problem of language. Firstly that the teacher must contend with english as a second language for both teacher and student, and secondly that the cultural aspects of language are situationally specific. In agreement with Malinowski's anthropological study of language and culture (Malinowski 1948 as in Maddock 1981), Maddock explained that the problem was "linguistic (meanings, structures and symbols) and socio-linguistic (the functional status of English in the society) and its "distance" from the mother tongue in status, in world view and meaning styles, and in internal structure."

(Maddock 1981:12). Bentley and Watts (1992) in their constructivist approach to communicating in school science backed up Prophet, Maddock and others by maintaining that even within the english language there is confusion and misinterpretation of science concepts because of language. They pointed out that "many of the difficulties experienced by youngsters in science classes arise from both the technical language used and the non-technical but supportive language that surrounds it" (Bentley and Watts 1992:9). They went further to remind the reader that much learning is social and depends to a great extent on language (Vygotsky 1986 as cited in Bentley and Watts 1992). They agreed with Vygotsky that language can be a very important inhibitor to teacher change, and must be addressed by proponents of any classroom teaching change.

Examinations and evaluation as inhibitors. The fact that examinations are the primary form of learning evaluation, and hence teaching evaluation - has been a problem for countries with national examinations. As noted above, external examinations are seen by African researchers such as Vulliamy *et al* (1992), Hungwe (1994), as inhibitors to change. Western countries have also been faced with examinations as constraining factors to innovative teaching explained Rudduck (1991) when she explained the importance of examinations as basically "ruling" what and how the teacher facilitates learning. Teachers in Britain said Ruddock, see their role as "ensuring good examination grades" by becoming a "human centre of information and assistance" (Rudduck 1991:43). On the whole teachers in Britain, continued Rudduck, find examinations a constraining factor to change. Teacher constructed examinations also provide a challenge according to Meisalo (1991) who contended that teachers trying to evaluate learning that is problem-solving in nature, also found the whole idea of evaluation a threat to creativity. Teachers, Meisalo explained, also must learn how to evaluate skills such as problem-solving, which they are not prepared for in traditional education. Lewin (1991) in evaluating the EAS syllabus in Zimbabwe noted that the national grade seven examination for EAS was almost entirely factual knowledge. This was in agreement with Vulliamy (1987) who found that this preponderance of factual recall questions was prevalent in developing countries.

Community related inhibitors. Related to the importance of examinations Vulliamy (1987) pointed out, is the importance to the community that students, and the education system be seen as competitive with global, especially western countries. As Prophet (1990), Hawes (1979) and others have noted, there is strong resistance to any change that would leave colonial style education behind. Attempts to introduce more community based vocational education have met with resistance because they do not coincide with the status quo academic examinations which involve community's perceived ladders to success.

A further constraining factor that comes from the community is that of the separation of school from the community (Vulliamy 1987). As Baimba pointed out the school curriculum usually does not "relate to the everyday lives of students in their traditional setting" (1993:213). This lack of relevance to everyday life in developing countries can be seen as inhibiting in two ways. First, according to Baimba, separation of school and community is viewed as a status provider, thus different is better. Second, the belief system of the community, which is quite different from the foreign colonial one is contained in the students' and teachers' conceptual framework (Baimba 1993; Cole 1975). This second inhibitor was reviewed earlier.

The added problem- donor reinforced marginalization of teachers. When speaking about donor agencies and where aid money is placed King emphasised the marginalization of the ordinary teacher when he said "(they) seem to be beyond the reach of aid; they have to be reached by the mysteries of the multiplier effect" (King 1986:125). He continues further that although human resource development was enthusiastically viewed by donor agencies the implementation was top down with the rural teacher definitely on the perimeter. Hungwe (1994) in his analysis of the Zimbabwe science education system, said of the rural teachers that they were marginalized in several ways. Their living and working environment were poor, with a rural society that remained quiet on educational issues; and they were isolated from education initiatives and the resources available to urban and private school teachers (Hungwe 1994).

2.5 HELPING THE CHANGE PROCESS

> Programs or innovations that are dramatically different from teacher's current practices or that require teachers to make major revisions in the way they presently teach are unlikely to be implemented well, if at all (Doyle and Ponder 1977 as quoted in Guskey 1986:9).

Fullan (1985), Guskey (1986), and Sparks (1986) all agreed that to have successful staff development certain factors must be taken into consideration. First that change in teaching style is a gradual and difficult process. Two inhibitors that put teachers at risk when trying something new - firstly that the teachers may face embarrassment and secondly that the students may not learn as well with the new method account for some of the difficulty (Guskey 1986). The second important factor for implementation of change was to give regular feedback on student learning. Teachers, according to Guskey were very concerned with the effect of new practice on students' learning. The third aspect of staff development initiatives was to maintain support and followup after the inservice. Fullan (1985) noted that difficulty might arise when teachers try to implement innovative practice without followup - they might give way to concerns and doubts. Walberg agreed when he said that unless reinforced, pedagogical skills might fade (Walberg 1991).

There was some disagreement among researchers about the role of teacher beliefs and attitudes in the change process. Sparks believed a change in teacher beliefs and attitudes must be affected in order to have effective change in teacher practice (Sparks 1988). Guskey in his model of the process of teacher change said that "significant change in the beliefs and attitudes of teachers is contingent on their gaining evidence of change in the learning outcomes of their students" (Guskey 1986:7). Fullan's research in 1985 also showed that generally, changes in attitudes and beliefs of teachers came after, rather than before changes in teaching behaviour. While Sparks saw the lack of teacher conviction re the new practice as an obstacle (inhibitor) to change, Guskey asserted that teachers, being for the most part pragmatists, need direct support through student success, in order to commit to a new practice.

Fullan and Steigelbaur (1991) in discussing their own and Hargreaves and Dawe's research (1989), looked at both sides of the "collegiality" exercises used in inservice training. On the one hand teachers can use this opportunity to "generate critical *yet also* practically-grounded reflection" while on the other it may become contrived collegiality "to facilitate smooth and uncritical adoption of preferred forms of action (teaching styles) introduced and imposed by experts from elsewhere, in which teachers become technicians rather than professionals exercising discretionary judgement" (Hargreaves and Dawe as quoted in Fullan and Steigelbauer 1991:142).

Facilitators for change

Researchers and teacher-educators have been concerned with the effectiveness and sustainability of inservice education (Fullan 1985). Sparks (1986) used research of Joyce and Showers (1981 as cited in Sparks 1986) along with her own research to give the following hypothesis for effective inservice teacher education:

> four components of training - presentation, demonstration, practice, and feedback - are sufficient to induce many teachers to transfer recommended practices to the classroom; and b) coaching may be a necessary fifth component for many other teachers (Sparks 1986:218).

Guskey (1986) and Rich (1990) emphasized the importance of teacher support for implementation of "new instructional practices" (Rich 1990:90). Rich went on to remind support personnel to "listen with a sensitive ear to teachers' comments...to determine the extent to which these concerns relate to issues of practicality, self efficacy, and to ideology...to deal effectively with the concerns expressed by teachers at different stages of implementation" (Rich 1990:90).

Sparks' research suggested that the following inservice training activities were most effective; small group, problem-solving formats; objective, non-threatening peer-observation activities; and trainer-provided coaching. She found the peer-observation superior to the other methods but admitted that there were too many variables in her research to draw a final conclusion. Sparks' further research (1988) suggested that if one accepted her claim that teachers' philosophical receptivity to new practice is

important to successful use of the practice then this receptivity must be increased during inservice.

Instructional support groups. Processes of inservice education/training that especially seem to help self-efficacy are provision of small intimate structured groups and problem-solving sessions (Sparks 1988:117). Sparks found that teachers saw these group sessions as "a safe environment...to discuss their concerns and victories and to learn together...they gained the confidence to try new strategies." (Sparks 1988:117). Baalsrud (1991) suggested "collaboration groups" as a very useful and effective way to organise both in-service science teaching and classroom based change processes. For classroom based changes this might mean formation of a collaborative group within the school. She suggested that individuals within the group have roles and responsibilities. Teachers would learn how to use groups by actually participating themselves. Baimba (1993) argued that for innovation in science curriculum the in-service should be *action* oriented with the full participation of the teachers. Thus he saw inservice as being more than "explaining" or "explaining by doing" - in that certain components should and can be designed or produced by the teachers themselves. This participatory aspect should help ensure relevance of the proposed innovation (Baimba 1993).

Inservice methodology. Current involvement of much education research and teacher education with constructivist epistemology, has put an emphasis on the methodological approach to in-service and to a re-examination of existing programs. Critical reflection based on philosophy of learning and change has been exhibited by Diamond (1991), Hargreaves and Fullan (1992), Prawat (1992), Hargreaves (1994) and others. "If teachers are to rethink teaching and learning...they must have the opportunity to participate in a learning community with other teachers and educators similar to the one they are trying to provide for their students" (Prawat 1992:389). Baalsrud (1991) in her report on in-service science courses for primary teachers in Norway contended that methods used in the course should be "interactive and usable in classes" (Baalsrud 1991:164). Teacher education, she argued should be done using a constructivist approach if the teachers are being encouraged to use that epistemology and pedagogy themselves. Further discussion of current research and thinking on inservice education is in the "Discussion" chapter 6.

2.6 THE TRANSPOSED *CONSTRUCTIVIST* PEDAGOGY

The UZ Project advocated change in pedagogy was based on 1) a belief in the need to change from the current traditional/rote style described by Lewin *et al* and Bhunhu in 1991; and 2) a belief that the generative or constructivist model of learning and teaching was the most appropriate one to use (Hodzi *et al* 1991). Rather than an inclusive review of the literature on constructivism that has become prevalent in several Northern countries, this review will concentrate on the view of "constructivism" held by research groups headed by Harlen and Driver, since their research was being followed by the UZ Project. The UZ project was associated with Russell of the Liverpool research group that produced the SPACE Project with Harlen. Research results, and other writings of this British group were used as models for the UZ Project.

The generative or constructivist view of learning used by the UZ project is explained historically by Driver and Oldham.

> This approach to learning has its roots in the long-standing epistemology of the interpretive or Verstehen tradition (Weber 1949), which has at its centre the importance of meaning as constructed by individuals in their attempt to make sense of the world. Thus the sense made of any event is seen to be dependant not only on the situation itself but also on the individual's purposes and active construction of meaning... Constructivist or interpretive tradition ...provides the rationale for qualitative research approaches such as ethnography, case study and participant observation (Magoon 1977)...Constructivist approaches to cognition have a long history. Piaget could be described as a constructivist...more recently the personal construct psychology of Kelly (1955) has been related to education in general...and science in particular. (Driver and Oldham 1986:3)

In another paper Driver sumed up her view on the constructivist theory of learning thus:

> The common feature in these apparently diverse fields (of natural and social sciences) is that, as human beings, we do not have direct access to an external world, but that our knowledge of that world either as individuals or as a social group is a personal and social construction. Human action, what is done, said and learned in any situation, thus depends as much on the mental constructions

> brought to that situation as on the features of the situation itself. To understand human behaviour, therefore, involves understanding the world as others "see" it. (Driver 1986:2)

Model of Learning and Teaching used by the UZ Project. The model of learning used by the UZ Project for teaching of primary environmental science was based on one presented by Harlen and Osborne in 1985, which in turn was based on an earlier one by Wittrock used in 1974 (Driver and Oldham 1986). Harlen and Osborne contrasted their "Generative Model" with one they designed to show the "Rote" model of learning and teaching. These models are to be found in Appendix 2.1, p 167 along with the model of constructivist teaching sequence that was designed by Driver and Oldham (1986). The terms *generative*, *constructivist*, and *diagnostic* though closely linked by the researchers Harlen and Driver, were used often interchangeably by the research team. Models associated with all three are very similar as can be seen from the models presented in Appendix 2.1. p164.

It is important to note two of the assumptions associated with the constructivist or generative model of learning and teaching. First, that learning is an active process, and second that the teacher has an important role in facilitating and guiding the students . Unlike proponents of the "discovery method" Driver did not believe students will always learn on their own through individual discovery. Rather she believed that learning is often socially constructed, needing interaction with peers and teacher. The role of the teacher can be seen in the model presented by Driver and Oldham (1986:18) in Appendix 2.1, p 172.

The research based model of "rote teaching" of EAS in Zimbabwe was given by Bhunhu (1992) in his report on EAS teaching. It can be compared with the rote model of Harlen and Osborne (1985). What can be seen in Bhunhu's model is that the classroom learning experience is predominately rote, teacher centred with activities meant to "show" or demonstrate the knowledge that was presented by rote (Bhunhu 1992:13). The model in given in Appendix 2.2, p 173. The earlier reported evaluation of Lewin *et al* in 1991 is in agreement with the model given by Bhunhu (who was part of Lewin's evaluation team). A further explanation of the current teaching practice as

reported by Lewin and Bhunhu may be found in Chapter 5 "Internal Inhibitors to Pedagogical Change".

Model of Constructivism and the UZ Project. The science component of the UZ project was modeled on the Primary SPACE Project conducted in England in the late 1980's with published reports 1990 - 1992. This classroom based project was based on constructivist theory, with belief that the meaning-making of challenges or experiences to alternative concepts is rooted in process skills similar to scientific skills.

> The Project is based on the view that children develop their ideas through the experiences they have. With this in mind, the Project has two main aims: firstly, to establish (through an elicitation phase) what specific ideas children have developed and what experiences might have led children to hold these views; and secondly, to see whether, within a normal classroom environment, it is possible to encourage a change in the ideas in a direction which will help children develop a more 'scientific' understanding of the topic (the intervention phase) (Russell and Watt 1990:1).

Emphasis on Science Process Skills. Emphasis within the STAR project and subsequently the UZ Project was placed on *how* the change in children's ideas is brought about. The science background of this group are in evidence as they explain

> ...for the outcome it matters that notice is taken of the evidence and use is made of that evidence. These things involve skills and attitudes of reasoning and investigation, such as suggesting hypotheses or possible explanations that can be tested; planning and carrying out fair tests; observing carefully; interpreting findings; reviewing evidence and procedures critically and being willing to change ideas in the light of evidence. These skills are variously described as science processes, process skills or simply - skills (Cavendish *et al* 1990:3).

The pedagogy advocated by the UZ Project was inclusive of the students' involvement with process skills (Kuiper and Hodzi 1993). Background information for teacher in-service included abbreviated versions of the writings of the STAR group.

Persistence of *alternative conceptions* in North and South

According to Clough and Driver (1987) research findings indicated that secondary students in Britain maintain their alternative concepts in physical and biological concept areas despite schooling. They contended that students need not only experiences that may challenge their current concepts, but time to think through these experiences and ideas. Time was seen by these researchers as often less than needed due to pressure from government to finish courses in a set amount of time.

Researchers working in developing areas such as Africa have also noted the persistence of alternative conceptions in students (Kuiper 1991; Tema 1989). Researchers such as Bloom and Tema contended that the science concepts talked about by Driver and others, are difficult to *change* in a non-Northern context because they are interpreted within the whole conceptual framework of the child.

> Such contexts of meaning are not strictly scientific in nature, nor are they strictly logical or rational. Instead, the contexts contain a wide variety of associations to different types of information, beliefs, emotions, values and aesthetics (Bloom 1990:558).

Tema and Bloom argued that the *isolation* of Northern developed science concepts can pose problems in the new environment because of the complex nature of contextual meaning. In this respect Tema warned researchers and advocates of constructivism in Africa

> It is therefore suggested that African pupils can best be helped to adopt the new scientific framework only when their initial/traditional one is recognised as legitimate within their context and they are allowed to juxtapose it with the new one that science educators wish them to acquire. The new framework may then provide better answers about life than the old one with the result that the old framework may be abandoned. (Tema 1989:206)

Jegede further commented that with African students "the learner's world view acts like a filter through which the mechanistic science concepts taught are assimilated" (Jegede 1991:46). For any degree of success he contends "curriculum and instruction for learners of science in non-western societies must begin with and reflect the world-views they already possess" (Jegede 1991:46).

CHAPTER 3

METHODOLOGY

This research is a case study of a group of rural teachers who were involved in a process of intended change from traditional to constructivist teaching styles. This process involved more than just a technological change; it involved a change in teaching strategy. The teachers, as individuals and as a group were trying to use a transferred pedagogy within their own context. Difficulties and resistance to change were greater than expected. Focus on this human change process and the people involved necessitated involving a variety of research methods over a period of almost two years. Most of the research was qualitative and ethnographic, with the last stage involving the beginning of real participatory research.

3.1 ILLUMINATIVE RESEARCH

The original plan was to use several methods to evaluate teacher change and the support structures: for example teacher observation by video and by observation schedules. In addition, interviews with a sample of all the participants and questionnaires distributed to all participants would provide some quantitative as well as qualitative data.

The research process started out as planned in January 1993. As explained in the introduction sudden changes in participant numbers and resultant changes in support structures in January 1993 altered the feasibility of some of the possible research methods. Further, the complexity of the change process for teachers seemed to have reached a point by May/June 1993 in which there was substantial feedback, showing a resistance to change that needed more investigation and analysis than previously thought.

Parlett and Hamilton note that in illuminative evaluation the "problem defines the method, not vice versa" (Parlett and Hamilton 1976;176). In this instance the original *problem* of observing and evaluating teacher change shifted suddenly to examining the *non-change*. By June-July of 1993 this researcher had observed the situation of the

teachers and had started to investigate further why there was resistance from them to use of the pedagogy. Much of the reason was there, in field notes, in film, and in the comments of researchers; but the analysis was elusive. This led to further study of change through literature, and an initial analysis of the inhibitors based on everything that this researcher had seen and heard to date. This analysis was given to one of the senior researchers for her feedback. She thought it had validity but since she was leaving the project she could not follow it up. After an absence of three months this researcher went back to the teachers with the initial analysis of inhibitors for their discussion and feedback.

3.2 DEFINING WHAT WAS SLOWING DOWN CHANGE

The problem was now redefined: rather than studying the correct use of the pedagogy, it was now necessary to study the complex reaction of teachers undergoing social change within the context of their total environment and background. The methodology of the research became less that of an outside observer and more that of facilitating the teachers' *voice*. They needed this writer's ability to try to develop an analysis based on their observations, and this researcher needed the teachers to start looking deeper into inhibitors other than the most obvious. The final stage of research involved a different approach and was separated from the first stages by about six months. Some contact had been maintained with teachers who were to become the collaborative group. In June and July of 1994, this researcher went back to the teachers who had been interviewed and filmed the previous year. She identified a group of ten collaborating teachers involved in the beginnings of participant research. At this point the collaborative group including this researcher decided to work through the inhibitors, and further to begin work on autobiographies as the start to understanding personal and professional development.

Where did this leave this research in terms of the illuminative evaluation? The intention was to develop as holistic a picture as possible of the difficulties that teachers encounter when given a pedagogy to transfer from the North to their own context. Vulliamy (1990) and Vulliamy *et al* (1990), argue the case for the importance of qualitative research in developing countries, especially connected with educational innovations. Their reasoning agrees with the rationale of illuminative research in that both are concerned with

providing a comprehensive, in depth understanding of "complex interrelationships of causes and consequences that affect human behaviour". (Goets and Lecompte, as quoted in Vulliamy *et al* 1990:11). The qualitative and illuminative can combine to give insight into the complexities and unexpected results encountered when trying to transfer ideologies and pedagogy from one context to another (Parlett and Hamilton 1976) (Vulliamy 1990).

To analyze these complexities this researcher has used a mixture of many methods, as can be seen from the description below. Since the major problem was identified after most observation was done, the analysis of the inhibitors suggested what research information would be used. The research included a second more in-depth analysis of the inhibitors using the collaborating teachers in participatory research. These collaborative activities occurred after June, 1994 and are presently ongoing, with a focus on teacher development rather than pedagogical change only.

3.3 VALIDITY

Cohen and Manion postulate that the "chief problem confronting the researcher using triangulation is *validity* (Cohen and Manion 1989:278). Since the object of the research was to provide a fuller understanding of the problems associated with the changes a teacher population was asked to undergo, the primary source of validity should be the teachers themselves. This *respondent validity* as it is referred to by Cohen and Manion was achieved by the direct involvement of a collaborative group of the participant teachers in analyzing this researcher's preliminary findings. This was done in two workshop situations, one with twenty teachers reviewing the original analysis in group sessions, and eight months later by meeting with a group of ten of the original twenty to go over the revised analysis and to stimulate their own critical analyses of the problem areas.

This researcher believes that the resulting research and analysis is valid for the group of eighty teachers originally involved in the project. There is no attempt to generalise the 'inhibiting factors' beyond the experience of an average rural Zimbabwean primary school

teacher in a similar situation. The validity must exist within the context of the teaching environment thus generalizations cannot be made outside the context.

Another form of validity referred to as *ecological validity* by Vulliamy *et al* (1990:12) has been served by including comments in chapter 4 and an appendix (Appendix 4.1, p 188) on the environment of the teachers and pupils, as well as an appendix (Appendix 4.2, p 197) incorporating autobiographical accounts of teachers' lives. As Vulliamy explains the external validity of research refers to the "extent to which findings from research can be generalised." (1990:12) This is often overcome in positivist research by population statistics as validity, which does not ensure that the results of one research may be generalised to another. "The problem with more traditional research methods...is that they are unlikely to give an accurate portrayal of the realities of teaching in a natural or conventional setting" (Vulliamy *et al* 1990:12). The ethnographic, descriptive and narrative style used with the teachers and presented in Appendix 4.1, p 188 and 4.2, p 198 is meant to give ecological validity to the research findings. The researcher acknowledges the weakness of such contextual emphasis, recognizing that the population validity of the research is not as strong as other forms of validity, hence the research findings may not be generalised. The important factor is that the context of the Zimbabwean rural teacher is very different from that of teachers involved in similar research in Britain. The question arises then as to whether there was any ecological validity in transposing the British pedagogy and research methods to rural Zimbabwe. This question will be discussed in chapter 5.

3.4 METHODS USED FOR THE RESEARCH

The research methods used were dependent on project research methods and what was appropriate to the research topic. The following research methods were used:

a) *Methods used for observation of classroom teaching*

The UZ project research was to include classroom observation. As part of the research team this researcher was allowed by senior researchers to use two forms of observation. of classroom teaching style in EAS. The first method involved this researcher in video

taping lessons that were presented in class and before peers at cluster meetings. These were then reviewed for examples of teacher innovation or change. Some of the videos were reviewed by senior researchers when this researcher pinpointed interesting examples. Most of the time the senior researchers did not review the tapes. Teachers were presented with innovative examples from the tapes at two of the workshops, but never individually.

The second method involved the use of observation schedules. These were used by the researchers and any peer observers at the 'cluster' meetings. The observation schedule had been developed by one of the senior researchers, Dr. Nyagura, for previous research. Observation schedules from the two teacher colleges were collected by this researcher for comparison. After the first two sets of 'cluster meetings', the schedule was modified by Dr. Jaji and this researcher to simplify the schedule for the observers. This was used for the last two sets of cluster meetings. The schedule used for the research in England, upon which the science section was based, was not used. This researcher was never given a reason. Almost a year later in 1994, Dr. Kuiper devised an observation schedule that was tried out to determine in some quantitative way what was going on during the teaching. This schedule had not been used in the original research. Schedules used are included in Appendix 3.1, p 175.

The observation schedules advocated by the UZ senior research team were not relevant to the teaching changes that the researchers were advocating. Items such as teacher/child interaction time were not noted in any quantifiable way. There was no chance during 1993 for this researcher to try different schedules, since the team insisted on the one (developed by Dr.Nyagura) they used and this researcher had been given too many other roles that took up her time. When the team went over the schedules this researcher decided they were useless for this research except in a very general way. Teachers did find the schedules useful as reminders of what to look for in teaching style. However they found them too long and felt they detracted from the lesson being presented.

b) *Methods used to gain understanding of teachers' backgrounds*

Questionnaires: Teachers were selected as participants for the research project by their Heads. The only requirement from the research team was that if at all possible they should have a teacher certificate or its equivalent. In June of 1993, the researchers decided that some background was needed on the teachers, in order to explain what was and wasn't happening in the classroom teaching. This had not been done at the start of the project in mid 1992. The questionnaire was devised by Dr. Jaji and this researcher and previewed by this researcher with teachers in both rural and high density schools. A copy of the questionnaire is included Appendix 3.2, p 181 as well as the quantitative analysis of some of the information done by Dr. Kuiper.

Interviews: General information about teachers' educational and personal backgrounds was collected by this researcher together with a group of teachers in the clusters she visited most often for the project. Most interviews were informal. A more formal structured interview was conducted in May-July, 1994, devised by Dr. Russell to evaluate the workshops and cluster meetings as well as teacher explanation and understanding of the pedagogy they were using. The interviews have recently been quantitatively analyzed by Dr. Kuiper and are in process of being written up by Kuiper and Russell. This researcher conducted many of these interviews and was convinced that the information was often given by teachers in the words they thought the researchers wanted to hear and would understand. Thus positive aspects were emphasized, and the "doublethink/double-speak" syndrome noted by Kirby and McKenna (1989) was noted by this researcher. Collaborating teachers later confirmed that they and other teachers often told interviewers what they thought would put them in a "good light".

Most of the interviewing done by this researcher was of an anthropological nature in order to build rapport and as an attempt to share with the collaborators rather than just elicit information from them. At the beginning of the research the anthropological methods of repeated visits and general conversations was adopted from this researcher's previous anthropological field experiences in Canada. As the research became more involved in the complexities of human social change this researcher turned purposefully to the interview methods as espoused by non-traditional research. As Kirby and McKenna

(1989:66-74) explain, interviews have a component that much traditional research de-emphasizes - that it is "an interaction between people" (1989:66). This researcher's method included as much as possible to give the collaborators a sense of equality and shared value in the research. The researcher stressed that the collaborators had understanding and knowledge that the researcher needed and vice versa so that most interviewing became a learning experience for all. This interviewing became the basis for the final analysis of inhibitors by the participant group of ten teachers plus the researcher.

School and home visits: An ethnographic (field study) approach was used in some instances to *get to know* a few of the teachers in a more personal way. This was to be helpful in understanding the context in which they lived and taught. Familiarity with and appreciation of the teachers' context and background, also allowed this researcher to refer to their comments in groups, thus drawing them into the discussion.

Maddock is emphatic that anthropological insights are essential when considering the implementation of any curriculum, including science (Maddock 1981). Although there was no attempt to engage in in-depth ethnographic research this researcher did try to look at the communities of the schools and teachers. Teachers were involved in conversations about their communities and home visits were used. The seven years of frequent involvement in rural visits by this researcher was also drawn upon in conversation and in writing. The results have been included as an ethnographic description of three communities within which the teachers grew up, live and work. These are to be found in Appendix 4.1, p 188.

Autobiographies: The writing of autobiographies by collaborating teachers was part of the participatory research that evolved from the original research since July 1994. Autobiography was used in an attempt to understand or illuminate through teachers own stories "the way in which teachers' early personal experiences and personal development have a profound influence on who they are and who they become as teachers" (Raymond *et al* 1992:159). Goodson further explains the reason for use of autobiography and ethnographic research as important to a fuller understanding of teachers' lives. This he believes is necessary in order to "understand teachers' priorities... (which is needed) to understand teacher development and curriculum development" (Goodson 1992:111).

Though the autobiographies are used here for insight they are also meant as part of an ongoing teacher development process with the group. Noddings and Witherell expressed the primary reason for use of the autobiography:

> Finally, stories are powerful research tools. They provide us with a picture of real people in real situations, struggling with real problems. They banish the indifference often generated by samples, treatments, and faceless subjects. They invite us to speculate on what might be changed and with what effect. And, of course, they remind us of our fallibility. Most important, they invite us to remember that we are in the business of teaching, learning and researching, to improve the human condition. Telling and listening to stories can be a powerful sign of regard - of caring - for one another. (Noddings and Witherall 1991:280)

Ten teachers agreed to write autobiographies as a further way to help themselves and this researcher put a *voice* to their lives and thoughts. This came after working closely with them as collaborators in determining what were the inhibitors to change and reflecting with them on various aspects of the project and their personal development, frustration and criticisms after 18 months with the project. The teachers were not randomly chosen. They were persons who had been part of the larger group of twenty teacher/writers asked to prepare model lessons based on the innovative constructivist methods espoused by the project. All of these persons had come to have good rapport with this researcher since by chance (originally) they had been participants who were visited often. As can be seen throughout the chapters these collaborative teachers speak with self assurance to the researcher, making sure through their writing that their view is heard. A sample of five autobiographies is given in Appendix 4.2, p 197.

c) *Methods used to identify and understand inhibitors to change*

A variety of methods was employed to help understand reasons why changes in teaching methodology and development were constrained or inhibited. These methods included:

1. **Teacher background questionnaires.**

   This method is explained earlier in chapter 3.

2. **Critical analysis and reflection by this researcher**

a) of the context within which the teaching takes place, including factors such as community environment (physical, economic, social), political factors (administration, ministry directives), and teacher development. This first analysis was written as a chart (see Appendix 4.3, p 211) with inhibitors, including the way they had been identified (in other words from personal observation, or comments from teachers or researchers or headmasters).

b) literature search for research on inhibitors to change and factors that are constraints or incentives to teacher development or change.

c) critical reflection of the first analysis, and of the *unspoken* factors within the project itself that may have contributed to resistance of teachers. This was done almost a year after the first analysis, and after working with collaborative teachers, including as well discussion over many months with other teachers and researchers.

3. **Workshop and collaboration with teachers**

Twenty teachers in December of 1993, spent an afternoon going over this researcher's first analysis of inhibitors. They worked in groups of five teachers and commented on the inhibitors and suggested support structures that were useful or might be developed. Comments on this first attempt are in Chapter 4.

A group of 10 of the original group met in August, 1994, to write their own version of the inhibitors to change. This time the collaborating teachers were quite aware of the importance of their role and though some of the writing is still limited, the discussion that occurred during the session was critically reflective.

Around the same time this second group, who were to write autobiographies and who comprised the ethnographic research, began to talk with this researcher about the project, their aspirations, and their disappointments. These conversations actually backed up what was written in terms of inhibitors, while also giving

insight to the whole question of *teacher development* as separate from the *teacher change* originally advocated.

Discussion with senior researchers

It was the disappointment of the senior researchers in April-July of 1993 over the minimal change in teaching style that suggested to this researcher the need to analyze inhibitors. The first analysis was shown to Dr Jaji and later to Dr. Hodzi. Their reaction was positive but not helpful. As will be shown in Chapter 4.4, the project design and the paradigm within which the senior researchers worked, contributed to the difficulties of the teachers. Informal discussions were more frequent than formal project meetings, especially while driving to cluster meetings. The senior researchers were over-committed to teaching and to other research and writing projects, leaving almost none of the original group available for discussion about teacher problems.

CHAPTER 4

EXTERNAL INHIBITORS TO PEDAGOGICAL CHANGE

4.1 INTRODUCTION

The following two chapters are based on teachers' own individual and group critical analyses of the factors they identified as having a restraining effect on their ability to change pedagogy or enhance their personal development. Although the comments and the rationale of administrators and ministry officers have been included, these chapters are meant to reflect the opinions of the classroom teachers as they and this researcher engaged in a process of intersubjective and critical reflection (Kirby and McKenna 1989).

The ten collaborating teachers plus this researcher have agreed that the factors can be divided into two streams - **external and internal factors**. The external factors identified are divided into two sections: 1) those related to the Zimbabwe education system and 2) those related to the community and school context. External inhibitors were ones "we cannot control ourselves...they are caused by outside forces" (collaborating teachers 1994). An understanding of the community environment is provided in Appendix 4.1, p 188, in the form of an ethnographic study of three community contexts used in this research.

The internal factors are those that the teacher finds within him/herself whether caused by background, economic or other socio-political factors. There is overlap between external and internal factors since to the teachers many of the internal or individual inhibitors were originally or are presently caused by their life and societal contexts. As one teacher put it "The internal is often caused by the external factors - we are who you see in our autobiography". Examples of the teachers' autobiographies are found in Appendix 4.2, p 197. Teachers decided that internal inhibitors were ones only they could overcome, with help, which is different from external inhibitors where they have minimal control.

A possible internal inhibitor not identified by the teachers is the *non use* of the constructivist or alternative paradigm in the project approach to the change process. The collaborating teachers and this writer called factors such as these the "invisible factors". Maguire (1989), Kirby and Mckenna (1989), writing about research with marginalized groups such as women or the economically disadvantaged, suggest that there are aspects of research itself that might account for difficulties in implementing pedagogical and epistemological change. This writer spent much time thinking about this aspect of the project in retrospect, asking critically what had really been going on in the research and how this might have affected the teachers. The last section of chapter 5 is the result of this critical reflection on the part of the writer with some input from the collaborative group.

The sections on External (4.2) and Internal (5.2) Inhibitors contain subsections on *support structures* that were either planned, executed or are being developed to help overcome the inhibitors. These may not be present for some inhibitors in which case the lack of support has been identified by the teachers.

4.2 EXTERNAL INHIBITING FACTORS

External inhibitors were seen by teachers as falling into two groups:

Government Education System Related
Community and School Context Related

4.2.1. Government Education System Related Inhibiting Factors

This section includes factors seen by teachers as having a restraining effect on changes in their teaching style. The factors identified here are:

i National Syllabus
ii National grade 7 exam
iii Time - daily and weekly requirements
iv Student writing and recording

v Language of instruction

These factors and the support structures used by the UZ Project are explained in the next five sections.

i. National syllabus

This section includes a look at the current Primary Environmental and Agricultural Science syllabus in terms of what teachers see as inhibitors to the use of the advocated teaching strategy.

Table 4.1: Inhibiting Factors in National Syllabus

FACTOR	TEACHER CONCERNS
Syllabus content	- too much content - teacher lack of knowledge on topics - emphasis on 'agricultural production'
Syllabus, textbooks, resource books	- syllabus difficult to understand - not enough copies - activities not done if no resources or encouragement by administration.

There is an ongoing discussion in some countries such as Great Britain, Australia and the United States, over the pros and cons of having national curricula, and a great deal of writing has been done on the topic (Diamond 1991). Zimbabwe has decided on a system of primary and secondary schooling that is based on a national curriculum with one syllabus for all primary schools in Environmental Science and Agriculture. The findings of Lewin *et al* (1991) are backed up by the collaborating teachers, none of whom were part of Lewin *et al*'s evaluation survey. Their comments, shown in Table 4.1, back up Lewin *et al*'s comment that there "were difficulties with the syllabus in terms of its presentation, sequencing, language level, and some aspects of its underlying structure" (Lewin *et al* 1991:6).

Teachers use the syllabus for planning lessons for the term, called *scheming*. The schemes seen by this researcher were almost entirely taken word-for-word from the syllabus. Mentioned activities were from the suggested activities of the syllabus. Topics to be covered would be arranged by week to correspond with later written work given to students to do in their exercise books. Since many teachers admitted that the recommended five period week was often shortened, they "rushed through the topics with some memory work and writing of lines (copying of sentences from chalkboard or textbooks)... especially ones we don't like" (Mrs G 1994 pers. comm.).

a. Support structure

Support for the understanding and use of the syllabus was given through workshop lectures and activities. There was also some written material given. For a description of the help teachers received see 'support structures' under 4.3.1. The National Syllabus has been revised since the beginning of 1994 and began an implementation stage in schools in 1995 with the lower primary grades (Heberden 1994 and 1995 pers. comm.).

One of the foci of the project in 1994 was the design of a workbook for teachers that included model activity-based lessons on each topic for each grade. In the process of working with the topics and concepts, the teacher-writers were not given the activities suggested by the syllabus. Instead they were to design activities using simple-to-make or readily available materials and equipment. For each topic they were to research the subject background to increase their understanding. The comment of collaborating teachers is

> In spending time thinking about and looking up information on a topic we were forcing ourselves at first... now it is a habit that seems to help...and after the first time getting the information and understanding we have it here in our heads or on paper. Reading the syllabus carefully now rather than just copy it down in our schemes, has made us more critical of how it is written, even the new one. Sometimes there is no real way to do activities with a topic and sometimes the topics still don't make sense the way they are written. (collaborating teachers 1994)

The Curriculum Development Unit will be spending the next three years (from 1995) providing in-service training on the revised EAS, now to be called simply Environmental Science. The Department of Science and Maths Education of UZ has offered to provide advice based on experiences using the revised syllabus in 1994 for the writer's workshops. The teachers participating in the project, especially the twenty who participated as writers may be suggested as resource teachers if requested. Certainly the teachers feel they have something to offer to in-service programs. "I can do more than just tell teachers what is in the syllabus...I can show them how to use it best...and they will believe me because they know I'm a teacher like them." (Mr. R. 1994 pers. comm.)

ii. National grade 7 examination

Between 1982 and 1989 the newly created EAS was not one of the grade seven examination subjects. This changed in 1990 and in October 1994 the fifth national EAS examination will be given. Examinations are produced by the Examination Branch of the MEC with suggested questions from CDU. Being an examinable subject along with mathematics, English and Shona/Ndebele, has the positive affect of giving status and incentive for the teaching of EAS in a more comprehensive manner than previously. A copy of the 1994 examination is in Appendix 4.4, p 214.

> Headmasters and teachers...especially grade 6 and 7, have now to make sure that the important core sections of the syllabus have been taught well. Before often many sections could be skipped over without anyone knowing... and the damage would not be known until secondary school where national exams are given. (Mr.R. 1994 pers. comm.)

There are difficulties and problem areas that instituting an EAS national exam for grade seven has presented to both administration and classroom teachers. Teachers saw problems in three areas related to the national exam; two stemmed from the implementation of the examinations, and the third from the related government teacher and school rating system. These are shown in the table below. Following Table 4.2 the areas of concern to the teachers is discussed.

Table 4.2: National Examination Inhibiting Factors

Factor	Teacher Concerns
National examination	Rush to finish syllabus Emphasis on facts - not application or problem solving
Rating system for teachers and school depends on pass rate of grade 7 examination	Competition with other teachers for examination pass rate

a) *Rush to finish syllabus*

The current EAS syllabus has a large amount of knowledge content to be covered by the grade six and seven students. Since content areas have been progressively built since grade one, any gaps or misunderstandings of the pupils must be filled in or corrected in these last two years. This means long review sessions during the year. Often schools move teachers from grades six to seven with their class to give support and continuity for the last two years. The grade six and seven teachers are usually ones with teacher certificates and some teaching experience if possible. The teachers involved in trying to change teaching style found that there was much pressure from the administration to put aside practical activities or to do them after school so that the EAS syllabus could be completed.

Support Structures

From CDU: The revised ES (1995) syllabus will decrease content for grade 7 to allow for revision time. From the beginning of the project there was an acknowledgement of the difficulties teachers faced, both by the research team and the cooperating resource persons from the CDU. The emphasis on preparation for examinations by the grade six and seven teachers compounding and overloading their schedule was acknowledged at the CDU May 1992 national workshop organized to revise the EAS syllabus. This researcher was involved in the workshop as observer and resource person. During the workshop participants decreased the content of the grade seven syllabus specifically to leave time for revision. In discussion at this workshop the pressure on the grade seven teachers with introduction of national EAS examinations was justified and given as the

primary reason for decreasing the content load for that grade. The topics were pushed down into other grades. This revised syllabus will not come into effect for the grade six and seven teachers until 1997-98.

From the UZ Project: Project support was limited to discussions with teachers and allowance for the decrease in grade seven teacher activity in the project especially in the third term. The issue of time taken for the project and possible implications for finishing the syllabus or revision was also brought up at the workshop for Headmasters in January 1993 and that for Education Officers in February 1993. The project researchers agreed that project work would not interfere with teachers fulfilling of their duties to the Ministry.

b) ***Examination structure - emphasis on facts***

Lewin's unpublished analysis of the 1990-91 examinations in terms of types of questions and required responses and the subsequent CDU analysis (Heberden 1993 pers. comm.) points out the almost total use of factual recall for the examination. The recommendations of Lewin included a) testing skills promoted by EAS, not just factual knowledge; b) training for examination writers; c) examination analysis and feedback to teachers (Lewin *et al* 1991:12-13).

Support Structures

This area was discussed with CDU who were also frustrated with the type of examinations issued so far. At the workshop with the Education Officers, some of whom sit on the examination committee, the UZ team again brought up the issue of assessment. The researchers explained the difficulty of expanding new teaching strategies if the testing was geared predominately for learning by rote. The Education Officers were not convinced or supportive in this area. They were insistent that the examinations were "the best that can be" and gave sufficient room for some "long answers". As a research project there was not much that could be accomplished since the University has no authority over the MEC. No alternative assessment testing was developed by the project, which might have given some proof of increased problem solving and 'higher order' learning.

c) *Teacher and school ratings dependant on exam pass rate*

The new (1993) method of giving teachers a *merit bonus* upon recommendation of Heads has increased competition among teachers. Since one of the recommended criteria being used for grade six and seven teachers is pass rate, teachers admit they are hesitant to deviate far from the "tried and true", as they put it. Although the merit bonus is nominal in terms of money, it holds a degree of status and upward mobility that the collaborative teachers all viewed as very important. Teachers in lower grades said the threat of poor examination results was less for them since there was little chance they would get any credit for good results.

Support structures

Certificates of Participation in the project workshops and praise of the participants to Headmasters did get some Merit Increases for a few teachers. There was no other form of support.

iii. Time as an inhibiting factor

Time is one of the most frequently mentioned inhibitors to using new teaching strategies. What teachers meant by time is explained here from teachers and headmasters interviews:

a) Science is required to be taught between four-five times per week in half hour sessions. There is no requirement that a certain amount of time be spent every day as there is in mathematics (one-half hour lesson per day), however all lessons are one-half hour in length. From research observations and from the 1990 evaluation (Lewin *et al* 1991) it is evident that less than the scheduled five lessons were actually held most weeks. Time spent in the school garden is considered class time.

b) Time here also relates to syllabus coverage, ie the amount given to each topic by the teacher when arranging schemes for teaching per term.

c) Teacher time for organization of activities and planning exercises and tests. This extra 'outside of school time' is often at the cost of teachers' personal commitments.

The table below expresses the concern teachers had about time and how these also related to their feeling of pressure from Ministry directives and Administration. As one teacher commented, " this method is new and takes time to sort out...it needs more time for activities especially if children think up some of their own activities... we have pressure from the admin to keep up our other work as top priority" (Mr. D 1993 pers. comm.).

Table 4.3: Time as an Inhibiting Factor

Teacher Concerns	Administrative Directives
This method takes more time for planning	Must finish core topics assigned for year
Need freedom to go over the 1/2 hour science period	Number periods / week determined by administration
If too slow may not finish syllabus	Changes to schedule must be approved
Gardening often is production oriented without learning activities being involved	Production from school gardens is important for income generation

The following is a closer look at the constraints that time puts on teachers change in teaching style. These comments are again taken from the teachers, administrators, teacher trainers, and researchers.

a) Placement of science at the end of the day

It should be noted here that the schedule of classes is done by administration with the agreement of the Education Officers. This means that the scheduling of EAS classes

at the end of the day rather than in the morning was not decided by the teachers. According to Lewin *et al* and Heads this researcher interviewed, the *important* subjects like english and mathematics are scheduled for the morning and science in the afternoon (usually last lesson). The older children are in charge of the garden for weeding, planting, and watering. Unless they stay after school to do the chores they must miss at least two of four/five classes for garden production.

> Science is often scheduled for the last subject in the day so that it is the one lost if other meetings and sports etc are called...how the time is used is most important. Some teachers use the time for gardening and this new ' production gardening' to raise funds for the school ...It is at the expense of learning concepts (teacher-educator 1993 pers. comm.).

The response of the collaborating teachers to the teacher-trainer's comment was

> We don't make the time table. This is decided by Heads and since almost all of them put it at the end of the day... then the Ministry agrees. The special subjects like maths and english are to be first when the children are 'bright'... We agree that some teachers take advantage of this time to use it for watering gardens and so on... until questions started to be on final exams nobody thought it mattered... some still don't. (collaborating teachers 1994 pers. comm.)

b) Half hour lessons

Teachers were encouraged by the project team to allow the children time to work out their own activities and discussions without too much time pressure. Most Heads were supportive, at least if this wasn't a regular occurrence. When flexibility of daily schedules was mentioned at the special workshop for Ministry Education Officers this was the response from the senior officer:

> Teachers must be careful not to double the lesson time if it takes away from a subject (such as maths) that must be taught every day. I would not be happy if I found taking extra time for science was taking time away from the core subjects like english, maths and Shona. (education officer 1993 pers. comm.)

The administrative ability to constrain teachers' use of time was emphasized to the researchers several times. Eventually teachers worked within the half hour frame more easily. This was partly as a result of more preparation and familiarity with the teaching style. Some teachers turned topics into projects which could be done at home or after school.

c) Amount of time given to particular topics

Teachers admitted that time given to topics depended often on how they felt about the topic. If they felt comfortable they might spend extra time on doing a demonstration or activity; whereas topics they found difficult they would skip or go over quickly. Other teachers said there just wasn't enough time to give to all the topics equally, so the ones they noticed were most likely to be examined were given the most time. Most teachers reluctantly agreed with the teacher trainer who said, " Teachers use time as the excuse when what they really mean is that they do not understand the topic... so they find some reason ...of time...to avoid teaching it" (teacher trainer 1993 pers. comm.).

d) Too much preparation time

"Taking the time to prepare for the activities... and to study what the topic is about" (collaborating teachers 1994) was difficult for the teachers. The amount of time usually taken for lesson preparation increased for the innovative lessons. Each time teachers and the research team met complaints were made to the research team. Teachers decided that this aspect had to do with their *internal inhibitors* because the problem was often personal. For example some teachers had other after school commitments, such as children, small farm plots, or small businesses. Others admitted that they didn't expect to work such long hours for their small pay.

Support for time as inhibitor

There was no specific support structure devised to help overcome the constraining factor of 'time'. The UZ team continued to listen sympathetically to the teachers at

cluster meetings and workshops when this factor was discussed. Since relatively few individual school visits were made suggestions for time effective organization could only be made at cluster meetings.

The senior project researchers tried to solve difficulties with Education Officers and Heads by bringing them to their own workshops in January and February of 1993. As can be seen from the comment above this effort was not completely successful, though most administrators and supervisors agreed to allow extra flexibility for the project. When Heads were interviewed by the UZ team in June-July 1994, they explained that they could have been more supportive if they had been included more often in workshops and other activities.

iv. Student written work

Children in the rural schools participating in the project each had only two exercise books where written exercises are kept, including work checked by the teacher, some tests, and individual assignments completed in school. These are checked by Heads and Education Officers routinely as part of teacher assessment. The following table gives in point form the main concerns expressed to the researcher concerning the need for these records as they are kept now.

Table 4.4: Inhibiting Factors Involving Students' Written Work

Teacher Expressed Concerns	E.O. and Headmaster Concerns
Daily written work required	Child must write to show learning
Takes time (needed for activities)	Shows teacher did cover syllabus
Language difficulty for some	One method of assessment
Tendency to have children copy	

Teachers did not express concern initially (prior to January 1993) that the required writing could be an inhibitor to innovative teaching. As they became involved with the

project some brought this requirement to our attention as a restraint. The researcher learned from discussion with individual teachers that in many instances children spent much time writing exercises from the chalkboard or texts simply to fulfil a requirement for administration.

> I am required to have so many lines per subject per day in each child's book...I have to put lines on the board, or get children to copy from a book... Why? Because their language skills are too poor to express themselves individually....These farm children have English as a third language and they can't read. The E.O. insists on so many lines... so I cheat... the children don't know what they wrote. (Mrs G. 1993 pers. comm.)

The diagnostic teaching that the teachers were asked to do required that teachers allow children to express themselves and their ideas in a variety of ways. The research team was surprised to find after some months that children's exercise books all looked alike. Teachers admitted that to elicit children's ideas they used oral questioning and recorded any interesting answer in their diary. They used exercise books only for tasks given to the students during group work, or as assessment. Below are comments made about the conformity seen in the children's exercises:

> This is part of the conformity that all answers must be the same - it gives no importance to the fact that there is usually more than one solution to a problem...We are trying to let the child take her own route to understanding and thus there may be more than one way to answer a question or do a problem...yet the teachers are still doing 'fill in the blank' style teaching and assessing (Dr. Jaji 1993 pers. comm).

Heads and Education Officers in their workshops would not change from the official stance. Their comments were all quite similar:

> If the head is not looking for something written every day on the lesson then he is not doing his job...We cannot know if the child has learned if he does not write something down. This is important for assessing how the child and also the teacher is doing... Teachers must prove that they have been in the classroom teaching what is in their schemes. This we can tell if they have the children do written exercises. Also this written work is used for exam preparation (Education Officer 1993 pers. comm.).

The collaborating teachers expressed their interest in allowing alternative ways for children to express their ideas. To sum up their reasons for including this particular Ministry requirement as inhibiting change they said:

> There is a time problem connected here because many children write and think at different rates...some very slow... and this fifteen line per subject per day takes time away from other activities... English as their second language makes it difficult for children to express themselves. To make their books look neat and correct we often give them all or most of the thought. Exercises and assessments usually require one word answers, so they don't have to translate the rest of the sentence...To please the administrators who assess us on the amount of written work in the exercise books, we get the children to spend a lot of time doing written work...at the expense of other ways of learning... This is seen by many of us (teachers) as evidence of lack of faith in our ability to teach... our ability to decide how to teach most effectively. This is a real top-down example of how the teachers are treated (Collaborating Teachers 1994 pers. comm.).

Support structures:

As with the time constraint, the research team could do little else but commiserate with the teachers on a personal basis. The Heads and E.O.s were introduced to the teaching method advocated by the project, but little was said about written work, since in January and February of 1993 the teachers had not yet identified this requirement as a problem. Researchers and teachers are confident that not much can be done about this difficulty until the Ministry acknowledges more teacher autonomy and self responsibility in the classroom.

v. Language of instruction as an inhibiting factor

Language will be looked at in two sections; here we will concentrate on its role as an "external inhibitor" because of the national directives for the use of English in Primary schools. The discussion of language as an inhibitor for teachers themselves is given under "Internal Inhibitors".

Table 4.5: Language of Instruction as an Inhibiting Factor

Teacher Concerns	National Directives
Children do not understand English	Teaching may be done in mother language up to grade four
Some children do not understand Shona or Ndebele (English is third language)	Mathematicss and EAS should start in English right away
Children have trouble responding to questions in English even if they understand the question	Examination in grade 7 is in English
Is it right to teach in Shona when later teaching and examinations are all in English	All texts and written materials are in English

Observations of classroom teaching, especially when done for English speaking visitors, showed some of the following characteristics:

- the use of English, especially in the first few grades, and especially in the rural and farm schools was not understood by the pupils

- the students could answer a few questions in a prepared, stilted manner, but most simply could not answer in English, even if they indicated that they knew an answer. Children put up their hands to answer, then faltered and gave up trying in English. If allowed to explain in Shona they completed their answer.

- that the teacher was very aware of the difficulty and pleased when we insisted he/she use the vernacular to explain and to receive responses

- English science terminology was written on the chalkboard and transferred to the children's exercises books. Children memorised the words. There were no extensive explanations or much communication between teacher and child, especially in English.

- there was little child to child interaction in either English or Shona. This was a result of classroom discipline and fear of the 'strange' outsiders watching them.

- when children were working in groups they communicated in Shona and translated into English for the written requirement, often taking words from the board. This was especially true when they were working on a 'problem' of some type.

Teachers explained that EAS was required to be taught in English even though officially indigenous languages could be used up to grade four. This meant that texts and all written work must be in English, while Shona could be used only for simple explanations.

As Bentley and Watts explain "many of the difficulties experienced by youngsters in science classes arise from both the technical language used and the non-technical but supportive language that surrounds it" (Bentley and Watts 1992:9). For the teachers in these rural schools the problem found in English speaking countries was compounded by the fact that English was a second language to themselves as well as the children. Words like *energy, work* and *force, animal*, etc. are used in science to mean one thing but in everyday English language may have other meanings. Adding to the confusion for non-English speakers is the fact that translated into Shona the words may have another meaning, multiple meanings that do not correspond to the English ones, or no meaning at all. Teachers found it difficult to explain certain concepts such as food production in plants because the words and concepts were not present in the Shona language or conceptual framework.

As teachers became involved in getting children's ideas they became aware of the interaction of language and concept change and/or development. For example teachers didn't use the term *control* in an experiment - rather they used the term *make fair*. This was because the political and disciplinary use of the word *control* was more familiar to the children than the scientific use. Since the teachers had little experience of

practical activities and the use of controls they too felt more comfortable with *make fair*.

There were numerous examples of confusion over words, and teachers gradually became more aware of them as the children were more open in communication with the teachers. When words were simply learned as definitions, there was no chance to "fool around with what the word meant...how to explain the concept in their own words" (Mr. D. 1994 pers. comm). As the collaborative teachers put it:

> When there was only one-way communicating you were not sure how much was just rote memorization. Now, if the child is trying to figure out concepts for himself, he can get terribly mixed up with language. It means that we have to pay more attention to getting extra science terms into the language part of our teaching and vice versa. (co-llaborating teachers 1994).

Support structures

One of the best supports for the teachers was the peer teaching at cluster meetings. Here they could identify for one another when a child had "not understood" due to language and when she simply "did not know". Teachers began to recognise, along with the researchers, when it was necessary to acknowledge the language or communication difficulty and "sort it out" as the teachers put it.

Another support that developed was to have teachers and researchers constantly pick out language difficulties when preparing model lessons. There were no linguistics experts among the researchers, but those with English as a first language helped those with difficulties, by finding other words and other ways of expressing a concept. Teachers' own difficulties with English as a second language is discussed in section 4.2.5.

Support in the form of getting approval for teachers to switch to indigenous language when needed, especially after grade four, drew debate not only from administrators but from teacher trainers and teachers themselves. Teachers decided that they would make

their own decision based on the situation - but generally try to use English as much as possible.

4.2.2 COMMUNITY AND SCHOOL CONTEXT RELATED INHIBITORS

The educational environment consists of socio-cultural as well as bio-physical and economic aspects within which the teachers and their pupils interact with one another and the educational environment. This writer believes it is important to look at the participant rural schools and their physical/social environment as the context within which the teachers work. For this reason an ethnographic study was undertaken of three communities - a farm compound, a mine community, and a rural communal area community. The result of these studies may be found in Appendix 4.1, p 188. Almost all research on teacher change and teacher development has been done in the North, where the political, socio-economic and school environment are very different from the rural South, as example, in Zimbabwe. Vulliamy (1987) stressed the importance of considering the environment within which a transferred innovation is to take place, while earlier, Hawes (1979) had warned that lack of understanding of the context leads to curricula designed for "ideal situations".

The school's role as part of a larger community environment is an important factor to consider in assessing what the community can provide for the classroom in terms of teaching aids and basic materials for the children such as pencils and paper. Collaborating teachers decided that the economic (below poverty line), and physical environment (land degradation) of individual communities had the greatest influence over their teaching environment. Other environmental influences included the social, cultural and political environment within which the school existed.

This section discusses the following community based inhibitors:

i Economic - lack of resources and materials

ii Economic and Social - class size, and structure

iii Relationship between school, teachers, and community - social and political

i. Lack of teaching aids and resources

> When we say we don't have resource materials we mean *not any*!...- What people from your part of the world do not understand is just how little we have. Even when we are given some equipment it might be *one* beaker for an eight room school, and that is so precious that the head keeps it proudly on a shelf in his office. What good is that? (Ms. M. 1993 pers. comm.).

All teachers and Heads involved in the project put lack of material needs such as teaching resources and equipment as one of the most important constraints affecting teaching activity. Teaching aids and resources come from several sources. They may be provided by MEC, as are textbooks and exercise books. They may be provided through donor aid, either direct to a school or through an agreement with MEC. This latter method was used to provide "Zim Sci" kits to rural secondary "O" level schools in 1987 (Heberden 1993 pers. comm.). Parents Associations and community donors such as industry, may also contribute resources or funding to a school. In the case of most rural schools the ability of the community to help the school with resources is minimal. This is emphasized by comments such as

> I have nothing to work with except the chalkboard. The children have one exercise book... no extra paper for practice... I have no place to lock equipment or even shelves to put it (Mrs G. 1993 pers. comm.).

> If you want us to have all the children do the activities then we need more equipment like hand lenses ... otherwise they must see demonstrations, or in most cases not do an activity that needs.. for example a thermometer, since the school only has an old minimum-maximum one left from before independence (Mr.N.1993 pers. comm.).

Prior to 1990 the CDU did an analysis of the equipment needed for the activities recommended in the EAS syllabus (Lewin *et al* 1991). This same list was shown to project teachers in November 1993 to determine whether they had access to any of the items. The results are shown in the in Appendix 4.5, p 233. The information gathered from the teachers shows the research population to have the same lack of resources noted in the EAS national evaluation. The information as shown in Appendix 4.5 points

out clearly the vast difference between resources in these schools and a North American school

> In Philadelphia, all schools would have the resources listed, and when something needed for an activity is missing it can be ordered from school supplies. This is provided by the school system. We take these things for granted in planning textbooks and learning activities. Even our poorest neighbourhood has everything on this list...though teachers may not always use them....When we talk about textbooks all students would have their own copy, as well as other science resource books in the classroom or in the library. (Dr. Brown 1993 pers. comm.)

The survey results shown in Appendix 4.5 were confirmed by observations during school visits. Typical classrooms use visuals such as chalkboard diagrams, posters, or work cards on desk-tables, and some student work is exhibited around the walls. Participant teachers were encouraged to provide low-cost, locally made equipment and aids and some examples of these were usually around the room. Most of the teaching aids were exact copies of those used in workshops. In demonstration lessons teachers attempted to provide sufficient manipulatives for all groups, often borrowed from other classes, nearby secondary schools or the teacher's own home. "I hope my wife doesn't need the salt and her dish pan today" jokingly explained young Mr D (Mr. D 1993 pers. comm). Another teacher commented "The children do enjoy the environmental science when there is some activity. It is hard to get the equipment made...parents have no money and it takes time to make more than one piece (of apparatus)." (Mr.A 1993 pers. comm.)

The research team felt that often inappropriate use of manipulatives while peer teaching may have been due to unfamiliarity with the teaching strategy and the science content. Most teachers had never tried out the activity before the lesson. Teachers admitted they had not had hands-on experience with science investigations or problem-solving activities.

Support structures

1) Project Supplied Equipment: The project supplied the original twenty teachers with a simple kit of equipment that would be needed for the first topic to be done on growth. This kit contained two beakers, two graduated cylinders, ten petri dishes, and ten hand lenses. The teachers were also supplied with exercise books for each child involved and others for teacher diaries. The second intake of teachers did not get a basin, and only a few got all or even part of the promised equipment. Teachers and Heads, who had been promised that they would receive science kits found the situation frustrating. Alternatives to most equipment were suggested as "make it yourself" projects.

Collaborating teachers agreed that lack of store bought equipment was not a sufficient excuse for not teaching in a practical, hands-on way. However, they emphasized that equipment such as hand lenses, mirrors, and simple graduated cylinders were needed just as much as in the wealthier town or private schools.

2) "Make and Take" Workshops by Mrs Nyandoro:

> The syllabus advises them (teachers) to use hands on investigations and suggests activities...We (CDU) put out books in the mid 1980's with suggested activities and diagrams of equipment etc. .. not enough were produced and most got lost somewhere. Teachers always ask for more 'kits' and then don't use them. They sit on shelves or in the Headmaster's office. Frankly its a constant complaint and mostly just an excuse not to spend time organizing activities. Many of the teachers may not have these resource books so we shouldn't be too harsh... some materials have been written for 'make and take' but again they are not in the schools...more inservice needs to be done with teachers to show them how to prepare materials and teaching aids. (Heberden 1993 pers. comm.)

The inexperience of teachers with practical activities included inexperience in making classroom teaching aids. Teachers did make posters and work-cards and some classroom decorations when the school had supplies. CDU produced a handbook in 1987 for primary school teachers that included a section on classroom aids and a few

production hints (CDU, 1987). This text was not distributed widely due to lack of funding - in fact not one of the participant schools had a copy.

Mrs Nyandoro of CDU was invited to give a one-day workshop to the teachers, where they could take home what they made. This is a service of the CDU, if requested by a school or group of schools. To participate the schools have to be near Harare, and provide their own materials. The "make and take" team have many other curriculum development commitments so they are not always available. The teachers thoroughly enjoyed the day and were involved in a mad scramble to try everything. A second involvement of Mrs Nyandoro was to show teachers in forms 1-3 how to use modelling as the beginning of mapping for the geographical part of science. Again, teachers enjoyed the activity. The modelling and relief mapping tried with teachers in senior primary was also beneficial. It was evident when the workshop was in progress that teachers had very little experience themselves of practical aspects of teaching landforms and weather - especially maps.

3) "Low Cost Locally Made" equipment: This researcher managed to get a small grant to buy materials for low-cost, locally made teaching aids. The teachers were introduced to a set of such aids - made at UZ and based on UNESCO designs - during cluster meetings. Many of the aids were constructed from recycled materials from homes. Teachers were encouraged to work with parents, students, and the community to produce equipment and teaching aids. Small funds were given to pay for nails, wood, or batteries. Teachers, at first made comments such as " they will work but did you have to make do with such teaching aids in your country?" This writer's response included explanation of current endeavours in the West to make resources from environment friendly or recycled materials. Later, some teachers, though not all, got very involved in making teaching aids. Comments after some months include

> The children collected Mazoe bottles and jars to do the experiment. They had the idea from me but then they decided what they could use to make funnels and ...they had good ideas to use things from home. The trouble is everything at home is used over again there. (Mr.H 1994 pers. comm.)

> This started out as a project of some children helping me... then their parents came to me and said what could they do to help. It was something parents could get involved with and it did not cost them much money... mostly time. (Mr.G 1994 pers. comm.)

The collaborative teachers all agreed that support for teachers and communities in producing resources intended for more active classroom teaching, can be achieved right in the community itself. The community must be "open to the fact that time and a little money from them will give the children educational aids" (Mr N 1993 pers.comm.). Teachers agreed that cluster meetings would be an excellent venue to introduce the practical *make it yourself* teaching aids to other teachers.

ii. Economic and social - Class size and the use of groups

The physical structure of the school - classroom space, number of grades occupying one class, number of sessions per day, and the furnishing of the classrooms - are a function of the community, and influence how a teacher organises the physical learning environment of the classroom. Teachers and researchers agreed that to teach in a way that encourages and allows both group interaction and individual participation of all children will take some creative organization. The typical classroom presents some constraints in this regard - the number of tables and benches, numbers of children, quantity of materials for group work and so on.

Each of the classes in the study has on average 45 students with about 6 - 10 to a table. Children sit on benches around the table. Books to be shared are piled on one end or brought from a shelf to the table by the group leader. Sometimes pencils, rules, etc are also shared from the centre of the table. Children are familiar with working in groups as this is the norm in all the classes we observed. Size of groups varied from the whole table to two groups/table. Some teachers used strictly ability grouping and some changed from mixed to ability groups according to the lesson.

Teachers seemed at the beginning to feel comfortable with discussions of group work, however observation of how the groups were used within the teaching strategy showed a difference between what the project team meant to happen and what happened in the

actual class situation. Following is a table that shows the different group dimensions observed by the researcher during class visits and cluster meetings.

Table 4.6 Use of Groups in Classroom Organization

Group Dimensions	Rationale from Teachers
Ability groups	Extreme variation especially in farm schools
Mixed ability groups	Good student in each group as leader
Grade groups (multiple grade class)	Some classes with 2 or 3 grades, especially farm schools
Group function for convenience	Must share books and materials group leaders help with organizing
Small groups for project teaching	Children interact with each other group reporting

As Bhunhu (1992) noted the classrooms may be organised in groups but learning is very traditional. Here are some comments by different research members about the traditional way teacher were using group class organization:

> They use groups for convenience but teach to individuals. In Training College they are told to use groups but since they are mostly teaching by rote, with chalkboard work, the groups serve an organizational service only. (CDU member 1993 pers. comm.)

> Even when he (teacher) gives out manipulatives for the group to use the children are not working together to solve a problem - all interaction is still between teacher and individual child. Children are not used to 'learning' together... they share apparatus but not ideas...there is very little talking...report back is not used effectively. (UZ team member 1993 pers. comm.)

> If I don't put a good student into each group then they are lost when doing an activity....it isn't fair to the top students to not work together so often I put them in ability groups....they have trouble reporting back in English but they must learn the language. (Mrs H 1993 pers. comm.)

Support Structures

The April 1993 Workshop had one morning set aside to work on "Class organization - grouping". This was led by CDU staff and teacher college lecturers. The need for this support session was demonstrated by responses on the January workshop evaluation and observations of demonstration teaching as well as by querying teachers on school visits. The senior research team had decided that the type of group structure and its use was not conducive to fulfilling effective learning objectives in the prescribed manner - especially when using process skills. The session thus used small groups in which teachers reflected on their practice and discussed this with one another. Ideas generated by the small groups were then brought to the whole group and reviewed. Teachers later agreed that this session was one of the first to ask their opinion on an issue and treat their answers as having value. Teachers agreed to try new ways of using groups when they could, though some felt that their traditional way was best, and others said they already used several types of grouping. The structure of groups was discussed and teachers began to see new possibilities for using groups to improve the learning process. There was however little followup to this session, except through cluster meetings run by the project.

iii. Relationship between school, teachers, and community

The material needs that are not supplied are discussed earlier as an inhibitor. Supplies for schools in more economically advantaged areas such as Harare are mainly supplied by the parent community. Government though intending to provide for all schools after independence, has been unable to decrease the large gap in provided resources between rural areas and traditionally advantaged or 'white' schools. As shown in Chapter 3 though the teaching context was not identical for all schools, rural and farm schools especially had much in common. The primary environmental factor was poverty. This was very evident in the lack of resources for the classrooms. Much of community involvement with the economic needs of the school is raised through 'building funds' or 'in kind' payments made by cash-deficient parents.

Other inhibiting factors discussed earlier such as language also have their origin in the community.

The traditional distancing of community from the school environment is seen by teachers as contributing to slow acceptance by students of innovative changes in teaching style.

Role and expectations of parents and community

The UZ Project was not involved with the community of the school. The project sought support from the Headmaster and Regional and District Education Officers - but not the immediate community. Indirectly some parents became involved through teachers who might ask for resource materials for hands-on activities. Occasionally teachers had children do projects at home which parents would observe. Teachers were asked by researchers in interviews how the parents supported the project and more specifically the way their children were being taught. The teachers responses were of three types generally

- They are in favour if it will help get a pass in the examination.
- They are not involved with the school so we have not asked them. We do not see them.
- They are pleased. (teachers did not elaborate on how they knew)

The collaborative group commented that the parents and community were most involved in communities where there was 1) a strong and outreaching headmaster and 2) where the community had responsibility for the school physically. Parents who tended to be involved in material ways often came to meetings while others stayed away, often from embarrassment that they were illiterate. Teachers were not familiar with parent and community groups that would be directly involved with decision making of schools.

Teachers were emphatic that parents, community, and administrators would not look kindly at any innovation that did not increase the pass rate of their students. Thus, as

shown in the literature review, the post-colonial attitude to education is very conservative, preferring the colonial system which worked for the colonials therefore must work for them (Vulliamy 1987).

What is the student's role in all this?

Teachers didn't ask their students how they liked or understood what was happening in the classroom. In some cases children seemed puzzled by the freedom they were given during observed lessons. Children in the project schools were only familiar with the traditional form of teaching and learning. Mr. M. commented after a year and a half of trying to use 'problem solving,' "It is not easy for children to start thinking seriously about strategies to use when faced with a problem because they have been used to being told" (Mr.M. 1993 pers. comm.).

The frustration felt by the UZ research team when children did not retest as hoped did not lay any blame on the children. The researchers were sure the children would improve if the teachers used the advocated pedagogy. Except for the original data collected by Dr Hodzi and Dr. Jaji on some "alternative conceptions" of the children, very little about the children's background was known. This researcher became aware of the many problems the children were having such as language, during school visits and classroom observations. Chapter 3 will give the reader more insight into the life of students as lived now and through the lives of the teachers. More research is needed to determine how transposed pedagogy and knowledge is accepted and incorporated into the communities targeted (Prophet 1990).

CHAPTER 5:
INTERNAL AND PROJECT-RELATED INHIBITORS TO PEDAGOGICAL CHANGE

5.1 INTRODUCTION

The collaborative teachers decided that there were inhibitors to change in both pedagogy and their own personal development that could best be described as coming from themselves. These they called "internal" inhibitors to change. These may have come from their educational background or might be attributed to present socio-economic or other psychological factors. These realities of "self", they reasoned, were much more complex and "immovable" than they or the senior researchers imagined at the beginning of the project. As Hargreaves and Fullan (1992) and Theissen (1992) argue, it is important to be cognisant of the whole person when attempting teacher change or development. A teacher's life story illustrates the "profound influence" of his/her early and present life on who she is as a teacher (Raymond *et al* 1992). When the collaborative teachers began discussing internal inhibitors in 1994, they were simultaneously writing autobiographies, which process they admitted allowed them to admit the vast difference between their educational experience and the one they were now being exposed to. Teachers further explained that in 1993 they would have found it difficult to express themselves easily in terms of these "internal inhibitors" partly because they did not have the understanding of either their traditional or the new pedagogy, and did not immediately feel comfortable discussing personal "self" difficulties with strangers.

The critical reflection of the collaborating teachers is backed up by 1) observation of teachers' misconceptions during peer teaching and discussion at workshops; 2) discussions with individual teachers as resource person for environmental science; 3) elicitation of ideas on the science concept of light as part of a constructivist enrichment lesson taught by this researcher. Chapter 5 will give examples of these internal inhibitors as well as a critical description of the structures meant to support the proposed teacher change. To supplement the information on teacher internal inhibitors

this researcher has included Appendix 4.2. p194 which contains sections of five collaborating teachers' autobiographies.

The Chapter sections include four general areas seen as internal inhibitors:

Lack of Subject-matter Knowledge

Pedagogical Differences as Inhibitors

Language

Unfulfilled Teacher Expectations

5.2 TEACHERS CAN'T TEACH WHAT THEY DON'T KNOW - LACK OF SUBJECT-MATTER KNOWLEDGE

> A teacher with a poor academic background cannot teach certain science concepts effectively because he lacks the concepts needed. ...Due to frustration caused by lack of knowledge, the teacher usually stops teaching or teaches at a very low note (collaborative teachers 1994).
>
> Some teachers lack interest in science (EAS was only introduced in 1984) for personal reasons...for example, they were no good at that subject and did not even pass it at 'O' level... they are frustrated by lack of knowledge (collaborative teachers 1994).

Much of the Western research and writing about changes in curriculum and teaching style assumes that teachers are relatively knowledgeable about their subject matter. The SPACE project that UZ had used as a model worked with experienced and knowledgeable primary teachers as collaborative researchers (Russell 1993 pers. comm.). The UZ senior researchers were aware that science knowledge might be weak in some areas but no testing of the participants was undertaken to ascertain specific knowledge gaps or misconceptions (Jaji 1993 pers comm.). As Rollnick and Rutherford (1990) point out this omission in teacher research is prevalent especially in Africa.

It is important at this point to clarify the use of the terms *alternative conceptions* and *misconceptions*. The term misconception was most often used by senior researchers and teachers. Russell during his first visit explained the reason for a separation of the two terms namely "the term misconception implies that something has been misunderstood

in the learning process whereas alternate conceptions refer most often to a child's original conceptual framework before learning of 'scientific concepts'" (Russell 1993 lecture).

a) Discrepancy between paper qualifications and environmental science knowledge

The basic requirement in terms of qualifications for participant teachers was that they have a teacher qualification recognised by the Zimbabwe government. Since primary teachers in Zimbabwe teach all the subjects in the curricula, it was not considered fair to require certification with science or mathematics as a major subject (Jaji 1993 pers. comm.). As explained in chapter 3 background information was requested from the participating teachers in May 1993 to help determine why teachers were resisting change. The analysis of the data by Kuiper (1994) showed that all of the participating teachers had qualifications from teacher training college or equivalent. Further the report showed that most of the project teachers had passes in "O" level science. The graphs by Kuiper are shown in Appendix 3.2, p 186. The questionnaires showed that of the 60 teachers who responded

87% had passed science at Zimbabwe Junior Certificate (ZJC) level
50% had passed maths, science and English at 'O' level
77% had passed science at 'O' level
18% had studied science as their main subject at college
17% preferred to teach science relative to other subjects

Other data from the questionnaires show that since leaving teacher training college only 15% of the teachers had ever attended a seminar on EAS. No one had attended an in-service training workshop on EAS, backing up Lewin *et al*'s findings that only a small percentage of teachers had been exposed to workshops on EAS (Lewin *et al* 1991). Questionnaire results did not give results that would answer questions such as "how much science and environment knowledge do individual teachers have?...do they have misconceptions similar to those of the children that might inhibit them from teaching effectively?" The teachers in constantly reaffirming their need for enrichment sessions

acknowledged their weaknesses, but on paper they looked quite able to cope with the science topics. Though almost 80% of the teachers had a pass in 'O' level science only 17% preferred to teach EAS. The collaborative teachers commented "yes, you see no one likes to teach something they do not feel comfortable about."

b) Relation of misconceptions in teacher colleges to classroom teachers

In July of 1993 the research team was invited to give a guest workshop with graduating students on the pedagogy of the project at S Teachers College. This researcher was asked to handle the section on classroom organization and the afternoon session on science. It was decided to introduce the student teachers to the generative model of learning and teaching by having them go through the process themselves. Some of the materials used are shown in Appendix 4.6, p 236.

The results showed an overwhelming lack of knowledge and misconceptions about a fairly basic concept: how light travels, what happens with reflective surfaces, and how one sees the reflection. The college lecturer when interviewed about the lack of basic concepts on light in these students commented

> They do not have to pass 'O' level general science to come to college...They may not have passed ZJC science as that is not a prerequisite to registering for 'O' levels. They probably did very little science in primary school as national exams have only been going for four years... They are afraid and that is why they seemed hostile... especially the ones entering the new 'infant' course where they will only be taught the little science they need for grades 1-3...This is why they will do gardening and avoid real teaching of science when they go out to their schools... We do not have time to teach them all that they missed in secondary school (Mrs M 1993 pers. comm.).

From this experience, this researcher began to understand that teachers working with the project, having come from a similar, or the same college, might well have graduated while retaining unchanged many alternative conception about science. Because, by their own admission, the previous education of most teachers was of a rote type, it is not surprising that they learned the "correct" answers, without ever "getting the concepts right" (Heberden 1993 pers. comm.).

c) Evidence of teacher science conceptions

The following are a few examples of the alternative conceptions or misconceptions that teachers exhibited during workshops and cluster meetings. This researcher prefers to call them misconceptions based on the fact that these adult teachers had some experience with science concepts and either maintained original alternative ones or somehow in their experience came up with a misconception.

- **Example # 1 - Where does the carrot seed come from?**

In January, 1993, visiting educator Russell during a practical activity meant to explain his findings about children's ideas, asked "where does the seed come from for a carrot, if not from the carrot top sprouting roots and shoots in the classroom?" There was no response from the group of eighty teachers. Eventually a few of them admitted that none of them had ever seen a carrot produce seeds. Since it is not an indigenous vegetable those few who might grow such a vegetable would buy seed. When this researcher explained the mechanism of carrots as a biennial plant, flowering and producing seed the second season, the teachers admitted that this plant was never used as an example in 'O' level science, to their knowledge.

- **Example #2 Day and night comes from the earth travelling around the sun**

The concept of 'day and night' was taught to grade five classes between May and August of 1993. During a school visit to B in preparation for a cluster meeting one teacher mentioned having difficulty with the topic. "How do I get them to understand that day and night comes from the earth travelling around the sun?" he asked. Another teacher and this researcher improvised an activity where the teacher could actually *see* a difference between how day and night might happen as opposed to seasonal travel around the sun.

Another teacher in describing his activity that was designed to get the children to demonstrate how day and night occur, showed the team a setup that included a light source and clay balls that the children could use to show day and night. His misconception was in evidence when he demonstrated what the children should do - he moved the ball around the light source. Another teacher caught the error and corrected him by keeping the ball in one position relative to the sun and simply turning the ball around on an axis.

The researcher includes these examples because they illustrate the fact that teachers usually <u>said</u> the correct concept, exactly as it was written in the syllabus. However, when trying to teach using an activity, or even in the planning process, the

misconception became evident. Trying to teach in a non-rote way was difficult for teachers who themselves had simply memorised the syllabus or textbook. The probable level of misconception of light concepts in some teachers is shown in the next section.

○ Example #3 The moon has its own light

Mrs G. had been trained as a primary teacher, but deployed as a secondary school English teacher for fourteen years. She had been reassigned to primary teaching the same year she was assigned to the project. While on an informal school visit this researcher was told by Mrs G that she was ready to teach about the moon and stars. She asked how 'reflection' had anything to do with the moon since the moon had its own light. If it didn't have its own light where was it coming from, she asked? Other teachers thought Mrs G was an exception because she had been away from primary teaching so long. The syllabus told them that light was reflected from the moon that came from the sun. No one had tried any practical activity to illustrate how this concept could be explained to students.

◊ The Workshop example: Light and seeing - role of reflection

In April 1994, thirty five teachers and four teacher trainers participated in an enrichment session designed by this researcher. The aim of the session was to illustrate through practice a constructivist lesson. The general topic of 'Sun and Cosmos' had been approached in April of 1993 in an enrichment lecture given by one of the teacher-trainers. Since that time teachers had been observed teaching about shadows, day and night, and reflection. Reflection had mostly been 'mentioned' in relation to shadows and day and night - but we had not observed a lesson specific to reflection.

All teachers attending were certified and all but eight had passed 'O' level science. Two of the teacher-trainers were science teachers and two were mathematics teachers. The introduction to the lesson included elicitation of teacher ideas on light travel, reflection and seeing. The lesson then included some group discussion on person's ideas followed by a variety of practical activities meant to provide illustration of concepts of light reflection, primary light sources and so on.

The elicitation question for teachers ideas is as follows:

" Describe in a drawing how the eye sees the clock in the picture. Show the way the light travels."

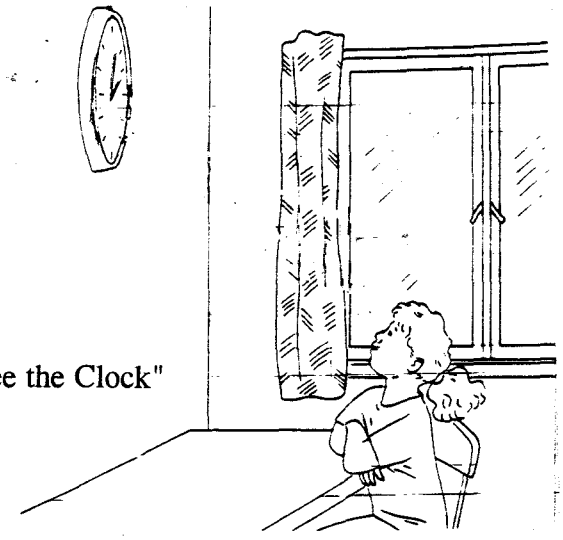

Fig. 5.1 "How Does the Eye See the Clock" (from Nuffield Primary Science KS2 Light, 1993)

The results of the teacher drawings were analyzed later and has been used to illustrate the level of teacher misconceptions. The results indicate that teachers had correctly indicated a need for enrichment on this topic. What researchers had not been aware of was the level of enrichment needs. Using the elicitation questions for children this researcher had found that 57% of the teachers had misconceptions about light travel and how seeing occurs. Conversations between this researcher and teachers during the hands-on session following elicitation gave further illumination to the misconceptions of the teachers. The following chart will explain the variety of ideas that the teachers had.

Table 5.1 Teacher Ideas on How the Eye Sees

total /35	**How the eye sees the clock - light travel --> shows light direction**
4	eye --> clock <--
2	eye --> clock
2	eye <-- clock

total /35	How the eye sees the clock - light travel --> shows light direction
2	eye <-- window --> clock <--------->
2	window --> clock <--> eye
1	window --> eye <--> clock
1	window --> eye --> clock
1	clock <-- window < -- eye
2	clock <-- window eye
2	no arrows shown
16	window --> clock --> eye

An analysis of the above information shows the following misconceptions:

1. The origin of light was understood to come:

   * from the eye
   * from the clock

2. How humans see was explained alternatively as:

   * light goes from eye to the object and back to the eye. Similar to children not associating the concepts of light travel, and reflection and absorption with seeing.

   * light goes back out of the eye after it enters ...another reason that we 'see' an object

The Zimbabwe Junior Certificate (ZJC) and the General Science 'O' level courses both include lessons on the eye and how "seeing" occurs. Both courses also include some aspects of reflection. Three of the teachers who had the scientifically correct concept did not have 'O' levels. Two of the three were older teachers with credentials from before Independence. Of the nineteen with misconceptions only five had no 'O' level

pass in Science. Since the researcher was not intending to use this data quantitatively no in-depth study of the science background was done on individuals with misconceptions.

Important to this study is the fact that the teachers' misconceptions about light were very basic ones. Teaching enrichment sessions assumed that teachers had such knowledge, and as a result did not help those whose misconceptions were at the level indicated in the chart above. This suggests the need for increased information about teacher and student-teacher conceptions of science and environmental topics before producing materials for them. A constructivist approach to the learning session had elicited these teacher misconceptions about light and seeing.

Support structures for enrichment sessions

a) ***Support through enrichment sessions at workshops***

"We need enrichment - teach us about the topics that we do not understand or find hard to teach", was the general comment on end-of-workshop evaluation forms in October and November of 1993, and again in January 1994. Grudgingly, the senior researchers decided to deviate from simply designing lessons to giving 'enrichment' sessions on topics requested by teachers.

> They (teachers) always want us to teach them content - that they should have learned in college or from their own reading. The project is not here to prepare these teachers for 'A' levels. They (participant teachers) have almost all got 'O' science and all have been through science preparation at college. There is little enough time for the project without taking much time to teach 'subject matter' (Mrs H 1993 pers. comm.).

In April, 1993 the first enrichment session was conducted at a workshop at UZ. The enrichment consisted of lectures on *Sun and Cosmos* with handouts from Rarayi of teacher college N; lecture and demonstrations on 'Electricity' by physics lecturer Ncube and B. Ed. students; and roundtable discussion on 'Pollution' for the grade 1-3 teachers, conducted by this researcher. Subsequently enrichment sessions have been given on concepts of light, Immunology and AIDS, and Landforms and Mapping.

A further session on "Science - Facts open to interpretation" was held by researcher Kuiper.

Most of the enrichment sessions were designed by the researchers or by invited speakers, based on topic areas requested by teachers. At first enrichment was given in lecture form, partly to save time, and partly as that was the normal teaching style of the lecturers. Some handout materials were given with information on enrichment topics, when there was photocopying available. No resource books were given to the teachers.

This researcher requested permission to include some simulation exercises and practical activities in early workshops. This was seen by some of the senior researchers as a luxury which would waste precious time. As this researcher took over most of the EAS activities in workshops in 1993, later workshops included more active participation of teachers in the enrichment process - ie a constructivist, diagnostic approach was used. The sessions on 'light' and 'mapping' as well as one on HIV and the immune system, were taught quite differently from the original lecture sessions throughout the first half of 1993. This occurred as the researchers started to merge the pedagogical sessions with the enrichment sessions.

Most teachers were hesitant at first to criticise the workshop structure or to question how enrichment was given. Only a few were critical during the formalised interviews that were used to evaluate the workshops. When asked how they would run a workshop themselves many shared Ms C's view that " I would have handouts on subjects and get an expert to lecture...then we could show the teachers some ways to teach." Their general acceptance of the workshop format was not unexpected given their traditional, rigid, top down, educational background (see section 5.3).

When teachers were questioned about the workshops in a way that did not put them in a formal critical position they were much more forthcoming:

> The best thing was when you did practical work with us...you know most of us never did any 'hands on' experimenting...we are a little unused and afraid...in case we fail (Ms G 1994 pers. comm.).
>
> I couldn't imagine just how the light could get from the flashlight to my eye through that box with the mirrors...or how to make someone see me around a door corner...the whole learning situation was better than a lecture I wouldn't understand. Now I can try the same with my students (Mr P, 1994 pers. comm.).

b) ***Support structure - cluster meetings***

At cluster meetings teachers corrected one another. The UZ team encouraged teachers to comment after a demonstration lesson, and quite often the other teachers "caught" a teacher's error. More often there was no explicit error in teacher's presentation; rather the straight rote teaching led the researcher to question the topical knowledge base of the teacher. It became the habit of this researcher to explain some basic *knowledge* through examples of how the lesson might be expanded. This way the teacher learned yet was not embarrassed by the situation. Since most demonstration lessons followed enrichment sessions on particular topics at workshops, the researchers were aware that teachers might be more knowledgeable on the demonstration lesson topic than on other topics. There had been no research to support this supposition.

c) ***Support structure - providing resource materials and encouraging teachers to research topics***

As has been noted earlier, there are few if any useful resources for rural teachers in their schools or community. If teachers lived near a secondary school they were encouraged to use its facilities for research. Teachers involved in the 'writers group' were to research and document resources used for model lesson preparation. These teachers used 'O' level texts and other resource books when they could find them. A few handouts were provided but this type of support did not meet the teachers' expectations. There was no money for photocopying or money for resource books for the participating schools. This was frustrating for the teachers and they complained about the problem in every workshop evaluation or questionnaire.

5.3 INHIBITORS TO PEDAGOGICAL CHANGE

> Personally I can sincerely claim that the new approach (constructivist) is the best teaching method...but the serious problems I noticed are: a) It is very difficult for the teacher to change from the well known conventional approaches and adopt this new one; b) It is very difficult for the teacher to get into full grip with the way challenges are set and how the children are guided through using thought provoking questions... (Mr N. autobiography 1994).

The UZ project was based on the assumption that teachers involved with this project taught in a similar fashion to those observed by the evaluation team of Lewin *et al* in 1990, reported in 1991 and analyzed as case studies in 1992 (Bhunhu 1992). Two of the original UZ team who put together the research proposal were also involved with the evaluation team of 1990. As was shown in the literature review (Bhunhu 1992), teaching style in these schools is basically traditional rote with some activities that are simply illustrations of rote information, and which may or may not add to the learning experience. Appendix 1.1, p 129 presents the summary findings of Lewin *et al*, and further description by Bhunhu of classroom teaching.

The following sections are illustrative of four inhibitors to pedagogical change that the collaborating teachers and this researcher identified and discussed.

a. Teachers teach as they were taught

> There is a tendency for teachers to employ methods which were used during their primary and secondary education...for example Nature Study emphasized on facts memorization at the expense of experiments. Teachers also believe that the methods they acquired during training are the best and most effective because they made them (teachers) pass." (collaborative teachers 1994)

One collaborative teacher in writing her autobiography proudly explained how she went from grade one and two in a school where she did not learn to read or write to a school where her father knew the headmaster. She explains here the method used in 1973 in a rural African school. The teaching style she describes has not changed, except for a few less 'strokes' by teachers. This researcher has sat outside classrooms in many rural

schools talking with collaborative teachers while the drone of times tables, or unison listing of science facts etc, hummed from the classrooms.

> Despite being a school Headmaster he did his work up to the required standard I can say. I remember him always coming from the office in the morning his first subject has Maths and he would say "Line up for the time tables". I had to know all my tables by heart and he would make me stand at the beginning of the line. I was not allowed to sit down - after getting the correct answer, he would order me to move ten pupils ahead and stand in a line again until everybody else got his turn. For every mistake it was a stroke on the back and we were not allowed to stammer or give a wrong answer first then a correct one later. He regarded this as guessing. By the end of the year we were perfectly good. I was proud of myself and my teacher. I started to like school (Mrs S. autobiography 1994).

All the teachers came from this traditional schooling. Further, they agreed that the approach to teaching in teacher's college was no less formal or traditional. The teaching style they had been exposed to through in-service was a lecture, top-down style. This was also true of much of the UZ project in-service workshops.

b. Teachers were unprepared for hands on activities, experiments, process skill development

The teacher college was the last place where practical learning could take place before the student teachers entered the school system. Since EAS has never been a core subject where student teachers are expected to regularly upgrade their knowledge, most teachers were taught only the primary syllabus and some basic teaching methods. Most teachers agreed that they had done a small amount of practical work, but usually this was limited to demonstration. They felt this only compounded the inadequacy they felt after not having had any practical experience in secondary or primary school.

One teacher explained what at first appears as non-conventional epistemology and pedagogy at one of the colleges in 1982-85.

> The bible used at MZC during my training was Paolo Friere's "Pedagogy of the Oppressed" supported by Rodney's "How Europe Underde-

> veloped Africa". Friere propounded that children are not empty receptacles to be filled with knowledge by the teacher. Thus, we were told over and over again to let children be active participants in their learning. Still these lectures did not specifically come up with a clear-cut way of achieving this "liberation" of the learner (Mr. A. C., autobiography 1994).

The two teacher colleges visited by this researcher admitted to predominant use of lectures as the classroom teaching method. Classes usually had over 100 students for lectures with smaller groupings for practical 'experiment' sessions. The class that this researcher tried to teach in an alternative constructivist style had 150 students sitting in rows in a lecture theatre. Lecturers at the teacher college stated that having only one year to prepare their students for the second year of practical classroom teaching was inadequate and rushed. The lecture method was the most efficient way to transfer knowledge (Rayayi 1993 pers. comm.). None of the lecturers commented on whether the lecture method was the most efficient method from the viewpoint of the student-teachers learning process. The year of supervised teaching was still used as a stopgap by schools to deal with teacher shortages, so student-teachers quickly became full time teachers with their own classes, and thereafter received very little school supervision and infrequent college supervisor visits. "While one class is out in the field we are busy teaching the new group and the third year students returning from their year out in schools" (Rayayi 1993 pers. comm.).

None of the science lecturers at the colleges visited had ever taught primary school. Further, they stated that there had been little possibility to upgrade themselves on new or innovative educational theory and practice. Lecturers felt that whatever "child centred" methods they might encourage teachers to use would probably not be used unless encouraged by the school administration. They were fully aware that their own methods were traditional but did not think this should change at higher levels (Mrs Mudunge 1993 pers. comm.). Mr Rayayi tried to set up a group method of using alternative teaching but thought the students were not happy because there were not enough college lecturers to be with each group. They did not see a connection between how adults were taught and how adults in turn would teach children.

c. Traditional pedagogy takes less time and thought

> Teachers try to refrain from methods that give them a lot of work in terms of preparation, research and supervision. (collaborative teachers)

The collaborative teachers discussed time as both an external factor (see Chapter 4.2) and as related to personal motivation. The traditional rote method took less time while fulfilling the requirements of the administration. The teachers admitted that the extra time needed had to come from "personal time" which most were not willing to give up. Many teachers had other commitments to supplement incomes, while others might be involved in distance courses. The collaborating group saw this lack of motivation as a stumbling block to increasing teacher involvement.

d. Traditional pedagogy keeps teachers in control

> Teachers are resistant to new methods that leave them open to questions, criticisms and suggestions from the pupils because they want to remain masters of all the learning processes...with full control. (collaborative teachers)

A tradition of strict discipline and the position of teacher as "knowledge giver", gave teachers a sense of power, according to collaborators. Insecurities that many felt about their own knowledge base prevented them from opening up for questioning from students. Such openness would be an admission to students and others that they were in a learning situation and on the same level as the class - a position which was untenable to most teachers. The collaborators admitted that until they had tried to teach innovatively, they would not have admitted that this fear of losing control was going to be such a strong inhibitor. There was a long and heated discussion on this factor as they discussed with the researcher feelings of inadequacy on certain topics, and how this affected "taking chances" in the classroom. In the end they decided that the fear of losing class discipline did not need to be a strong inhibitor for experienced teachers. The loss of control, which they perceived as loss of "discipline," was now seen as an excuse to cover the real fear of teachers to expose themselves to criticism - to expose the reality of their weak knowledge of science.

Support structures for pedagogical change

> To overcome these serious problems, I feel teachers need enough exposure to both theory and practice of this constructivist approach. (Mr. N. autobiography 1994)

The project provided support at workshops and cluster meetings. Some support such as video was not used as extensively as originally hoped. Resource materials were sometimes provided and a workbook for teachers was produced in 1994 by a group of teachers and researcher Kuiper. This document is not published as of June 1995.

a. Workshops

Workshops included lectures on new methods and handouts on advocated teaching methods. Participants were encouraged to learn by watching others teach, once by practising on one another, another time with children from a nearby school, and once through a video example of Mr. AC. teaching. Teachers practised questioning techniques on one another. Practical activities were set up in the January, April and August 1993 workshops. The making of low cost resources was demonstrated through hands-on sessions in April and at cluster meetings.

Criticism of the workshop structure did not come easily to participants. Some of this reluctance they later attributed to lack of experience with such workshops, and their powerless position in the project structure. By August 1994 the collaborative group was much more open about their feelings of frustration. The following writing by Mr AC was agreed upon by the others as explaining what happened when the project advocated that children be active participants in their own learning

> The project, during the initial phases, failed to offer us clearly-defined information to put into practice. Initially, the organisers used the lecture method which they wanted to be discarded as much as possible. It was like a father explaining to his son not to speed when he (the father on the wheel) is doing k/h. Or an old woman with a crate of beer telling gullible youths the evils of drinking. Teachers hated those lectures which were monotonous and dull. They only came alive - lecturers too - during discussion and group work (Mr A.C. 1994)

b. Cluster meetings

A system of *cluster* schools exists in Zimbabwe but is infrequently used (Anonymous headmaster 1994). Some schools use the cluster system for joint staff development and in-service programs. However it is used primarily for sports competitions. The use of cluster schools as a basis for workshops can have two objectives

1. inservice introduction of new syllabi, innovative or new pedagogy or enrichment

2. support of teachers and administration during a period of change in pedagogy or syllabi.

The cluster group meetings were used by the project primarily as a support structure (above No 2). Since non-project teachers were often involved in the cluster workshops some in-service was accomplished although that was never an explicit objective of the meetings.

The original plan was to have two central schools with a group of schools as satellite or sister schools in the near vicinity. These might correspond to the *cluster* school system being set up by MEC. With the sudden increase from an anticipated 20 schools to overr 50 schools in January 1993 the original plan was scrapped. To accomodate the wider geographical distribution of the schools a special system of clusters was set up except in cases where one already existed. With over 50 schools and a very small UZ team it was decided that the team would observe peer teaching at the cluster group meetings, as well as give any support needed, check journals and meet with headmasters. Under the original proposal the cluster system resembled the *study group* that was to be used for peer group work.

Some members of the UZ research team were critical of the cluster meetings. They became as one member put it, "a show". The teaching was done as demonstration, sometimes rehearsed, occasionally even teacher oriented in a kind of showmanship style. The opportunity to use observation schedules was weakened by the type of observation schedule used (see Chapter 3). Thus for the purpose of academic research

these cluster meetings became a *promised necessity* that was not useful for data collection on how teachers were using the constructivist method in their classrooms (Mtetwa 1993, pers. comm.). The time constraints posed by having two sets of cluster meetings in one day often left time only for lesson demonstration and brief comments. The other anticipated results - such as visiting with individual teachers and headmasters at the school and from sister schools, reviewing journals and discussing teacher problems, both individual and group - were seldom realised to the extent the researchers felt was needed.

> Teaching ... suffers from the lack of opportunity that teachers have as individuals, and particularly in interaction with other teachers, to reflect, to observe, to discuss, to plan. (Fullan 1982:259)

The researcher's presence at many project cluster meetings and interviews with both teachers and headmasters attending, gave a positive and important justification for using cluster group meetings as a support structure. In the cluster meetings, a lot of teacher exchange occurred and the feedback from teachers was much more supportive of the idea than the research staff expected. From the teachers' perspective these lessons were

> a chance to have other teachers see us and comment ... we don't get a chance to see ourselves or others...we are too busy(Mr Q 1993 pers. comm).

> I get ideas on how something might work...or what is wrong with what we are doing when I watch someone else...even when I have to prepare (for the demo) I have to think about what I'm doing...teaching the way you (project) want (Mrs R 1993 pers. comm.).

Whereas University staff person M saw the cluster demonstrations as "a complete waste of time", the teachers themselves, with their limited experience of classroom observation, felt the meetings provided encouragement, some peer support, boosted morale, and gave them a chance to discuss classroom teaching with research staff and peers, and occasionally with E.O.'s. It was used to initiate staff development in two instances where the participant teachers, having gained confidence through their role

at UZ workshops and cluster meetings became involved in future staff development in their own schools.

Thus as can be seen the teachers themselves concur with the researcher that the clusters were useful as a vehicle for improving staff, peer and interschool relationships. This was achieved by giving the participants a reason and opportunity to discover other teachers' points of views and thereby giving a chance for a more co-operative approach to innovative change in teaching style. The teachers summed up their opinions in response to this researchers question:

> What is your response if someone says the demonstration teaching at the cluster meetings was 'just a show'?"

The collaborative teachers' response was:

> No, we don't believe that...if he means it isn't just like in the classroom, well that's true...how can the children be absolutely the same as usual when there are more than fifteen strangers in the room? ...But we prepared for the lesson and we were very excited and proud to teach in front of our other teachers, heads, E.O.'s and the professors from UZ...was it wrong to be proud to show our efforts? ...The cluster seminars boosted the morale, made the teacher-participants confident and, indeed, clarified the problem-solving method (collaborative teachers 1994).

c. Use of video

This researcher videotaped about ten environmental science lessons from cluster demonstrations and a few ordinary classroom lessons. These were later used to show teachers *good* examples of use of problem-solving. The idea of using video to help individual teachers *see* themselves did not occur regularly due to lack of electricity or playback facilities except at the workshops when time did not allow for individual attention. The children were surprisingly at ease with the video, partly because they had no idea what it was doing. Teachers sometimes became quite self-conscious or alternatively "turned into actors" (UZ lecturer 1993 pers. comm.).

Use of video segments for illustration in workshops was difficult due to background noise and other interruptions on the tapes. Training films that were started were never edited or used. However this researcher was able to replay some lessons to show what was happening in the attempts at innovation. Teachers were disappointed that they did not get to watch themselves on video. It added to the feeling of exclusion and separation from the real research being done.

d. Production of teachers guide

In 1994 a teachers' manual of model lessons and pedagogy explanation was started. This was a combined effort of 18-20 teachers with co-ordination and editing by Dr. Kuiper. This researcher participated occasionally as an observer and commentator. The difficulties of this endeavour are noted in the Chapter 5.5 with discussion of teacher expectations and again in the Chapter 5.6 in the discussion of project related inhibitors . The main benefit to the involved teachers was discussed by the collaborating teachers with this researcher. As part of the "writers' group they had continued getting together on a regular basis, as often as twice per month. Though the meetings had their frustrations, this had helped them become more sure of themselves. They felt they would not have maintained any of the innovation if they, like the rest of the eighty teachers, had suddenly lost contact with the project and with each other.

e. Individual school visits

> Visits to individual schools also paid dividends as individuals problems were attended to. However more visits were essential (Mr A.C. 1994 pers. comm.).
>
> My teaching approach improved considerably. I had a feeling that the Research team (from the University) could have equipped me better had they paid me regular visits at my work place and observed me teach rather than require me to attend workshops and seminars at the university campus...you understand nobody really knows how I teach except from what I tell them (Mr. MW, autobiography).

As explained in Chapter 1, there was a sudden expansion of numbers of teachers and schools in the project as of January 1993. With a maximum of four UZ researchers at

any one time there was no possibility of visiting all the schools on a regular basis. Later, the collaborating teachers discussed the fact that often when visits were made they were quick visits to bring information or set up cluster meetings. Teachers might have a short talk with the visitor, but not enough time to observe a lesson or get into detail about what problems the teacher was encountering.

f. A buddy system

Teachers often talked about the loneliness of the teacher in schools where only one teacher was involved with the project. Some teachers deliberately started to involve another of their school staff but often this fell through if the project could not invite this extra person to workshops. Cluster meetings did help overcome isolation, but they did not continue after the first year.

Three of the collaborating teachers were involved with "buddies" who also were part of the project. These teachers informed the rest of the group of the value of having a person to share the experience with - who also knew what one was talking about. The frank opinion of the collaborative group was that innovation should not be done with only one teacher involved at a school.

5.4 LANGUAGE AS INHIBITOR - TEACHERS' OWN DIFFICULTIES

The teachers faced many of the same problems as their students when teaching in English. For the teachers as for the students, English was their second language.

> If my first explanation is not understood I have a hard time to think of another way to say it...sometimes I just have to say to 'learn it'...their (pupils) English and my English is just not good enough to think of other words that can mean the same or explain better." (Ms M. 1994 pers. comm.)

The second problem that teachers saw as an inhibitor to changing from rote, "chalk and talk", was the language of science and environment

> Science in general is a subject with words very difficult to understand...for example photosynthesis, enzymes, chlorophyll, just to name a few. These words are very difficult to define to the pupils or to translate into the local language. This problem of terminology hinders both the teacher and the pupils to express themselves freely...some of the terms we may not understand well so it is harder to explain to the students. (collaborative group 1994).

This comment by the teachers was an acknowledgement of the difficulty that had been noticed by researchers during peer teaching observations. Teachers would often write the technical term to be learned that day on the chalkboard. Then, depending on their own understanding of the term or their decision about the children's ability to understand, they would define the term or give a "fill in the blank" rote response for the children to memorise.

For example a cluster peer demonstration lesson was about how plants get food. The teacher put the word "photosynthesis" on the board, the children were told "the lesson today is about photosynthesis...Let's say it together...photosynthesis...and again Tsetsi what is our new word?..." The process of photosynthesis was not explained.

In another instance the new words *condensation, and evaporation* were part of the lessons on "water cycle" and "changes of state" (the contemporary term of "phase change" was not used by the syllabus). These again were taught as new words to be learned and memorised before the concepts were introduced. Unlike an English as first language class, these were indeed totally new words to the children. The teacher in question did not connect the new words to the experience the children had in Shona of the processes. The lesson was presented entirely by rote, and the teacher evidently felt considerable unease about the science concepts.

Teachers found that they also had trouble understanding the language of the "academic". They admitted to feeling embarrassed to ask what the UZ staff meant by terms like "constructivism, pedagogy" and so on.

> Terminology has also led to individual interpretations of educational terms...Eg 'constructivism', 'diagnostic teaching', 'generative teaching', etc. This is

because of their lack of knowledge on the terms. This will lead to some of the teachers not fulfilling or pursuing the epistemology of the project." (collaborative teachers 1994)

To some extent a teacher may even teach wrong ideas to the pupils due to his lack of understanding the science terms in use...Some teachers avoid doing certain science projects once any big words or offensive words have been used. They are simply scared by the big words and this stops them from attempting anything. (collaborative teachers 1994).

Support structures

There were no support structures devoted specifically to language. Discussions with teachers in late 1994 led this researcher to comment that teachers felt the best way to overcome the inhibitor of language was to use it more often. Having to explain themselves and their ideas to researchers and to one another encouraged them to try different ways of expressing themselves. Habits of investigating topics before teaching, which were encouraged during the writing of model lessons, gave the teachers an opportunity to learn environment and science language. This was however hampered by lack of reading material. Use and understanding of the language of the academic, came slowly, due in part to the project team's attitude toward teachers. One teacher summed up his feelings thus "I want the people who are watching and listening to me...all these educated people...to know that I understand what I am doing. I have to speak their language" (Mr AC 1994 pers. comm.).

5.5 UNFULFILLED TEACHER EXPECTATIONS

One of the most important inhibitors to change was also one of the most difficult to evaluate and talk about. This researcher finally decided that the complex feelings teachers were showing her in conversations during the year could best be put under a label of "unfulfilled desires or expectations". As explained in the literature search , teachers as people will enter a new situation with their whole being, and the complexity of this person will become part of the process of change (Rudduck 1991). The *unmasking* of expectations and hopes, and the *affirmation* of the project's role in keeping teachers in a marginal position (Kirby and McKenna 1989) was slow precisely

because the teachers were used to being marginalised. A situation of trust between this researcher and the teachers had to evolve before they would express many feelings that might be seen as critical. With this sensitivity in mind the researcher has not spoken without the permission of the teachers.

Each individual had their own hopes and expectations about their involvement in the project. Some came with few expectations except to follow headmaster instructions and report back on workshops. Others in the original group were given financial expectations which to some were primary incentives to "do what was expected". Many collaborating teachers agreed that the most discouraging aspect of the project was "unfulfilled promises of support". Some unfilled desires were ones that the project never expected or offered to fulfil. Teachers sometimes saw their association with UZ as a panacea for their career hopes, and grew disinterested when this did not happen.

Unfulfilled promises

This area will be discussed further under "Project - Related" inhibitors. The collaborating teachers expressed their disquiet and frustration in late 1993 and again in 1994 that the promises of material resources never came through, or came late and in partial terms. They also complained that non-monetary rewards were given at the discrimination of the UZ team without participant teacher involvement in decision making. Teachers felt that rewards such as choosing whose writing was to be included, or who would become an editor, were given unfairly due to lack of contact with them in their schools.

> I feel betrayed... the researchers should have done more visits to ensure that teachers were actually trying lessons before submitting them... and to see which one is a better example for other teachers to try... how could researchers know what was going on, or if teachers even really asked questions if they didn't visit schools regularly...some of the culprits got away with it... (Mr. AC 1994 autobiography).

One important disappointment that was mentioned many times was the lack of *certificates of participation* at regular intervals or after workshops. Again these were

promised frequently but given only once. Teachers felt they deserved commendation and recognition that could be seen by E.O.'s and other persons in authority. Career advancement was often made through teacher involvement in outside activities such as that provided by the UZ Project, but written confirmation of involvement was needed as proof.

The question of money

There was never a simple answer to why things were "going wrong" as one participant later described.

> From April 1992, when we first started to work with the project we were told we would be paid "something for our pocket"...for our extra work. The headmaster was given a tape recorder for the school to be used for the interviews. The other school got one too but it was stolen. Anyway we were paid $... per month plus transport when we came to workshops. After the changes in January 1993, when there were so many new teachers, we heard the directors tell everyone that they would get paid for transport and "something for their pocket". We were told not to worry that we would get paid when the money came in. We don't know if anyone got paid but we didn't get paid. Even our headmasters used to get paid. We don't know if they still got paid...they didn't say. After we complained a lot we were given $30 one month. Why did they take all those other people? We (original group) felt that we were not important any more and besides we have too many other things to do after school to make money. The head forced us to stay with the project but we no longer put much energy into it (teacher X 1994 pers. comm.).

Finances were not discussed between senior researchers and other participants including this researcher. Travel to cluster meetings was to be paid for but teachers were not encouraged to request any payment since the distances were small. The attendance dropped. To get a lift one needed to contribute to petrol and if no money was available many teachers elected not to walk the long distances involved. Teachers admitted that they lost faith in the project's willingness to "come through" for them. They saw themselves as having no value to the project except in their role of teaching the children to be tested by the researchers.

The original group of teachers who were no longer receiving regular payments were angry as noted above. Others had been promised 'something' which was never spelled out in quantifiable terms, was always put off while the project awaited its funding grant, and was used as a threat when reports and lessons did not indicate *change*. Teachers brought their reports to the May '93 workshop, and they were graded by the two visiting participants from CDU. A few were awarded prizes of less than $50 for writing up what looked like well thought out reports, while the others were told that they were not doing their best in the project. It was a frustrating week. In the end the teachers went home with no extra money, and still only part of the promised equipment, though they finally got their maths kits.

One teacher explained his feeling over this event as "rejection of the treatment they were receiving from the project leaders". The disquiet was explained by another teacher this way

> It's like a parent holding out the promise of some candy if you're good, but never saying when you'll get it or how much. First you dream... then it gets insulting when it's less than your car fare... it would be better to treat us like real partners in the research and never mind about the money. Some of us who came in after the first group, never cared about the money all that much and we never knew what the first group got except for rumours. (Mr.A.C. 1994).

5.6 THE NON-VISIBLE INHIBITORS - PROJECT RELATED

There are several project-related assumptions, priorities and paradigms that this researcher believes affected the change process for the teachers. These were not written in any document, and were often unspoken or unrecognised by the researchers. This researcher has had to stand back from the project and reflect critically on what was really at work within the project itself that might have inhibited or prevented support structures from being effective. These factors are:

> A. Most support personnel were not familiar with, or at ease using the new epistemology or pedagogy.

B. There was a conflict between the paradigm used for the advocated pedagogy and the positivist one that was being used in the research.

C. The research agenda on 'children's problem solving strategies' gave priority to the teacher as an 'instrument of change'.

D. The failure in the first year and a half to engage in true participatory research.

The UZ Project Proposal of 1992 (presented in Appendix 1.2, p 143) refers to the role of the classroom teacher as involving several dimensions. They were to act as "colleagues", being "fully involved in the research process" (Appendix 1.2, p 151). They were also to be participants in an in-service program in order to become familiar with the transposed pedagogy, and then to use it in the classroom.

The actual roles of the classroom teachers within the project were identified by this researcher through observations during implementation of the project. These roles were assigned to teachers at different times during the project. There are three identified roles as explained below

◊ as participant in knowledge and skill development
◊ as research instrument
◊ as collaborative researcher

Participants.

Teachers were to be participants in a program of knowledge and skill development. Teacher development was to take place at workshops led by the university faculty/researchers and teacher trainers as well as invited workshop facilitators such as T. Russell from the SPACE project in England. The teachers were to be introduced to the epistemology and pedagogy that the researchers wanted to test in the classroom.

Research instruments.

Teachers were to be research tools for the university researchers. The researchers involved the teachers as practitioners to test their hypothesis that children would improve their problem-solving abilities if taught in the new way. This was to be tested

and shown through quantitative research methods. The teachers were to use innovative methods to instill problem solving skills and scientifically correct knowledge in the children. The senior researchers would post-test the children.

Collaborators.

Teachers were to be collaborative researchers with the university researchers and teacher-trainers. This involved teachers getting a base-line for the researchers on children's ideas about selected science concepts. Further, teachers were to design by themselves or with help from other teachers, intervention strategies in the form of lesson plans that they would use by themselves. These lessons were to be tried out alone and as demonstrations for peer (cluster) meetings. Teachers were to keep a record of their trial lessons and comments.

5.6.1 Support personnel not familiar with the pedagogy

In Zimbabwe, science pedagogy traditionally came from the colonial authority, Great Britain (Heberden, pers. comm. 1993). Changes in current learning theory were brought back by returning university PhDs educated usually in Britain, the United States, or Canada. New theory and teaching styles could be transferred to the teacher colleges by university sponsored lectures or through upgrading of a college lecturer at the university.

A learning theory such as constructivism, which is still relatively new to the North (see Chapter 2), has only recently been presented to Zimbabwe university students by a few lecturers as an alternative learning theory. The British research followed by this project only published teachers guides and childrens' texts based on their constructivist approach to learning and teaching in 1994. When the project started in 1992, there was very little literature offered to the teachers or support persons except some research reports from the SPACE Project. There was no literature review on constructivism available for the support of classroom teachers. This researcher had to go to other universities to accumulate literature on the Northern background of the epistemology for this transposed pedagogy.

The relative autonomy of teachers' colleges did not encourage quick dissemination of the new education theory (Jaji 1993 pers. comm.). What happens in one college might have no relationship with what happens in another. The science teacher-educators from the two teachers colleges involved in the project were only superficially familiar with the epistemology and pedagogy upon which the project was based (Rayayi and Mudunge, pers. comm. 1993). The library at one of the two colleges did have one of Harlen's books on science learning but the college faculty had not had much time to "come to grips" with what it meant to use this approach to science teaching methods in Zimbabwe. As Rayayi explained

> We have agreed that children are not 'empty vessels' as was thought with pure rote type learning. Most of what we are learning now with the project is new to us and we are beginning to understand how all this new theory fits into and expands the old theories we learned in college. However we have not yet changed our teaching methods to be like the new ones shown by the project...the diagnostic or generative ones. We could only explain to student teachers... because the reality in the schools does not yet encourage too much 'fooling around' with new teaching... the traditional is still used and advocated by the administration ... This is not to say teachers aren't encouraged to teach with experiments...even the syllabus says to use activities to teach... but the way it happens or doesn't happen is dependent on the school situation (Rayayi 1993 pers. comm.).

The Education Officers and Heads involved with the project were not familiar with constructivist approaches. What they understood from previous transpositions were terms such as *active classrooms, enquiry method, discovery method*, and *child to child* learning, but little about the methods themselves. Those interviewed said that the "experimental" aspect of teaching, based on Piaget, was good for the learning stages of the child.

The collaborative teachers felt that school administrators, who were meant to give support, were actually hindering their growth in several ways. First they saw the administrators' role as an extension of the top-down, rigid supervisory role advocated by the Ministry. Secondly they felt that where they should have received some moral support and recognition for their work from the Education Officers and Heads, in practice these persons were simply not informed or interested. When questioned

teachers noted the lack of support but did not immediately admit this lack as a problem. When this researcher's observations were discussed teachers commented " True, only a few times did one of them help with workshops...they seemed to be learning with us... " The following is a more detailed explanation of the possible reasons for this lack of support.

Heads. The Heads were included with the original teachers in workshops in 1992. The original Heads and Heads of the newly assigned schools were sent by the MEC to a workshop in January 1993, the week before teachers were to be assigned from each school. Heads from 50 schools arrived, creating a dilemma for the senior research team. The one day workshop included lectures on the research project and the teaching method. There was no attempt to involve Heads in constructivist activities as explanation. The logistics of dealing with so many new schools took up most of the time. A few handouts were given to the Heads, mostly including the teache-r/researchers' write-ups on childrens' ideas and their proposed interventions to correct misconceptions. There were no write-ups on the theory behind the proposed changes in pedagogy. There was no written material on how to help the teachers, though Heads were encouraged to allow teachers extra time and flexibility in their mathematics and science classes. The workshop in January 1993 was the only one attended by Heads, though a few dropped in on their own at other workshops on at least three occasions. Although they were not invited they were never turned away. The feelings of the Heads has been expressed earlier in section 4.1. To summarize this researcher will use the words of a headmaster: "We cannot help supervise when we don't know what is going on"(Mr H 1994 pers. comm.).

Education Officers. This group of possible support persons was notable mostly by its absence from support-giving activities. The MEC had given permission for the research and indicated which schools might participate. The education officers and district education officers for the areas that included project schools were invited to a one day workshop in February, 1993. This workshop, like the one for Heads, included lectures by the senior researchers on the project. With the recommendation of this researcher, an environmental problem solving activity related to the EAS syllabus was incorporated into the schedule. The reaction of the Education Officers, though at times favourable

to the concept, was absolutely rigid in practice as they refused to allow classroom teachers any self-determination in their classrooms. This was shown in section 4.2 as an external inhibitor of Ministry directives.

5.6.2 Conflicting research paradigms confused teacher change

The following section attempts to analyze the researcher's reflective criticism of the project's mixture of paradigm and methods.

> The power of a paradigm is that it shapes, in nearly unconscious and thus unquestioned ways, perceptions and practices within disciplines. It shapes what we look at, how we look at things, what we label as problems, what problems we consider worth investigating and solving, and what methods are preferred for investigation and action. Likewise, a paradigm influences what we choose not to attend to; what we do not see (Maguire 1987:11).

On critical reflection of her involvement with the project this researcher has come to believe that the most important constraints to teacher change came from the approach used by the project team for inservice. This was rooted in an inappropriate paradigm and methodology and a lack of a full understanding of the change process.

So what is the problem with mixing methods from one paradigm with methods from other paradigms? Vulliamy (1990) reminded researchers preparing to do qualitative research in developing countries of the difficulties that might emerge from relationships "between the epistemology and research techniques" of researchers (1990:9). The argument between theorists has two extremes: (i) those who say that because the basic assumptions of positivist and interpretative or critical reflective epistemology are "fundamentally opposed", there can be no blending of methods from one epistemology with the other, especially of conventional with qualitative; and (ii) the other end of the spectrum, which allows for any accommodation that seems appropriate. A third middle-of-the-road approach allows for a choice of methods from either epistemological base which can then be interpreted within the framework that is preferred. This latter approach is similar to the illuminative evaluation techniques discussed by Parlett and Hamilton (1976).

One of the major objectives of the project was to introduce a change in teaching strategy or style. The UZ researchers said that they agreed with the constructivist epistemology of learning and thus of teaching (Jaji 1993, pers. comm.). So one could say that the underpinning of their research method was a qualitative, interpretative, constructivist world view. Yet their method of helping teachers change was rooted in a type of transmission methodology which was in turn rooted in positivist epistemology. Further, the research on children's change in thinking was to be carried out in only quantitative ways. The argument of this writer is that difficulties arose when *social change* involving *conceptual transformation* was attempted from a positivist, behavioral paradigm. Put simply - the "blend" did not work. This will be discussed further in Chapter 6.

How the positivist paradigm was manifested

The senior researchers often slipped into the conventional academic role of spectator or commentator. This objective role was to allow them to 'observe' as researchers, after finishing their role of teacher-educator. What teachers found disconcerting was that given the limited contact time between teacher-educators and teachers, this spectator role did not allow for the close interaction that they needed. The closeness that is part of participatory research was, for the most part, missing.

The attitude of the researchers to the teachers was friendly, warm and very much of the parent-child variety. This is typical of the positivist paradigm, and of a colonialist attitudes. There was a firm belief on the part of the researchers that failure to perform well on international examinations was caused by the rote learning of students (Hodzi *et al*, 1991, Lewin *et al* 1991). Researchers saw the proposed changes in a determinative way - that constructivist teaching and teaching through use of process skills was what teachers must learn to use. The approach adopted by the researchers consisted of teaching the teachers, who in turn would use the *taught* practice in the classroom facilitating children's use of process skills and generative learning.

Oversimplification of the change process stemmed from a positivist tendency to generalise, thereby not taking account of the uniqueness of *context* and the *individuality*

of teachers. The strength of the inhibitors that are described in chapter 4 was not expected by the researchers again due to this positivist tendency to generalise from one context to another - to transpose a pedagogy developed in one context to another.

The patronising attitude that became evident at times, was not missed by the teachers who later wrote comments such as this in their biographical comments

> Teachers knew more about today's primary pupil than the researchers...but they (the researchers) never knew that" (Mr AC 1994 autobiography).

One outspoken teacher wrote later

> They missed the creative things I do with my kids...they never let me explain how what the project liked about my teaching really was already there...no one used my knowledge and experience. (Mr AC 1994, autobiography)
>
> The project missed the chance to get involved in teacher development by not getting involved with any of the teachers in a personal, biographical or collaborative way. Teachers were (as explained elsewhere) participants in research aimed to measure change in children's ability to do problem solving. Change that we teachers had to undergo was thought up by researchers in England, certainly not evolving from the views of the teachers (collaborative teachers 1994)

The patronising noted by teachers was evidenced further in the control that was always held by the project. Teachers gradually felt frustrated due to lack of any self determination in a project that purported to have collaborative and participatory aspects. Here again, the reality of support persons working within one paradigm while telling teachers to use another, created frustration. Teachers were learning that recognition and value must be given to children's conceptual frameworks in order to begin a change process. Meanwhile their own knowledge, experience and conceptual frameworks were not valued or used. This paradox created an inhibitor to change as teachers resisted or ignored the positivist approach.

5.6.3 Other research priorities slowed teacher development

The priority placed by senior researchers on collection of empirical data for production of scholarly papers put pressure on the teachers to show knowledge and skill development. It had become evident that what the researchers wanted was empirical data from the children that would uphold research results from England. Their faith in the teaching method and its transferability to the Zimbabwe school environment led them to lay the blame for any failure on the implementation of the teaching method within the classroom. Unfortunately for the researchers, the empirical data collection did not give the hoped for results. Pressure to produce positive results had failed to account for the time consuming factors that are involved in teacher development (Fullan and Stiegelbauer 1991; Hargreaves and Fullan 1992). Their emphasis on positivist, empirical research gave the role of teacher as "research tool" a higher priority than their role as individuals involved in teacher development. The teachers' role in this situation was not conducive to change within either an interpretative or critical reflective paradigm.

5.6.4 Failure to engage in true participatory research

It is of course too easy for the collaborative teachers to look back and blame the "project" for their disappointments, just as teachers could be blamed by the researchers. As has been shown earlier, other project-related inhibitors contributed to the failure to involve teachers in a full participatory process. One of the major changes in the original project occurred around the time this researcher joined the team, January 1993. This was a change in size of the working group of teachers from 20 to 80. Unfortunately there seemed to be no way to deal with the increased size of the working group except to change the method of school visits. Many of the new schools were not near the original ones; hence the logistics of travel itself were daunting for the research team. It took two weeks of constant travel for a round of cluster visits, spending only half days at each location. The personal contact with individual teachers was thus cut to almost nothing at a time when teachers, newly exposed to the generative approach to teaching, desperately needed social contact for personal constructive change.

The project team never included more than four persons - with themselves and a few seconded faculty trying to fit in cluster visits between university and other commitments. Workshops were too costly to run every month, so now were held during the three school holidays and gradually changed from a full week to two days. By June the research team realised the impossibility of using this entire group for research. It was decided to include the entire group for a form of in-service at workshops while picking a small group of 20 to work with more closely on the writing of lesson modules.

The development of action research through the writers group did develop during 1994. However, teachers expressed frustration in June 1994 to this writer, that they were not treated as full and equal partners in the writers group.

> Out of over seventy teachers, twenty were picked to write model lessons...but every meeting we were told how to change the format of the writing...we were never part of the decision making...we feel that we are quite able to help in making decisions in this group...after all we are the ones trying our ideas in the classroom... (Mr N 1994 pers. comm.)
>
> The selection of the editors should have been discussed with the whole group to dispel the suspicion of favouritism which now exists. Most writers are convinced - and with a reason - that the selection was not based on merit. (Mr. M. and Mr AC. 1994 pers. comm.)

As shown earlier this was one of the first indicators to this researcher that teachers were in fact developing into critical thinkers, quite ready to take affirmative stands. This researcher recognizes that the relationship within the writer's group had in fact become more participatory during the action research in late 1994 and into 1995.

CHAPTER 6

CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

Environmental education may be communicated using a variety of forms of epistemology and pedagogy, due to its global perspective. The conclusions of a group of collaborative rural and marginalized teachers bring into question the assumptions of researchers and teacher-educators that transposition of a pedagogy developed within one context (in this case Northern) to an entirely different context, is appropriate and possible. The conclusions come from the researcher's discussions with the collaborating teachers. Discussion of key issues from the research follows with recommendations for researchers and teacher-educators involved with educational theory and practice in environmental education.

6.1 CONCLUSIONS

There are four conclusions reached by the collaborative group of teachers and this researcher. The first conclusion involves the transposition of pedagogy developed within one context to another very different context. As has been shown in this thesis, inhibitors to sustainable change within the classroom were very strong, and in many cases not effectively addressed by the project. Inhibitors that were of government-directed nature were identified, as were those originating from the social-economic situation of the immediate and national environment. It was the conclusion of the collaborative group that without attention to these factors, sustainable and appropriate implementation of the transposed pedagogy would not be possible.

Teachers acknowledged that inhibitors due to their limited environmental science subject-knowledge base were more important than they had first understood. As they began to spend much time in researching and preparing lessons for other teachers they began to understand more fully and to more easily admit, the limitations of their environmental science knowledge. These limitations, coupled with a lack of experience with the new pedagogy or the epistemology it was based on, posed difficulties for teachers that could not easily be solved.

The second conclusion reached by the collaborative group involved their self development as individuals and professionals. Teachers decided that, in spite of - and in some cases as a result of - the difficulties they encountered, they had undergone a process of change and development. They viewed this change as very positive and empowering, though within limitations. Through the long process of the *writers group* and the *collaborative group*, teachers agreed that they had begun to lose fear of the unknown subject-knowledge, finding instead a challenge to learning more themselves. Learning theory and different teaching praxis became more familiar and thus less "awesome" as they expressed it. As they began to listen and discuss educational theory, they began to understand the limitations of their background, and to want to learn more.

The third conclusion reached by the collaborative group involved their perception of the methodology used in facilitating the change in pedagogy. As they became more assertive they were more vocal in criticism, and in understanding which methods were most "helpful". In general they decided that methods that "involved us (teachers), and considered our ideas as important...that used the *constructivist* theory the researchers wanted us to use" (Mr M autobiography) were best. Further, they agreed that the closer relationships formed among themselves and with the researcher in the collaborative group actually helped in their self and group understanding. The use of narrative and autobiography was seen by teachers as helpful, especially helping them to engage in self exploration and to express professional thoughts.

A fourth conclusion is based on the subjective insight of this researcher based on her work with these marginalized teachers. The original *quietness* of the teachers, on subjects such as knowledge base and learning/teaching theory, was due to their fear of being pushed out of the research group. There was an intense desire on the part of teachers to be involved, to be seen as worthy and important. Their very limited educational background, which only became evident slowly and most clearly through their autobiographical writing, had presented a strong inhibitor to change. At the same time their personal histories of overcoming obstacles such as poverty and war in their educational and professional lives, had given them the strong desire to continue trying. Through a process of getting to know the teachers, and of letting them get to know the

researcher, teachers were able to express themselves, as is evidenced in the use of their statements throughout this document. There was a fear expressed by some teachers that their *words* would not be accepted or fully understood by persons reading an academic document. This was based again on their limited use of english and of the "education way of talking". To avoid being marginalised and to ensure that readers would "understand and believe us" the collaborative teachers worked on their writing together (except autobiographies) and with this researcher.

6.2 DISCUSSION

The qualitative research conducted here has attempted to provide some understanding of the complex interrelationships of external, internal, and project-related factors that affected expected change in teaching style. By focusing on the process of teacher change within environmental science, this researcher was able to identify inhibitors to change that were subsequently critically reflected on by the teachers themselves. As Fullan and Stiegelbauer (1991) and Vulliamy (1990) have noted it is by

> concentrating on the 'phenomenology of change' (that) qualitative research strategies have a vital role to play in contributing to our understanding of the processes of educational change in developing countries (Vulliamy 1990:20).

Using Fullan's definition of teacher education as social change (1985) this research backs up Fullan and Stiegelbauer and Vulliamy in showing that failing to recognise and deal with how people actually experience change accounts for much failure of social change. The disappointing resistance to change first noted within the UZ Project has become a source of unexpected but potentially important illuminative understanding of teacher education and development in a non-western environment.

This discussion will review the collaboratively identified inhibitors and attempt to put them into the context of other research findings. Recent publications of related research will be used to help explain this researcher's critical reflection on two areas of inhibitors - those from the teachers' environmental context and those arising from the UZ project approach. Finally, recommendations for future in-service and pre-service

education of teachers especially relating to introduction of new pedagogy in environmental education, will be presented.

6.2.1 Importance of contextual inhibitors

Most researched and documented classroom use of constructivist teaching has been in Northern contexts as seen for example in writings by Harlen and Osborne (1985), Robottom (1987 and 1992), Erickson (1991) and Harlen (1992). Research interest in Zimbabwe and other countries has focused on the child as learner, leaving the *educating* of the teacher to be done in more conventional ways. Recent recognition in the North that constructivist praxis was not sustainable in many instances, has led to evaluation of teacher education from a constructivist viewpoint (Ebenezer 1995). The problems and issues that have been voiced as inhibitors to use of the new pedagogy here, are part of what Ebenezer calls the teacher's "conceptual ecology" (1995:103). Ebenezer further contends that if teacher-educators are to implement a constructivist approach in education of these adults, they must put themselves into the place of the teachers, accepting and valuing their problems, before designing pre and inservice programs.

The contextual inhibitors for the rural teachers in this study though valid only for this particular group may also be useful as a starting point for other teaching/learning environments. The first inhibitors that teachers identified were those that came from the directives of the Zimbabwe educational system. National curriculum and national examinations contributed to the administrative top-down system within which the teachers worked. These factors contributed to feelings of powerlessness associated with marginalization. Cultural factors such as use of English as as a technical language as well as a second language were seen by teachers and researchers as strong inhibitors to the increased freedom within the classroom needed for the new pedagogy. Poverty was a powerful inhibitor which extended from the inability of the community to participate in children's education, to the schools' lack of resources. Poverty stood in the way of teachers' further professional development, just as it had shaped their lives so far. Autobiographies were a revelation of the effect of poverty, colonial segregation and war on the shaping of their lives.

Teachers' personal backgrounds were also considered inhibitors and again were influenced by their socio-political and economic histories. The extent of their subject knowledge and roots in traditional pedagogy became easier to discuss as they became more familiar with the researcher and with their own ideas. The relatively unknown level of subject knowledge of the teachers seems to have been a greater inhibitor than expected. It is the opinion of this researcher that the area of teacher subject knowledge, which is being currently addressed in Zimbabwe through several new inservice programs (Kuiper, Heberden, and Engels 1995 pers. comm.) is making assumptions about levels of subject knowledge based on questionnaires asking about "needs", rather than research into teacher concepts. From the limited research done within the UZ Project it is evident that there may be many more basic misconceptions than imagined by researchers and inservice teacher-educators.

A process of enabling teachers to uncover their own conceptual frameworks had not occurred until late in the pedagogical inservice. As teachers explained, "we really didn't know what you meant or what we were doing for the longest time" (collaborative teachers 1994). Thiesson reports that there is a tendency in many projects in the North to "concentrate on developing students while ignoring the complex connections with teacher learning" (1992:85). The importance of a shared understanding and shared commitment cannot be underestimated as explained by both the collaborative teachers here and those engaged in a research project in Canada:

> Now it seems clear that this time period of close to a year was necessary in order to negotiate among one another the unique personal meanings that underlie many of the terms that were used...we were slowly and quite unconsciously forging a set of shared commitments about how best to think and talk about the instances of classroom practice...Without realising it, we were ourselves engaging in a form of constructivist learning as we grappled with the problems of initially communicating our thoughts and actions to each other and later to other educators... (Erickson 1991:233).

The *way* inservice is implemented, is a subject that teacher-educators need to address, if they are to work with teachers who ultimately share their epistomology and pedagogy. This has been discussed earlier in chapter 4.3 as a project-related inhibitor

to change. The relationship to other inservice programs should be considered as of the upmost importance - as being equally important to alleviation of contextual inhibitors.

6.2.2 Preservice and inservice teacher education - what can be learned from research

Transformation from a conventional to a constructivist approach to teaching should involve a progressive-personalistic approach to teacher education (Diamond 1991). Current writing by educators such as Ebenezer (1995), Hand and Treagust (1994), and Erickson (1991) stress the importance of the ideology of teacher-educators/researchers when setting up research that involves inservice of a new pedagogy such as *constructivism*. Two interconnected factors are involved, both evidenced through this research as well as that of the writers mentioned above. First, the approach to teacher education depends on the view of learning held by the teacher-educators. Second it depends on the teacher-educator/researcher's view of the learning environment and the role of the teacher within it, hence the importance of understanding inhibitors. The constructs/world views of the teacher-educators/researchers are therefore most important when considering any form of teacher education. However, as Hand and Treagust (1994) point out, there is very little research so far on teacher or teacher-educator ideas about knowledge areas or educational views.

In the UZ Project teachers were asked to do more than to use constructivist classroom techniques. They were asked to accept the constructivist view of learning and hence of teaching. In requiring this acceptance researchers should have expected an acceptance by teachers and their teacher-educators of the same view of learning. This should involve a process similar to that advocated for the learning environment of the teacher's classroom.

> If teachers are to rethink teaching and learning along (constructivist) lines...they must have the opportunity to participate in a learning community with other teachers and educators similar to the one they are trying to provide for their students (Prawat 1992:389).

Hand and Treagust found in their research that "Examining teachers' thinking is a very powerful means to begin the process of measuring change" (1994:111). Their work with teachers in inservice programs using constructivist perspectives, brought them to the conclusion that the change process in teachers was complex, slow, and involved starting with a focus on self-constructed understanding before focusing on approaches to classroom practice. Their work backs up earlier writings of Erickson on constructivist in-service. Erickson again stresses the slow process which he emphasizes must include collaboration between teacher-educator/researcher and teacher. The result is a situation of "shared beliefs and values about how people learn" (Erickson 1991:237).

Teacher education as transformation. Prawat, Beattie, and Diamond use the term "transformation" when discussing constructivist learning.

> To learn about professional practice and to develop as professional educators requires that we engage in the making of new forms, new relations and connections and by continually transforming what we know (Beattie 1995:66).

Diamond (1991:8) explains what he means by "transformation" as the goal of pre- and in-service education or "the transformation or the critical retheorizing both of teacher's perspectives and of teacher education." He further explains his meaning of learning as transformation for adults and teachers in this way:

> Perspective transformation...involves helping beginning and experienced teachers to gain access both to their own and alternative meaning perspectives from which to interpret reality...(It) consists in the reorganization or confirmation of cognitive structures in the light of experience. As a shift in world view...or preferred way of perceiving reality (Diamond 1991:16-17).

The process of perspective transformation Diamond argues is important because it provides a teacher who has altered an "initially non-reflective consciousness by emancipatory action," thus "enlarg(ing) first his/her awareness and then his/her capacity to direct it more fruitfully" (1991:17).

6.2.3 Commentary on research methodology

> There is power in being able to tell your story and hearing others tell theirs. Sharing experiences triggers some life, some anger, some need to create change (Kirby and McKenna 1989:170).

The research methodology evolved and changed as the focus of the research changed. As this researcher tried to make sense of frustration and disappointment in the research project she began a process of critical reflection, which led in time to the involvement of the collaborative teachers' group. As has been seen throughout this thesis, the identification and explanation of inhibitors to change became a group effort. There was a struggle to understand and explain the complex issues and interplay of numerous factors within both the learning environment and themselves. The process of individual and group critical reflection on the social reality of teaching and learning in rural Zimbabwe became, for those involved, a time of self understanding and development. Cooper points out when speaking about the use of narrative that it gives "form to our experience" as a way of encouraging ourselves to enter a "caring" relationship with the "self" (Cooper 1991:96). Though the process was sometimes almost painful, the collaborative group admitted to feeling "empowered" - at least to the point of being able to express their opinions, if not yet able to solve the problems they identified.

The question of *context* for transposition of pedagogy brought teachers and researchers to a further discussion of North-South context differences and their position "on the margin"(Kirby and McKenna 1989). Besides the marginalization imposed on them due to their poverty, they felt an inequality and powerlessness within their professional lives, including their present role in the research project.

The group discussed the importance of working together and "speaking together to the outside world". An opportunity to "speak to those who make decisions...to those who advocate new teaching style" (collaborating teacher 1994) was very important to the group. The rationale for use of teacher comments and autobiography came from this strongly expressed desire of teachers as well as this researcher's belief that looking at

change from inside the "marginalised community," the teachers, would be most appropriate to both understanding and action.

Learning about participatory research

> Participatory research offers a partnership: We both know some things; neither of us knows everything. Working together we will both know more, and we will both learn more about how to know (Maguire 1987:37).

What was happening in the collaborative group was, this writer believes, participatory research. The inability of the UZ Project to fully implement participatory research was overcome in this instance. The action research methodology shown in chapter 3 was not participatory as it treated the teacher as *practice* more often than as *person* (Goodson 1992). It is important in Goodson's view and that of Maguire (1987) to be very aware of the tendency of the increasingly popular "action research" to be practice oriented and grounded in conventional paradigms. Participatory research, by contrast, may be "action" research of a type but concentrates on the involvement of persons more than on practice.

Democratization of the research process can only happen when there is firm belief, by all involved, in both the capacity of the participants to contribute meaningfully and their capacity to be personally transformed (Maguire 1987). This writer is convinced that this method was more transformative than using more traditional ways of identifying inhibitors. Rather than reliance on questionnaires teachers engaged in narrative and personalized group discussions. By personal involvement in the creation of knowledge about inhibitors teachers were actually involved in critically reviewing their own view of learning and educating (Diamond 1991).

Familiarity with teacher responses in conversation and questionnaires over time including finally the intersubjective dialogue of the collaborative group has convinced this writer that many of the early responses were influenced by the marginalization of those being researched. For example the "tell you what you want to hear" or "double-think/double-speak" scenario did occur when persons were being formally interviewed

(Kirby and McKenna 1989) (collaborating teachers 1994 pers. comm.). The collaborative group discussed their marginalised position and their feelings that what they said might get them in trouble. This conscientization of all participants, including this researcher, enabled teachers to talk openly and search for answers. This also resulted in a higher degree of validity of what was said within the group.

Perhaps most important for this researcher is the growing realization that *alternative* research methods are critical to understanding of complex social problems, such as teacher change or transformation. The form of research should be guided by all those involved, and be flexible to include different methods which may be illuminative or socially transformative. The collaborative and narrative style that evolved in this research provided something beyond illumination of inhibitors to change. It began to help the developing or transforming of the teachers and in the process they became much more self-assertive. The fact that social process also implies political process, that empowerment may mean going against the status quo, are added challenge to the researcher to be accountable to those whose voice she seeks to represent.

Taking risks and being honourable. One of the most personally constraining factors for this researcher throughout much of her association with the UZ Project was the uncomfortable knowledge that all the *risk taking* was on the side of the co-operating teachers. As explained in chapter 4, the researchers were working within a traditional paradigm. In such a paradigm the researcher/facilitator remains *separate*, unconnected to the objects or person-subjects of the research. Research and education that gets close - that delves into the lives and human development of teachers as persons - cannot honestly remain detached. The researcher/educator who believes in the conceptual framework he/she advocates, must also bear the responsibility that goes with the use of its methodology.

If one believes in a constructivist way of learning and teaching (as did the UZ Project proponents), one must then place real value on the conceptual framework of the teachers. This must include all the indigenous beliefs and ways of communicating - the non-northern scientific, cultural, professional and life precepts that guide the teachers classroom practice. Further the researcher/educator must go beyond a simple

acknowledgment that learning is socially constructed. He/she must be ready to risk personal involvement of his own conceptual base through engaging in a closer relationship with those he is educating than is usual in traditional education. This will often mean that both researcher/educator and teacher become open to trading, hassling over concepts, and learning. The loss of power that teachers feared was due to their anticipation of using constructivist principles in the classroom, and was just as real in the potential relationship between researcher/educator and teacher. It was the experience of this researcher that researcher/educators within the UZ Project did not risk loss of power, because they remained separate from the teachers, even when providing group work or other potential *close* relationships designed to facilitate change.

Participatory research, problem solving and accountability. It is the belief of this researcher that, especially in working with marginalized teachers, it is critical to be very cognisant of and honest in the use of power given to the researcher by the persons on the margin. One aim of environmental education is providing the learner with enhanced ability to solve environmental problems. Participatory research may be viewed as a problem solving activity which can enhance the ability of all those involved, to "investigate..educate... and take action" (Maguire 1987:29). During the process of research the direct link between research and action may encounter inhibitors beyond the ability of the group to overcome. It may then become the responsible role of the researcher to help encourage transformation of societal or government structures and relationships. In the instance of this research, though teachers were conscientized and initiated into problem solving processes the barriers (inhibitors) they encountered were outside their control and were not attended to. As said before in this discussion, this researcher believes it is important to challenge the status quo of ministerial directives and inequitable reward systems for teachers, in an effort to be accountable to the participants in the research - the teachers themselves.

6.3 RECOMMENDATIONS

The recommendations of this writer to researchers and teacher-educators in environmental education are based on research findings and comparisons with other

current research on implementation of constructivist pedagogy. It is recommended that in considering the transposition of a pedagogy from a western to non-western context there should be in-depth consideration of

♦ the context or environment within which the pedagogy was developed *and* that in which it is to be transposed. A broad definition of environment/context should be used. This consideration will involve questioning which contextual factors will affect implementation and to what degree. It may mean looking closely at traditional (including indigenous) communication and education systems - how they differ from the proposed pedagogy, their effectiveness, and their possible adaptation or inclusion.

♦ whether this pedagogy is appropriate to the new context. This will involve questioning the prevalent epistemological views, including both educational and socio-political views. Educators must be actively involved in the process of questioning, comparing and decision making to ensure contextual validity. Again, as with the first recommendation, this will need to involve close comparison with traditional, indigenous ways of communicating knowledge and problem solving processes.

♦ the importance and form of implementation that is needed in pre- and inservice programs. The success of implementation will depend to a great degree on whether the teacher's learning has been addressed as carefully and in the same manner as that advocated for the students. The complexities of teacher learning must be addressed. This may mean broad changes to the current teacher-education pedagogy in many tertiary learning environments.

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PERSONAL COMMUNICATIONS

Teachers quoted in this thesis have expressed their wish to remain anonymous. Comments from teachers are given references such as (Mrs G 1994 pers. comm.). To personalize the quotes they are identified by gender - again according to direction given by them to this researcher. In accordance with the wish of teachers to be clealy understood by an academic audience they worked with the researcher to "polish" or "make clear" what they meant. The statements are in accord with what they said though the speach may seem too "educationalist" as they put it.

Heads and Education Officers expressed the wish to be anonymous.

Brown, S. 1993. Visiting researcher from Philadelphia, attached to the UZ Project 1993.

Dembezeko, C. 1993. Education Officer with Curriculum Development Unit of the Zimbabwe Ministry of Education and Culture, Harare.

Heberden, R. 1993-1994. Education Officer with Curriculum Development Unit of the Zimbabwe Ministry of Education and Culture, Harare.

Hodzi, R. 1993-1994. Head of Department, Department of Science and Mathematics, University of Zimbabwe, Harare.

Kuiper, J. 1994-1995. Research Fellow, Department of Science and Mathematics, University of Zimbabwe, Harare.

Jaji, G. 1993-1994. Professor, Department of Science and Mathematics Education, University of Zimbabwe, Harare.

Mudunge, J. 1994. Head of Science Department, Seke Teacher College, Seke.

Mtetwa, Dr. R. Lecturer in Mathematics, Department of Science and Mathematics Education, University of Zimbabwe

Rarayi, A. 1994. Head of Science Department, Nyadire Teacher College, Nyadire Mission.

APPENDIX 1

APPENDIX 1.1

Executive Summary of the following report:

Deutsche Stiftung für internationale Entwicklung

German Foundation for International Development

DSE

MINISTRY OF EDUCATION AND CULTURE

ZIMBABWE

TEACHING AND LEARNING IN ENVIRONMENTAL AND AGRICULTURAL SCIENCE: MEETING BASIC EDUCATIONAL NEEDS IN ZIMBABWE

AN EVALUATION

by

Keith Lewin, Sam T. Bajah
et alii

EXECUTIVE SUMMARY

1. Since 1982, the Curriculum Development Unit (CDU) of the Ministry of Primary and Secondary Education (now Ministry of Education and Culture), Zimbabwe and the German Foundation for International Development (DSE) have been and are positively affecting environmental and agricultural education in the existing 4,400 primary schools.

   Successive writer-educator workshops (1982-1986) facilitated the writing of a total of 22 resource booklets for teachers (grades 1-7) and 4 resource booklets for pupils (grades 4-7) to help implement the teaching/learning of Environmental and Agricultural Science in primary schools and primary teachers education colleges.

   In 1987 and 1988 workshops at regional and district level tried to disseminate the resource materials and to create an awareness amongst inspectors and teachers for the importance of EAS in primary education.

2. The purpose of this evaluation is to appraise the development and implementation of EAS in terms of patterns of use of the curriculum; the impact of EAS teaching and learning; the availability of material resources for EAS; and the effectiveness of the curriculum development process.

3. The findings are collected together under eight headings: teachers of EAS; patterns of teaching and learning; the syllabus; textbooks; support for teachers; equipment; assessment; and the impact of EAS. Recommendations are then identified concerning the syllabus document; curriculum materials; distribution; examinations; training; and the future of the MEC/DSE collaborative programme.

F I N D I N G S

4. Teachers of EAS

In the schools we surveyed nearly 70% of teachers had "O" level qualifications, though these did not necessarily include Science. 41% of teachers surveyed held a Certificate of Education, with 31% holding lower training awards; an additional 17% were untrained (compared to 42% nationally). The number of untrained teachers was greatest in rural district schools (36%), farm schools (34%), and mine schools (17%). Those with least formal schooling teach the lowest grades - 73% of those with grade 6 and 52% of those with ZJC educational levels are teaching the lowest grades. Unqualified teachers are concentrated in grades 3, 4, and 5 (69% of unqualified teachers). The progression in level of profes-

sional qualification from grade 1 to grade 7 teachers is very striking - 37% of grade 1 teachers have a Certificate of Education or above; 65% of grade 7 teachers.

5. The teachers were evenly split between males and females (49/51); they were not evenly distributed between schools however. Rural district, farm, mine and mission schools had between 59% and 66% male teachers; urban high and low density schools had between 30% and 34% male teachers. Female teachers are heavily concentrated in the lowest grades - 89% in grade 1 reducing stepwise to 18% in grade 7. Over 90% of head teachers were male.

6. **Patterns of Teaching and Learning**

The analysis of patterns of teaching observed showed that the largest amounts of lesson time are devoted to class discussions, questioning and pupils undertaking an activity. Class discussions rarely seem to involve much input from students. They tended to be teacher centred with little negotiation of meaning between teacher and taught; they involved a lot of teacher talk and not much discussion. Questioning strategies most commonly employed require one word answers given individually or in unison. It was rare to come across linked sequences of questioning that developed a line of reasoning. It was also unusual for the course of lessons to be altered by "wrong" or unexpected answers to questions.

7. Class and group activities did occur and some practical activities were genuine "look and see" exercises. Very few were class experiments involving testing out propositions. We did find examples of good activity based lessons, but this skill seems to be employed by a minority of teachers who were able to integrate an activity into a learning sequence. Though "investigating" and "experimenting" appeared often in schemes for teaching, pupil's work showed little evidence of this. It should give some grounds for concern that 42% of pupils in the survey prefer teachers to undertake activities rather than doing them themselves. Some teachers indicated that students did not learn much from working in the garden. Disturbingly 39% of teachers in the survey indicated that pupils are mostly used as workers, not learners, in the school garden and 43% indicated that they did not go there often.

8. Teacher talk seems dominant in the lessons with pupils contributing only as a direct response to questions. Writing tasks tended to be stereotyped exercises involving sentence completion exercises with little opportunity to develop powers of expression. Paper was short in some schools and limited the amount of writing that could occur. Reading was

generally restricted to the relevant pages in students' texts. Blackboard work most commonly involved writing words to be remembered and/or sentence completion exercises to copy. Diagrams were only drawn by a few teachers. Many of the case study lessons observed involved listing things - the uses of water, the causes of pollution, the names of seeds - without conscious effort to develop skills like classification or relate ideas conceptually. The pupil's questionnaire showed that fully 81% of pupils thought that there were too many facts to learn in EAS. Teaching we observed tended to be discrete, with links to material in previous lessons infrequent, and an emphasis on content and definitions rather than process skills or enquiry.

9. We came across a certain amount of overlap in the treatment of topics from year to year and between EAS and Social Studies and teachers commented on both problems. Thus the treatments given to some parts of the course, which recurred in the spiral curriculum, in some cases simply repeated the same kind of material as had been taught before. The health and geographical aspects of Social Studies seemed to be treated by some teachers as if they were "the same" as the EAS treatment. A clear sense of progression in difficulty and conceptual demand towards the older grades was elusive.

10. Though EAS is intended to have 5 periods allocated a week from grade 3 our case study data suggest that often only 3 of these periods are taught. In almost all of the case study schools EAS was taught late in the school day. The early periods were reserved for Languages and Mathematics.

11. **The Syllabus**

Fully 96% of teachers reported that a syllabus document existed in their schools. Only 33% indicated that syllabus documents were available to them in the classroom however. On average 4.9 syllabus documents were available per school. 46% of teachers thought that there was too much content to be covered in their grade.

When we requested suggestions for the improvement of the syllabus the most frequent responses were requests for more suggestions for pupil's work (35%) and more explanation of content (19%).

12. It appeared that the most common pattern of use of the syllabus was for "scheming" at the beginning of term, with no further use until the following term. Much "scheming" seemed stereotyped, and was content not process orientated. Records were conscientiously kept. We note that 58% of teachers preferred to use textbooks rather than the syllabus

in planning lessons though these do not always follow the syllabus closely. Seasonality appeared important for some teachers' planning to ensure topics were covered when natural materials were available.

13. Most teaching sequences did follow the syllabus quite closely. Whilst this was true for individual units of work, we found examples where core topics were omitted from a grade and where there seemed no particular rationale in the order in which topics were treated. Many of the teachers we interviewed were unable to identify clearly core topics for their grade or explain how they differed from optional ones. Several teachers referred to the CDU Teacher's Book or other EAS materials as the "syllabus" indicating confusion between materials.

14. Our analysis of the syllabus highlighted difficulties with the syllabus in terms of its presentation, sequencing, language level, and some aspects of its underlying structure. We have therefore made recommendations relating to these.

15. **Textbooks**

We asked about the availability of the three types of teachers' guides and pupils' texts - CDU, Longman and Ventures (College Press). Head teachers indicated pupils' books were not sufficient for grades 1-5 (60%) and grades 6-7 (50%). Between 20% and 30% of schools had insufficient teachers' guides according to the heads. 72% of teachers had no CDU teachers' guide. The majority of teachers had either Longman's or Ventures' teachers' guides. Pupils' texts available were far less than the number of students. 79% of teachers had no CDU pupils' books; of those who had these only 2.2% of teachers indicated that they had more than 10 copies. 57% did not have the Ventures' materials; of those who had 11.1% indicated that they had more than 10 copies. 49% did not have the Longman's pupils' materials; of those who had 14.3% indicated that they had more than 10 copies. In our survey the majority of teachers say that lack of teachers' guides (54%) and lack of pupils' texts (61%) hampers their teaching. In the survey heads indicated strongly that EAS books need to be improved (81%).

16. We asked teachers to identify those topics that were easy and difficult to teach and those liked and disliked by students. Those most frequently identified as easy and liked were Water, Soil and Health. Those most frequently identified as difficult to teach, and disliked by students, were Sun and Cosmos, Infrastructure, Landforms, Machines. Fuel and the Veld were also regarded as problematic. The reasons identified for the difficulty of teaching topics clustered around two main observations - they were difficult to

understand (22%) and there were insufficient teaching aids (27%). Pupils' activities not being practicable (18%) also attracted significant responses. The case study interviews strongly reinforced the view of these elements of EAS as being difficult for teachers and pupils.

17. Our analysis of curriculum materials strengthened our views on the need to consider their revision carefully. These are detailed in the Report. In particular we note that CDU materials require finalisation in ways which eliminate problems of sequencing and syllabus matching, clarify learning objectives for topics, reduce content in favour of more emphasis on the cumulative development of process skills, ensure the accuracy of Science concepts, and provide easier access to teachers and pupils.

18. **Support for Teachers**

Two thirds of heads and teachers say that their school has an EAS subject team or committee. However only 39% are members of these groups. 40% of heads and 44% of teachers reported no meetings in the first term of 1990. The case studies indicated that EAS subject and content groups did not seem to function effectively in many of the schools. In some, all the general paper subjects were combined, adding to confusion about differences between them. There were however some cases where these groups were very active and helpful. There seems to be scope for written material to assist the activities of these groups and advise coordinators on how best to organise them.

19. Practice on supervisory support varied widely. A good proportion of teachers had not been observed teaching EAS; those that had generally spoke appreciatively of the experience. Head teachers were the most likely observers. Some DEOs and EOs observed teaching in a minority of the schools visited. A good number of teachers in the case study schools had experienced some in-service support over the last five years. Generally they spoke well of it and requested more opportunities. More than 10% of the teachers in the survey sample claim to have attended a course at circuit, district or regional level. When asked to indicate how in-service courses could be improved three responses were most common - more practical demonstrations (34%); more experienced resource persons (26%); and more time spent on syllabus interpretation (17%). Heads identified the same categories and 85% indicated that they wished to see improvements in EAS in-service courses. Our observations of teachers in the classroom led strength to our conviction that though materials' development and distribution was a high priority, complementary in-service efforts were needed to assist in changing classroom practices towards the aspirations of EAS materials.

20. **Equipment**

The survey of heads drew a strong response on the lack of equipment for pupils' activities (79% of schools); also stressed were lack of teaching aids (74%), and lack of storage space (60%). 57% of teachers said that it was difficult to do practical activities because of lack of resources. The case study data repeatedly illustrate the paucity of equipment available for the teaching of EAS. Most schools have little or no equipment specifically for use with the subject. There is also some widespread misunderstanding of what equipment is needed. Several heads indicated that they had thermometers in the school, but these turned out to be maximum and minimum thermometers unsuited for many activities; anemometers were requested though these would be expensive and only useful for one purpose. When EAS equipment exists it is kept by most teachers in the open classroom (57%), classroom cupboards are only available to a minority of teachers (25%). A small number (9%) use a storeroom and the head teacher's office (3%).

21. It was refreshing to see some attempts at improvisation in some schools where teachers were creatively using old cans and other local materials. But this was the exception rather than the rule and there seemed to be very limited sources of advice on the improvisation of science equipment available within schools. Classrooms in the case study schools generally had some decoration using students' work. Very little of this was EAS related. Posters and charts for EAS were also very scarce. We have suggested that a systematic revision of the EAS materials should assess equipment needs when activities are selected and should seek to minimise these. Improvisation suggestions should be included.

22. **Assessment**

The most common forms of testing in EAS are sentence completion and multiple choice questions. Teachers were asked to indicate the main methods that they used and 37% indicated sentence completion and 37% multiple choice. The case studies illustrate that multiple choice testing and sentence completion are indeed the dominant methods of assessment. Practical assessment does not seem to be attempted, and exercises involving expression seem rate. Many teachers are concerned about assessment, particularly with the introduction of EAS items in the General Paper. Most head teachers thought that the grade 7 examination will encourage teachers (97%) and pupils (87%) to put more effort into EAS. 45% of heads felt that the examination would increase the cramming of facts and a larger number of teachers (62%) expressed the same sentiments. We note with concern that 76% of pupils believe that to do well in EAS you only need a good memory, contrary to the orientation of the EAS curriculum.

23. The General Paper contains items on a mixture of subjects that do not rest easily together - Religious Education, EAS and Social Studies. The type of reasoning required by the different subjects and the educational goals are qualitatively different. We have noted above some confusion between Social Studies and EAS in the schools. The practice of having a single paper which does not, at a minimum, have clearly identified separate sections for the different subjects seems to us to be detrimental to the implementation of EAS.

24. Our simple analysis of the twenty EAS specimen items suggests that the great majority operate at the level of recall and do not require higher order cognitive skills. This is inconsistent with the learning objectives outlined in the syllabus. Over time we would hope it will be possible to introduce a higher proportion of items which utilise scientific thinking skills and the kind of conceptualisation that EAS promotes. The format of items could make more use of data interpretation items, observation based on diagrams or photographs, and items where necessary information is supplied, not recalled, and where students are asked to utilise it to identify correct conclusions.

25. **The Impact of EAS**

The development of EAS does seem to have had a number of effects. Many teachers believe that children are learning ideas in EAS that they did not before. A good number also argued that the teaching of the subject had encouraged more activity based teaching and less lecturing though we could not confirm this was the case. Several informants observed that some knowledge from EAS was filtering into local communities and some examples are provided in the full report. Our evidence does suggest to us that EAS has had a worthwhile effect on both what is taught and how it is taught. Thus more Science is being taught than in the past; students' exercise books show evidence of Science knowledge being acquired and the subject is regarded as enjoyable by them; and some practical work occurs. However, much of our evidence suggests that full implementation of EAS has not been achieved: many teachers seem not to fully understand its content and organisation; text materials and equipment are in short supply and significant numbers of heads and teachers are ambivalent about its benefits.

26. Heads' opinions on whether EAS was an improvement over separate subjects were positive but a significant minority (36%) felt that it was not. Teachers were less sure with 45% unfavourably disposed towards the change. 50% of heads also felt that EAS did not provide an adequate foundation for Geography, Science and Agriculture in the secondary schools. This suggests that there is still a problem of commitment to EAS amongst a significant group of teachers. About half the heads felt EAS should be given more time in the curriculum. 29% of students indicated that their parents did not want them to study EAS.

27. Our students' questionnaire showed that EAS had made little headway in popularity when compared to other main subjects. Only 5% of students identified EAS as their favourite subject compared to 38% for Mathematics and 43% for English. Perhaps surprisingly Shona/Ndebele were only marginally more popular (7%). On the positive side the great majority reported enjoying EAS (87%) and found it interesting (85%); 74% said EAS would be useful to them in future, and only 34% said they did not like EAS.

R E C O M M E N D A T I O N S

28. **The Syllabus Document**

(a) Its format needs to be simplified and the language used made more accessible to average teachers many of whom are unqualified.

(b) Its structure needs reconsideration to increase its coherence, reconsider the sequencing of topics, and make its underlying conceptual structure clearer.

(c) It should abandon "core and options" in favour of a single progression.

(d) All topics should not necessarily be taught to all grades and a judicious selection should be made to rationalise content and match it to the capabilities of pupils and teachers.

(e) Consideration should be given to publishing the syllabus in two volumes (grades 1-3 and grades 4-7).

(f) Relevant parts of the syllabus document should be included in each grade's teachers' guide books to encourage a developmental view of topics amongst teachers.

29. Our evidence suggests that radical redevelopment of the syllabus document is unnecessary and would be counter productive. We therefore strongly recommend that the Syllabus Review Committee considers an incremental approach to revision. Since what we suggest will preserve the majority of topics and their underlying rationale we would hope that other important work, especially the finalisation of CDU materials, can proceed in parallel with this activity.

30. Curriculum Materials

The large amount of work involved in producing the pilot materials should now be consolidated. The existing revised manuscripts need considerable work to bring them to publishable quality. The magnitude of this task should not be underestimated. The standard required of revised materials will have to be at least comparable with, and we would hope better than, texts available in the market place. Their production should be placed on a realistic time schedule which is likely to be met. We propose that the task is approached in several phases:

(a) The manuscript drafts of the books should be checked for completeness, match with the syllabus, scientific accuracy, presentation, and graphic designs/photographs needed should be specified and equipment demand should be minimised (see Chapters 3 and 4).

(b) We suggest that the revision is focused on the two cycles, grades 4-5 and grades 6-7 and that composite teachers' guides are considered, one for grades 4-5 and one for grades 6-7, whilst publishing separate pupils' texts for each grade.

(c) We argue that the materials should be finalised for grades 4-5 first, then for grades 6-7.

(d) We feel that a composite teachers' guide might be considered for grades 1-3 after the higher grade materials have been finalised.

(e) When clear decisions have been taken on the matters outlined above, we recommend that a full time editor is appointed to coordinate and bring to finalisation the production of the revised materials. It will be necessary to exert firm overall editorial control, whether or not some of the work is subcontracted, and this will require the undivided attention of a scientifically and editorially competent staff member.

(f) The mechanism of production and distribution of the teachers' guides needs to be considered carefully. One option for which we understand there are precedents is to enter into an agreement with a commercial publisher to co-produce such materials exploiting the comparative advantages of the CDU and publishers.

(g) To be effective we would propose that a target is agreed for book production. The original modest target of three full sets per school strikes us as a minimum.

31. Finally we would suggest that appropriate equipment in the form of a low cost desk-top publishing facility is acquired by the CDU and dedicated to this use alone for the duration of the revision of EAS materials.

32. **Distribution**

We are concerned about the pattern of distribution of learning materials. These are unevenly available as our data show. The current system of financing textbook provision is not adequate to ensure widespread distribution.

33. We therefore suggest that an agreement is reached with a commercial publisher to print large numbers of texts and that this is linked to a negotiation of the price to the lowest possible level consistent with reasonable margins. This might involve subsidising production and the basis for this requires closer examination.

34. We also see attractions to the development of a special scheme to finance the purchase of books for the most deprived schools. Such schools can be identified from existing MEC statistics according to a relative deprivation index. We would suggest targeting between 10 and 20% of the most deprived schools for free text book provision in the first instance (i.e. 450 - 900 schools). We would further advocate incentives in the form of matching funds for textbook provision that multiply the number of copies for a given amount of money committed from school budgets which might apply to larger numbers of schools.

35. There is a strong case based on equity for this approach. The GOZ is committed to providing education at primary level to all its citizens on as equal a footing as possible. Schools which are underestablished (i.e. have unfilled teaching posts), and have a high proportion of unqualified teachers, have much lower unit costs than those that are fully staffed with qualified teachers. Some of the salary savings which are currently made should be redistributed back to these schools so that conditions in them improve. Allocating free textbooks would be a small move in this direction.

36. **Examinations**

The new primary school leaving examination will be critical to the effective teaching of EAS in the higher grades. It is imperative that the examination tests, as far as practicable, the skills that the EAS curriculum is designed to promote.

37. To this end we recommend that a training workshop for item writers be mounted during the next year to develop a bank of suitable items, and to consolidate the skills of effective item writing amongst team members taking advantage of the most recent techniques. This we suggest lasts for at least three weeks. In the medium term training at Master's level of a member of the CDU/Examinations Department in the assessment of primary students should be considered.

38. We also suggest that, complementary to the objective of improving the quality of the EAS examination, serious consideration should be given to providing active feedback to teachers (possibly through the national monthly "Teacher's Forum") on the performance of students on different types of item. Examination analysis should also be developed as a powerful in-service and supervisory tool.

39. Since we regard the examining system as critical to the teaching of EAS in the higher grades we suggest that consideration be given to examining the subject separately from the General Paper, and placing it as equivalent in status to National Language, English and Mathematics. If this is not possible in the short term, at a minimum EAS items should constitute a separate, clearly identified section in the General Paper.

40. **Training**

It is suggested that a Review Committee is established, composed of representatives of both Ministries, the Teacher Training Colleges and the University of Zimbabwe which validates college courses, to examine how EAS should be integrated into training college curricula and how best resources can be provided to this end.

41. We recommend that future in-service courses should be competency based and take teachers through a sample of teaching activities for each grade step by step. Trainees should be expected to work through topics themselves and present lessons to colleagues for constructive criticism. In-service workshops should also be used to generate learning materials (charts, improvised equipment) for EAS.

42. A targeted in-service programme is therefore proposed for key teachers and DEOs. There are 55 educational districts in Zimbabwe. A strategic plan is needed to ensure that at least one DEO in each region has received sufficient EAS training in depth to be able to catalyse in-service activity for the subject at the district and lower levels. Full use should be made of the potential to utilise the resources of teacher training colleges to support in-service work at the regional level.

43. Within such an in-service programme careful thought should be given to its extension below the district level into the schools. District representatives should be encouraged at in-service workshops to devise strategies to promote EAS in their district and required to report back regularly to colleagues and superiors on the progress being made. The scale of this exercise will depend on the resources made available.

44. All staff involved in EAS in-service should be provided free with a full range of text materials and teaching aids as a small incentive to take part.

45. **The Future of the Collaborative MEC/DSE EAS Support Programme**

This Report provides a thorough analysis of the achievements of the programme to date. These have been substantial and a measure of success has been achieved in pursuing project goals. Pre-tested materials exist, draft revisions are underway, writing workshops have involved large numbers of educators and in-service workshops have reached out to substantial number of teachers. The bilateral support provided by the DSE has complemented the MEC's substantial support for the development of EAS and has facilitated a higher level of activity than would otherwise have been possible. We see a continuing role for this support to bring to fruition the investment that has taken place to date.

46. The development of the programme has not been as rapid as originally anticipated and we understand the many good reasons for this. We therefore feel that future planning should make realistic estimates of the time necessary to achieve targeted outcomes in the next cycle of development for EAS, based on the experience of the past and the resources likely to be committed.

47. As part of this planning process we suggest that joint discussion be held between the MEC and the DSE to explore the implications of our recommendations. These we would anticipate should generate agreement on those recommendations that will fall within a continued programme of support and those which are to remain the sole concern of the MEC.

48. Without wishing to anticipate the substance of such discussions our analysis suggests that the most fertile areas for collaboration may be selected from those indicated below:

- Support for the appointment of a full time editor to finalise and publish the EAS materials to a satisfactory level of quality within a timescale of the order of two years.

- Hardware provision (desk top publishing system for the CDU) to expedite the design of high quality learning materials to pre-publication standards.

- Tailored financial assistance to expedite the production of agreed numbers of teachers' and pupils' texts for distribution to schools within a system designed to positively discriminate in favour of those schools most disadvantaged.

- Assistance with the development of curriculum sensitive examination item writing through workshop activities designed to lead to the creation of an item bank, and in the medium term, performance-related feedback to schools based on detailed pedagogically-orientated analysis of examination data.

- Seedcorn backing to nourish the development of competency based training methods for in-service activity.

APPENDIX 1.2

The UZ Proposal:

Children's Scientific and Mathematical Problem Solving Strategies and Teacher Support Models: An Action Research Proposal

Submitted by the University of Zimbabwe

Project Directors

i. Dr. Richard Hodzi, Chairman
Department of Science and Mathematics Education
ii. Prof. Gail Jaji, Senior Lecturer
Department of Science and Mathematics Education
iii. Ms. Ros Herberdeen,
Curriculum Development Unit, Ministry of Education & Culture

Total Amount Sought
US$302 068
(Exchange rate as of 27/3/1991; 2,94Z$ to 1 US$)

Duration of Project
3 years

Proposed Start-up Date
~~July~~, ~~1991~~ Jan.

PROJECT SUMMARY

Project Outline

Objectives

Aims of the current science and mathematics syllabuses for primary schools in Zimbabwe stress the contributions the disciplines can make to national development. Not only the attitudes and problem solving skills associated with science and mathematics, but also the skills commonly associated with technology are seen to be vital to development. However, the necessary teacher support systems such as teachers guides and pupils books; equipment and materials, and in-service teacher support mechanisms have not yet evolved sufficiently to make the desired impact. Furthermore, though new skills and knowledge have been introduced to the syllabus, little cognizance has been made of the ways that children themselves think about science and mathematics as they develop through their time at primary school.

This study will look at the development of children's problem solving strategies within the primary school population as well as at those factors most conducive to their development. Some of these factors will relate to teachers classroom practices; others to the school environment and finally, those that relate to basic teacher support systems.

The basic objectives are to explore the possibilities of children doing more than receiving information and teachers doing more than transmitting it, by offering the latter involvement and ownership of the techniques developed. There are existing instruments and methods which could be adapted to local needs.

It is strongly advised that in order to maximise local relevance, the following factors should be brought to bear: the research personnel should be teacher trainers and curriculum developers; the subjects of the research should be teachers/teacher trainees and children in their normal classroom settings; the research and data collection should be collaborative, with teachers taking a major responsibility and providing feedback about classroom viability; the instruments should focus on first-hand classroom behaviours rather than surrogate variables; the subject matter of the enquiry should be drawn from the syllabus used by teachers and children. The results will then have direct implications for teacher training, INSET and curriculum development.

The research will be part of an integral programme of establishing baselines from which development can proceed. This baseline will include the identification of good practice which may be recorded as case-histories for dissemination within the programme. The project should not depend on assumptions that such good practice is widespread; the evidence from other countries suggests that the

shift from 'passive' to 'active' learning has profound training implications. The emphasis should therefore be on:

1. clarifying objectives in terms of children's procedural and conceptual knowledge in primary science and mathematics; this is likely to include helping identified groups of project teachers with a clear understanding of what such understanding entails.

2. undertaking empirical investigations which serve to describe the current teaching/learning state of affairs in classrooms, in respect of the above objectives.

3. observing and supporting groups of project teachers in developing and testing classroom strategies which serve to enhance learning.

The Context: Mathematics and Environmental and Agricultural Science in Zimbabwean Primary Schools

Some of the problems currently experience by teachers and learners within the Zimbabwean EAS syllabus and the Mathematics syllabus have been reported recently (Lewin, Bajah et alii, 1991; Jaji & Nyagura, 1989; Shumba, 1988). Among the many real difficulties identified, (understandable in view of lack of training), the following are particularly pertinent:
"Though 'investigaing' and 'experimenting' appeared often in schemes for teaching, pupils' work showed little evidence of this"..."Teacher talk seems dominant in the lessons with pupils contributing only as a direct response to questions",(Lewin, Bajah, 1991). "The difficulties displayed in terms of understanding of the meaning of fractions and pupils' somewhat better performance on computational items also suggest this emphasis on the mechanics and underscores the danger of such an approach.(Jaji & Nyagura, 1989). It would appear that active learning, problem solving approaches and the use of process skills to support learning are not greatly in evidence.

As well as describing some of the difficulties relating to active modes of teaching/learning, the authors also indicate some problems with conceptual understanding:
"Those [topic] most frequently identified as easy and like were Water, Soil and Health. Those most frequently identified as difficult to teach, and disliked by students, were Sun and Cosmos, Infrastructure, Landforms, Machines. Fuel and the Veld were also regarded as problematic".

The support of active learning, (using science processes and a problem solving approach) and conceptual understanding are identified as areas in which teachers are in need of help in their attempts to deliver the Environmental and AGricultural Science syllabus and the Mathematics syllabus in Zimbabwean primary schools.

Acquisition of Process Skills

Problem solving in science and mathematics is mediated by the use of process skills. While many science and mathematics curricula make reference to process skills, few make any requirement for their assessment; since the skills are not assessed, they tend to be neglected by teachers. Instead, factual science knowledge and mechanical mathematics is emphasised. Furthermore, an emphasis on the acquisition of scientific knowledge and facts and in mathematics on computational skills is usually associated with a style of teaching which resorts to direct transmission methods, requiring children to be passive recipients. The assessment methods associated with this didactic style tend to emphasise recall of information and mechanical use of algorithms. This appears to be the case in the Zimbabwean context also: 'The most common forms of assessment in EAS are sentence completion and multiple-choice questions'(Lewin et al, 1991). In contrast, assessment which aims to assess more active understanding on the part of pupils requires evidence of the ability to transform information in some way. Such transformations, which might include applications, making predictions, generating hypotheses, etc, call on the use of process skills.

Just as process skills can be used to assess acquisition of knowledge with understanding, so they can support the acquisition of concepts in an active learning environment. Indeed, it is impossible to explore the use of process skills divorced from any content. Thus it makes sense to link the use of process skills, to the exploration of the concepts in the science and mathematics syllabuses -- to observe, record, hypothesise, interpret data, seek patterns, and so on, in relation to forces, plant growth, materials, landforms, the veld, or whatever else in specified in the science syllabus and in relation to addition, fractions, shapes, measurements, or whatever else in specified in the mathematics syllabus.

A range of practical, observational and pencil and paper methods for assessing science process skills in the primary range in U.K. schools are available (See Russell, ed. 1989; Russell and Harlen, 1990; Schilling et al. 1990; Cavendish et al. 1990) as well as similar methods for mathematics problem solving and process skills in the primary range in the U.S.A. (See Cobb, Wood, Nicholls, Wheatley, Trigatti & Perlwitz 1991).

Conceptual Understanding

A great deal of evidence has been collected by science and mathematics educators in support of the view that children's development of conceptual understanding is an active process. Even in the absence of formal instruction, children develop their own theories to explain objects and events in the world. Certain ideas have been found to recur with high frequency in schools in the U.K.

and elsewhere; for example, that plant growth is a process involving the creation of new matter; that seeing, hearing and smelling are all active processes (rather than the passive reception of sensory stimulation); that rust exists under the surface of bright metal; that water is drawn towards the heat source which causes it to evaporate. Also, children re-construct information which is directly transmitted by teachers in such a way that it makes personal sense; this often results in distortions of formal models. In mathematics the constructivist view is that mathematics learning is a process in which students reorganize their activity to resolve situations that they find problematic.

Teaching, Learning and Assessment

It is possible to describe a framework for primary mathematics and science in which the links between the curriculum, teaching, learning and assessment are made explicit. This is useful because it enable us to specify

* the teaching (what the teacher does)

* the learning (what the pupils do)

* assessment (ways of judging the success of the teaching/learning interaction)

The teaching agenda is set by the curriculum, or more specifically in the Zimbabwean context, the primary EAS syllabus and the primary mathematics syllabus. When assessment is used formatively, feedback about learning outcomes is used to inform teaching so that it is responsive to needs.

The particular needs which have been identified and which form the focus of the research programme and development involve the following steps or phases:

Phase A. Training Workshop and Collection Classroom Baseline Data

1. Training Workshop

A group of teachers, (both initial training (6-15)and INSET(6-15)) and college tutors(4-10)(tutors of the initial training teachers) will be identified to participate in a training or induction programme. The major objectives will be

to establish a thorough direct experience and understanding of process skills

to develop awareness of techniques for eliciting evidence of children's understanding of a specific and limited range of scientific and mathematical ideas.

to develop personal understanding of particular mathematical and science concepts which will be used as the content area of classroom activities and research enquiry.

No assumptions will be made about teachers' own understanding as the workshop induction programme is able to take teachers through the sequence at their own level (as opposed to role play) without any danger of any sense of condescension.

The workshop will include practical sessions aimed at the identification of process skills, discussion of definitions and generation of new formative assessment procedures based on local materials, i.e., observing interpreting, hypothesising, planning, measuring, recording and communicating, raising questions, looking for patterns etc. -- all in the context of locally available materials, objects and events. As well as addressing basic understanding of the process skills, the workshop will, in effect, be generating assessment items. Practical tasks could also be re-constituted as pencil and paper tasks for use in schools.(See, e.g. Commonwealth Secretariat/Unesco, 1987).

A similar set of activities for the elicitation of ideas within a prescribed conceptual domain will be included in the workshop. Initially, the range of concept to be approached should be limited, but potentially amenable to a practical mode of enquiry. (Russell et al. 1990, 1991).

The training workshop would be written up as a set of replicable activities, together with explanatory notes, This would be a re-useable resource for INSET and initial training which could be refined for publication as one of the products of the research programme.

2. Collection of Classroom Baseline Data

The extent to which it is possible to collect data using whole class groups will be assessed using procedures very close to those used in the teacher induction workshop. That is, children will be presented with 'problems' (to elicit science and mathematics process skills) and 'thinking activities' (to elicit conceptual understanding). These methods do not depend on exceptional practice on the part of teachers; neither do they put children at risk of failing. THe techniques are designed to provide baseline data and the instruments enable recording of:

* children's use of process skills in response to a range of practical situations with which they are presented.

* children's conceptual understanding in relation to a range of 'thinking activities'

Both of these areas are amenable to pencil and paper methods of data collection or direct observation or a combination of the two, depending on what we find works locally. The data collect as described has close affinities with deferred and continuous pupils assessment methods, underlining the relevance of the research methodology to classroom practice.

Phase B. Classroom Intervention to Improve Performance

The research team will work cooperatively with the identified teachers and college tutors to develop and systematically document a variety of interventions to determine those that are most effective in improving children's problem solving strategies. These interventions will focus on changing teacher classroom practice, rather than on developing new syllabus material. The use of locally available materials, games, outings, worksheets and so on are anticipated.

Phase C. Teacher Support Systems

During this phase of the study, the research team together with teachers and college tutors selected during Phase A will use the experience gained during Phase B to explore ways of working with groups of teachers and training college students so as to improve the scientific and mathematical problem solving skills of pupils they teach. The use of printed material, video, training workshops, audio tape to simulate radio, itinerant master teachers and teacher focus groups may all be used. Staff from central and regional education offices, particularly the EOs and DEOs, will be involved in this phase of the study.

Phase D. Project Dissemination Workshop

The final phase will be the dissemination of study findings. This will be done through a 5 day seminar and the publication of a project report. The seminar will be attended by curriculum development, education officers, and teacher training staff in Zimbabwe as well as key personnel from other countries in the sub-region.

Prior to the workshop special prototype curriculum materials would be developed incorporating the lessons learned. These would then be presented as part of the workshop in addition to teacher training packages.

At periodic intervals throughout the study, professional assistance will be provided by Terry Russell of Liverpool to a maximum of 4 visits and 75 days.

Target Audience

i. Primary school children and teachers

ii. Those responsible for teacher support systems in Zimbabwe namely curriculum staff, central and regional education officers and teacher educators.

iii. Similar personnel from the African sub-region.

Expected Outcomes

Expected project out comes are:

i. Baseline norms of what sorts of mathematical and scientific problem solving strategies children in Zimbabwe are capable of at various stages of development.

ii. Documentation in print and video on in-puts required to improve children's scientific and mathematical problem solving strategies.

iii. Documentation in print and video of teacher support mechanisms that are effective in improving teachers abilities to develop children's scientific and mathematical problem solving strategies.

iv. Multi-media training packages that can be used in in-service and pre-service teacher education.

v. Curriculum packages that match with the syllabuses in mathematics and environmental and agricultural science which can be used by teachers in the classroom.

Organisation to whom Funds Should be Made Available

Funds should be made available to:

The Vice-Chancellor, The University of Zimbabwe

PROJECT DESCRIPTION

Research Team

Resumes are attached of the major researchers. Since the university accredits all primary school teachers and supervises the colleges that train them, these members of the research team are in a position to influence training practices of primary teachers throughout the country. Mrs. ? of the National Curriculum Development Centre is one of the team responsible for developing materials for the primary science course and Dr. Jaji has served as the major consultant to the National Panel for Primary School Mathematics. Thus, study findings are likely to be absorbed into both pre-service education practices and new developments in the primary science and mathematics curriculums. Terry Russell's extensive experience of similar work in the UK(resume attached) will give an added dimension to the study. In addition to assisting with conceptualising the study, he will visit Zimbabwe periodically to assist with research design, instrumentation and documentation, data analysis and design of training packages and the project report.

This core of researchers will be expanded at various stages of the study. Regular departmental seminars in the Department of Science and Mathematics Education will inform other staff members and solicit their in-puts. These seminars will be open to appropriate staff from the curriculum centre, regional and central education offices and training colleges.

Teachers identified in Phase A of the project will be regarded as colleagues and fully involved in the research process and in subsequent phases of the project. During Phase C(Teacher Support Systems), when appropriate, education officers, other curriculum developers, and teacher educators will be involved, again as colleagues.

Through the involvement of a broad range of personnel in the study, it is hoped that distinctions between the research aspects of the study and the absorption of its findings by the educational system, will become blurred.

Study Sample

Phase A. Training Workshop and Collection of Classroom Baseline Data

The sample will be chosen from schools in the high density schools in Harare region of Zimbabwe and also from schools near the training college(s) of the selected tutors. At least two tutors from each selected training college(we will use at least two colleges) will also be selected. High density schools in Harare were chosen for their proximity to the main researchers. The conditions in the high density schools are reasonably similar to those throughout the country. By also taking schools near the training college of the selected tutors we will have typical rural schools also represented. This will enable us to have as representative a sample as possible while still providing for close cooperation between the principal researchers and their colleagues in the field. It will help to provide the support the teachers will need for using innovative practices which research elsewhere as shown to be necessary to sustain the required effort for such extensive change.

During Phase A, teachers from only a few schools (probably 4 to 8 schools -- two high density and 2 to 6 rural) will be selected.

Within each school, suitable teachers from grades 2,4 and 6 will be identified. Within each grade level, 10 pupils will be selected at random for periodic observation.

Phase C. Teacher Support Systems

School clusters will be selected in the vicinities of those schools selected for Phase A. There will be no more than 6 schools in each cluster and each must be within easy travel from the original school. To isolate the "companionship" variable, teachers from cluster schools will be selected alternately in singles and pairs from each of the 3 grade levels. For example: a single grade 2 teacher from school 1; a grade 4 and grade 6 teacher from school 2; a single grade 4 teacher from school 3 and so on.

Again 10 randomly selected pupils from each grade level will be observed periodically.

Instrumentation and Documentation

The following instruments will be developed, adapted and pre-tested.

1. Test of Scientific Conceptual Understanding (for each of 3 grade levels)

2. Test of Mathematical Conceptual Understanding (for each of 3 grade levels)

3. Test of Scientific Process Skills (for each of 3 grade levels)

4. Test of Mathematical Process Skills (for each of 3 grade levels)

5. Classroom Interaction Schedule

Participating teachers will be encouraged to keep project diaries and the study will evolve simple check lists to record pupils progress both as an aid to help researchers monitor the study and as a potentially useful teacher training instrument.

Project Interventions

Phase B. Classroom Intervention to Improve Performance

This phase of the study will be exploratory. Its purpose will not be to develop new syllabus material but rather to evolve ways to use existing syllabus content to achieve its problem solving goals. The research team, together with participating teachers, will evolve a series of teaching strategies that are effective and feasible in developing pupil's problem solving skills and which can be used regardless of any future changes in the syllabus. The following indicates a range of the classroom interventions that may be used.

Locally available materials
Use of pictures
Guided discussion
Puzzles
Photographs
Use of local experts
Children's magazines
Science and Mathematics competitions
Games
Stories
Visits
Use of case studies
Audio recordings (to simulate radio)
Maps
Simulations
Quizzes

Similar techniques will be used by the college tutor in the study and his or her students will be followed up during their teaching practice.

Phase C. Teacher Support Systems

The purpose of this phase of the study is to evolve effective ways to help teachers to develop their skills of promoting children's problem solving strategies. Participating teachers will again be used as colleagues during this phase, their schools being used as focal points. The following are indicative of the range of intervention strategies the study will use in training the second generation of teachers.

Hands on workshops	Printed material
Video	Audio recordings (to simulate radio)
Itinerant master teachers	
Self monitoring techniques	Teacher study groups

During this phase, education office staff at central and regional levels will be involved as much as possible in both the planning and implementation of the study. Financial records will be kept of this phase to facilitate decisions about the cost effectiveness of each type of in-put.

Phase D. Project Dissemination Workshop

A workshop will be held at the end of the study. The major purpose of this workshop will be to expose curriculum development staff and those responsible for in-service and pre-service training programme throughout the country to the findings of the study, namely;

i. Teaching methodologies found most effective and feasible within the primary school environment of Zimbabwe in developing pupils mathematical and scientific problem solving strategies.

ii. In-service approaches found most effective within current constraints in the Zimbabwean educational system in training serving teachers to promote the development of children's problem solving strategies.

iii. Pre-service approaches found most effective within current constraints in the Zimbabwean educational system in training serving teachers to promote the development of children's problem solving strategies.

Key staff from other southern African countries will also be invited to the dissemination workshop. An expected workshop outcome is a series of recommendations to governments on ways to improve science and mathematics teaching at primary school levels.

References

Commonwealth Secretariat/Unesco (1987) Primary Science Teacher Training for Process Based Learning. (Harlen, W., ed.)

Jaji, G. and Nyagura, L. (1989) "Attained Mathematics Curriculum in Zimbabwe Primary Schools" Zimbabwé Journal of Educational Research 1:2.

Lewin, K., Bajah, S., et alii, (1991) "Teaching and Learning in Environmental and Agricultural Science: Meeting Basic Educational Needs in Zimbabwe: An Evaluation". Deutsche Stiftung fur internationale Entwicklung.

Cobb, P; Wood,T.;et al (1991) "Assessment of a Problem -Centered Second-Grade Mathematics Project" Journal for Research in Mathmatics Education 22:1.

Calendar of Events

(Flexibility will be required to adjust to school year)

Phase A. Training Workshop and Collection of Classroom Baseline Data

EVENT	MONTH
Development of instruments and documentation strategies	0 - 6
Selection of teachers	7 - 8
Documentation of classrooms	8- 10
Training Workshop	10-11

Phase B. Classroom Intervention to Improve Performance

Development of intervention material	0 -10
Classroom interventions & documentation	11-19

Phase C. Teacher Support Systems

Development of teacher support material	11-19
Teacher support system interventions & documentation	20-29

Phase D. Project Dissemination Workshop

Preparation of materials	30-36
Workshop	36

APPENDIX 1.3

Introduction to the SPACE Project

Reproduced from:

Russel, T., Watt,D. (1990). Growth, primary space project research report. Liverpool: Liverpool University Press.

INTRODUCTION

The Primary SPACE Project is a classroom-based research project which aims to establish

- *the ideas which primary school children have in particular science concept areas*
- *the possibility of children modifying their ideas as the result of relevant experiences.*

The research reported here was funded by the Nuffield Foundation and is being conducted at two centres, the Centre for Research in Primary Science and Technology, Department of Education, University of Liverpool and the Centre for Educational Studies, King's College, London. The joint directors are Professor Wynne Harlen and Professor Paul Black. Three local education authorities are involved: Inner London Education Authority, Knowsley and Lancashire.

The Project is based on the view that children develop their ideas through the experiences they have. With this in mind, the Project has two main aims: firstly, to establish (through an elicitation phase) what specific ideas children have developed and what experiences might have led children to hold these views; and secondly, to see whether, within a normal classroom environment, it is possible to encourage a change in the ideas in a direction which will help children develop a more 'scientific' understanding of the topic (the intervention phase).

The concept areas studied so far have included:

Electricity
Evaporation and condensation
Everyday changes in non-living materials
Forces and their effect on movement
Growth
Light
Living things' sensitivity to their environment
Sound.

The Project has been run collaboratively between the University research teams, local education authorities and schools, with the participating teachers playing an active role in the development of the Project work.

A close relationship has been established between the University researchers and the teachers, resulting in the development of techniques which advance both classroom practice and research. These methods provide opportunities, within the classroom, for children to express their ideas and to develop their thinking with the guidance of the teacher, and also help researchers towards a better understanding of children's thinking.

The involvement of teachers

Schools and teachers were not selected for the Project on the basis of a particular background or expertise in primary science. In the majority of cases, two teachers per school were involved, which was advantageous in providing mutual support. Where possible, the Authority provided supply cover for the teachers so that they could attend Project sessions for preparation, training and discussion, during the school day. Sessions were also held in the teachers' own time, after school.

The Project team aimed to have as much contact as possible with the teachers throughout the work to facilitate the provision of both training and support. The diversity of experience and differences in teaching style which the teachers brought with them to the Project meant that achieving a uniform style of presentation in all classrooms would not have been possible, or even desirable. Teachers were encouraged to incorporate the Project work into their existing classroom organisation so that both they and the children were as much at ease with the work as with any other classroom experience.

The involvement of children

The Project involved a cross-section of classes of children throughout the primary age range. A large component of the Project work was classroom-based, and all of the children in the participating classes were involved as far as possible. Small groups of children and individuals were selected for additional activities or interviews to facilitate more detailed discussion of their thinking.

The structure of the Project

For each of the eight concept areas studied, a list of concepts was compiled to be used by researchers as the basis for the development of work in that area. These lists were drawn up from the standpoint of accepted scientific understanding and contained concepts which were considered to be a necessary part of a scientific understanding of each topic. The lists were not necessarily considered to be statements of the understanding which would be desirable in a child at age eleven, at the end of the Primary phase of schooling. The concept lists defined and outlined the area of interest for each of the studies; what ideas children were able to develop was a matter for empirical investigation.

Most of the Project research work can be regarded as being organised into four phases, preceded by an extensive pilot phase. These phases are described in the following paragraphs and were as follows:

Pilot work
Phase 1: Exploration
Phase 2: Pre-Intervention Elicitation
Phase 3: Intervention
Phase 4: Post-Intervention Elicitation

The phases of the research

Each phase, particularly the Pilot work, was regarded as developmental; techniques and procedures were modified in the light of experience. The modifications involved a refinement of both the exposure materials and the techniques used to elicit ideas. This flexibility allowed the Project team to respond to unexpected situations and to incorporate useful developments into the programme.

There were three main aims of the Pilot phase. Firstly, to trial the techniques used to establish children's ideas; secondly, to establish the range of ideas held by primary school children; and thirdly, to familiarise the teachers with the classroom techniques being employed by the Project. This third aim was very important since teachers were being asked to operate in a manner which, to many of them, was very different from their usual style. By allowing teachers a 'practice run', their initial apprehensions were reduced, and the Project rationale became more familiar. In other words, teachers were being given the opportunity to incorporate Project techniques into their teaching, rather than having them imposed upon them.

In the Exploration phase children engaged with activities set up in the classroom for them to use, without any direct teaching. The activities were designed to ensure that a range of fairly common experiences (with which children might well be familiar from their everyday lives) was uniformly accessible to all children to provide a focus for their thoughts. In this way, the classroom activities were to help children articulate existing ideas rather than to provide them with novel experiences which would need to be interpreted.

Each of the topics studied raised some unique issues of technique and these distinctions led to the Exploration phase receiving differential emphasis. Topics in which the central concepts involved long-term, gradual changes, e.g. 'Growth', necessitated the incorporation of a lengthy exposure period in the study. A much shorter period of exposure, directly prior to elicitation was used with 'Light' and 'Electricity', two topics involving 'instant' changes.

During the Exploration, teachers were encouraged to collect their children's ideas using informal classroom techniques. These techniques were:

i. *Using log-books (free writing/drawing)*

Where the concept area involved long-term changes, it was suggested that children should make regular observations of the materials, with the frequency of these depending on the rate of change. The log-books could be pictorial or written, depending on the age of the children involved, and any entries could be supplemented by teacher comment if the children's thoughts needed explaining more fully. The main purposes of these log-books were to focus attention on the activities and to provide an informal record of the children's observations and ideas.

ii. *Structured writing/drawing*

Writing or drawings produced in response to a particular question were extremely informative. This was particularly so when the teacher asked children to clarify their diagrams and themselves added explanatory notes and comments where necessary, after seeking clarification from children.

Teachers were encouraged to note down any comments which emerged during dialogue, rather than ask children to write them down themselves. It was felt that this technique would remove a pressure from children which might otherwise have inhibited the expression of their thoughts.

iii. *Completing a picture*

Children were asked to add the relevant points to a picture. This technique ensured that children answered the question posed by the Project team and reduced the possible effects of competence in drawing skills on ease of expression of ideas. The structured drawing provided valuable opportunities for teachers to talk to individual children and to build up a picture of each child's understanding.

iv. *Individual discussion*

It was suggested that teachers use an open-ended questioning style with their children. The value of listening to what children said, and of respecting their responses, was emphasised as was the importance of clarifying the meaning of words children used. This style of questioning caused some teachers to be concerned that, by accepting any response whether right or wrong, they might implicitly be reinforcing incorrect ideas. The notion of ideas being acceptable and yet provisional until tested was at the heart of the Project. Where this philosophy was a novelty, some conflict was understandable.

In the Elicitation phase, the Project team collected structured data through individual interviews and work with small groups. The individual interviews were held with a random, stratified sample of children to establish the frequencies of ideas held. The same sample of children was interviewed pre- and post-Intervention so that any shifts in ideas could be identified.

The Elicitation phase produced a wealth of different ideas from children, and led to some tentative insights into experiences which could have led to the genesis of some of these ideas. During the Intervention teachers used this information as a starting point for classroom activities, or interventions, which were intended to lead to children extending their ideas. In schools where a significant level of teacher involvement was possible, teachers were provided with a general framework to guide their structuring of classroom activities appropriate to their class. Where opportunities for exposing teachers to Project techniques were more limited, teachers were given a package of activities which had been developed by the Project team.

Both the framework and the intervention activities were developed as a result of preliminary analysis of the Pre-Intervention Elicitation data. The Intervention strategies were:

(a) Encouraging children to test their ideas

It was felt that, if pupils were provided with the opportunity to test their ideas in a scientific way, they might find some of their ideas to be unsatisfying. This might encourage the children to develop their thinking in a way compatible with greater scientific competence.

(b) Encouraging children to develop more specific definitions for particular key words

Teachers asked children to make collections of objects which exemplified particular words, thus enabling children to define words in a relevant context, through using them.

(c) Encouraging children to generalise from one specific context to others through discussion.

Many ideas which children held appeared to be context-specific. Teachers provided children with opportunities to share ideas and experiences so that they might be enabled to broaden the range of contexts in which their ideas applied.

(d) Finding ways to make imperceptible changes perceptible

Long-term, gradual changes in objects which could not readily be perceived were problematic for many children. Teachers endeavoured to find appropriate ways of making these changes perceptible. For example, the fact that a liquid could 'disappear' visually and yet still be sensed by the sense of smell - as in the case of perfume - might make the concept of evaporation more accessible to children.

(e) Testing the 'right' idea alongside the children's own ideas

Children were given activities which involved solving a problem. To complete the activity, a scientific idea had to be applied correctly, thus challenging the child's notion. This confrontation might help children to develop a more scientific idea.

In the Post-Intervention Elicitation phase the Project team collected a complementary set of data to that from the Pre-Intervention Elicitation by re-interviewing the same sample of children. The data were analysed to identify changes in ideas across the sample as a whole and also in individual children.

These four phases of Project work form a coherent package which provides opportunities for children to explore and develop their scientific understanding as a part of classroom activity, and enables researchers to come nearer to establishing what conceptual development it is possible to encourage within the classroom and the most effective strategies for its encouragement.

The implications of the research

The SPACE Project has developed a programme which has raised many issues in addition to those of identifying and changing children's ideas in a classroom context. The question of teacher and pupil involvement in such work has become an important part of the Project, and the acknowledgement of the complex interactions inherent in the classroom has led to findings which report changes in teacher and pupil attitudes as well as in ideas. Consequently, the central core of activity, with its pre- and post-test design, should be viewed as just one of the several kinds of change upon which the efficacy of the Project must be judged.

The following pages provide a detailed account of the development of the Growth topic, the Project findings and the implications which they raise for science education.

APPENDIX 1.4

Schedule of workshops and other support structures for the UZ Project. This includes the schedule of school visits and cluster meetings.

CHRONOLOGY OF UZ PROJECT SUPPORT ACTIVITIES FOR TEACHER CHANGE

DATE	SUPPORT ACTIVITY	TYPE OF SUPPORT
Jan '93 18-22	Teacher workshop	*Terry Russell ran group work on finding children's ideas *questioning and intervention strategies *hands on science activities *communication - use of plays, stories, etc
14	Headmaster workshop	*introduction to project *eliciting support
Jan 25-Feb 12	School visits	to locate new schools deliver notices and materials
24	Education Officer Workshop	*introduction to project *eliciting support
Feb 24- March 12	Cluster visits (12 cluster groups)	*reports from teachers *demo of low cost equipment *set up peer teaching
March	Cluster visits (second round)	*peer teaching & critique *video for research
April 26-30	Teacher workshop	*video critique *science enrichment *methodology (planning for problem solving, groups, questioning, correcting, use of manipulative include make own resources etc)

May	video of in-class and interview of teachers teacher college visit	this researcher to visit and film identified teachers support to teacher colleges
June (2 weeks)	Cluster visits (3rd round)	peer teaching and critique
June 8	Seke Teacher College workshop	demonstration of project teaching by researchers as support to college lecturers
July (2 weeks)	Cluster visits (4th round)	peer teaching and critique
August 5-6	Teacher workshop	* science enrichment *problem-posing *questioning * process skills * make equipment
Aug 10 Aug 13	Teacher/writer workshop	maths lesson plans science - identifying topics science - key concept & process skill identification
Oct 1	Teacher/writer workshop	maths concentration
Nov 5	Teacher/writer workshop	science concentration group activity on inhibitors to change
Jan '94 Jan 21	Teacher/writer workshop	maths and science lesson plans (researcher not present)
March 4	Teacher workshop	Terry Russell visit class and lesson organization * science enrichment using constructivist strategies
April	Teacher/writer workshop	(researcher not present)
From May	"	this researcher participated part time - all monthly workshops included reports on written and trialed lessons - no enrichment
From May	school visits interviews	formation of `collaborative teacher group' for work on inhibitors to change and biographical approach to teacher development.

Children's Scientific and Mathematical Problem Solving Strategies and Teacher Support Models: An Action Research Project

CLUSTER WORKSHOPS, FEB.- MARCH, 1993

The members of the UZ and CDU research team who attended the cluster meetings are:

R. Hodzi	(RH)	S.Brown	(SB)
G. Jaji	(GJ)	K.Stiles	(KS)
K. Ncube	(KN)	R.Heberden	(RHb)

CLUSTER	MEETING DATE	RESEARCH-ERS	ATTEND-ANCE	SCHOOLS ABSENT
Chinyika	March 3	KS,SB,GJ,KN		Chinyika
"	March 15	"		---------
Chishawasha	Feb. 16	GJ,SB,RH		---------
"	March 18	KS,SB,KN		---------
Domboshawa	Feb. 25	KS,RHb,GJ		---------
"	March 17	KS,SB,KN		---------
Glenview	Feb. 22	KS,GJ,SB		---------
"	March 18	KS,SB,GJ		---------
Goromonzi S.	Feb. 15	KS,GJ,SB,RH		Raymondale
"	March 10	KS,GJ,SB,KN		---------
Juru	Feb. 23	KS,GJ,SB,RH		St.Francis
"	March 12	KS,SB,GJ,KN		Dehwe St. Francis
Rusike	Feb. 22	KS,GJ,SB		---------
"	March 15	KS,GJ,SB,KN		----------
Seke 1	Feb. 16	GJ,SB,RH		
"	March 8	KS,GJ,SB,KN		Kudyarawanza
Seke 2	Feb. 16	GJ,SB,RH		---------
"	March 8	KS,GJ,SB,KN		---------
Seke 3	Feb. 15	KS,GJ,SB,RH		---------
"	March 10	KS,GJ,SB,KN		Kandava
Shamva	Feb. 19	KS,GJ,SB		Mavudzi
"	March 17	KS,GJ,SB		---------

Nyadire Teachers' College and Nyamhara Primary were visited March 5 by KS, GJ, and SB. Second visit on April 1-2 by KS and SB.

Seke Teacher's College and Dudzai Primary were visited March 2 and March 11. Seke Teachers' College again on March 23, by KS and SB.

APPENDIX 2

2.1 Models of Learning and Teaching Used by UZ Project

2.2 Bhunhu 1992: patterns of lessons seen

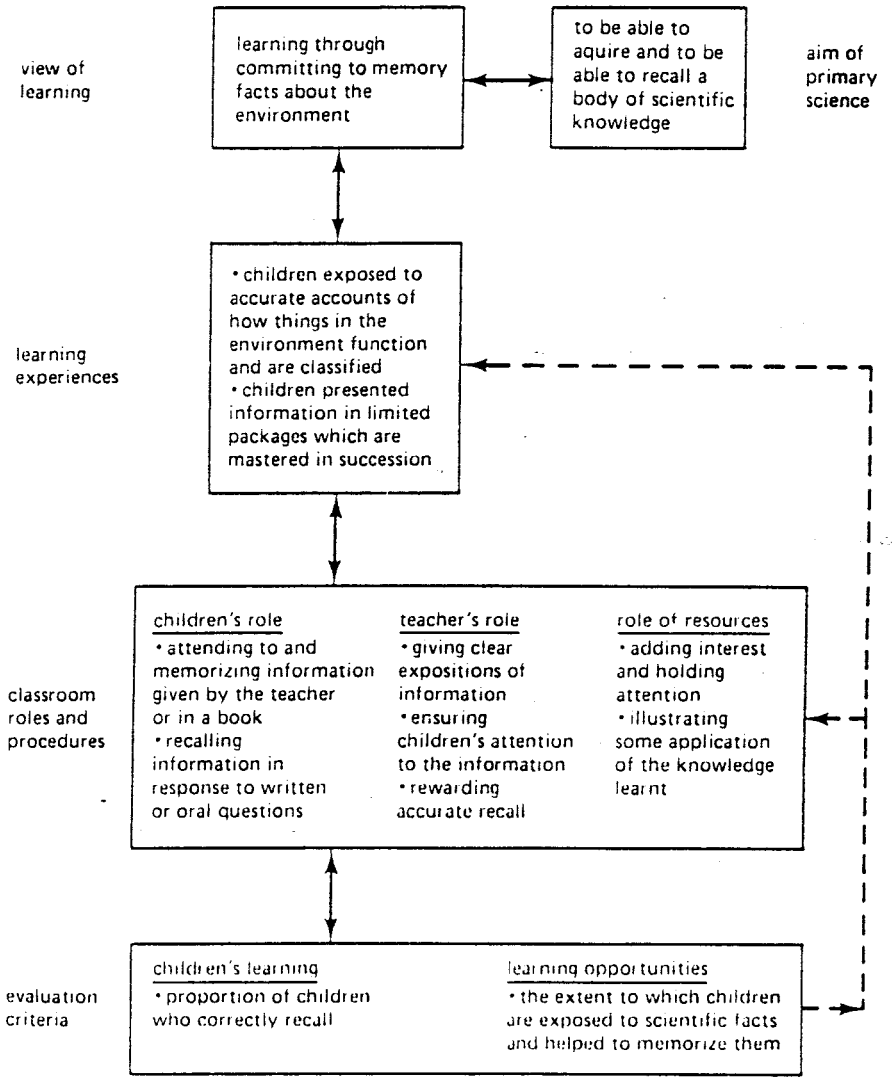
APPENDIX 2.1

Models of learning and teaching used by the UZ Project

- Rote Model
- Generative Model
- Diagnostic Teaching Model
- Problem Solving Model
- Constructivist Teaching Sequence

MODEL FOR LEARNING AND TEACHING

ROTE MODEL



(Harlen, Osbourne, 1985)

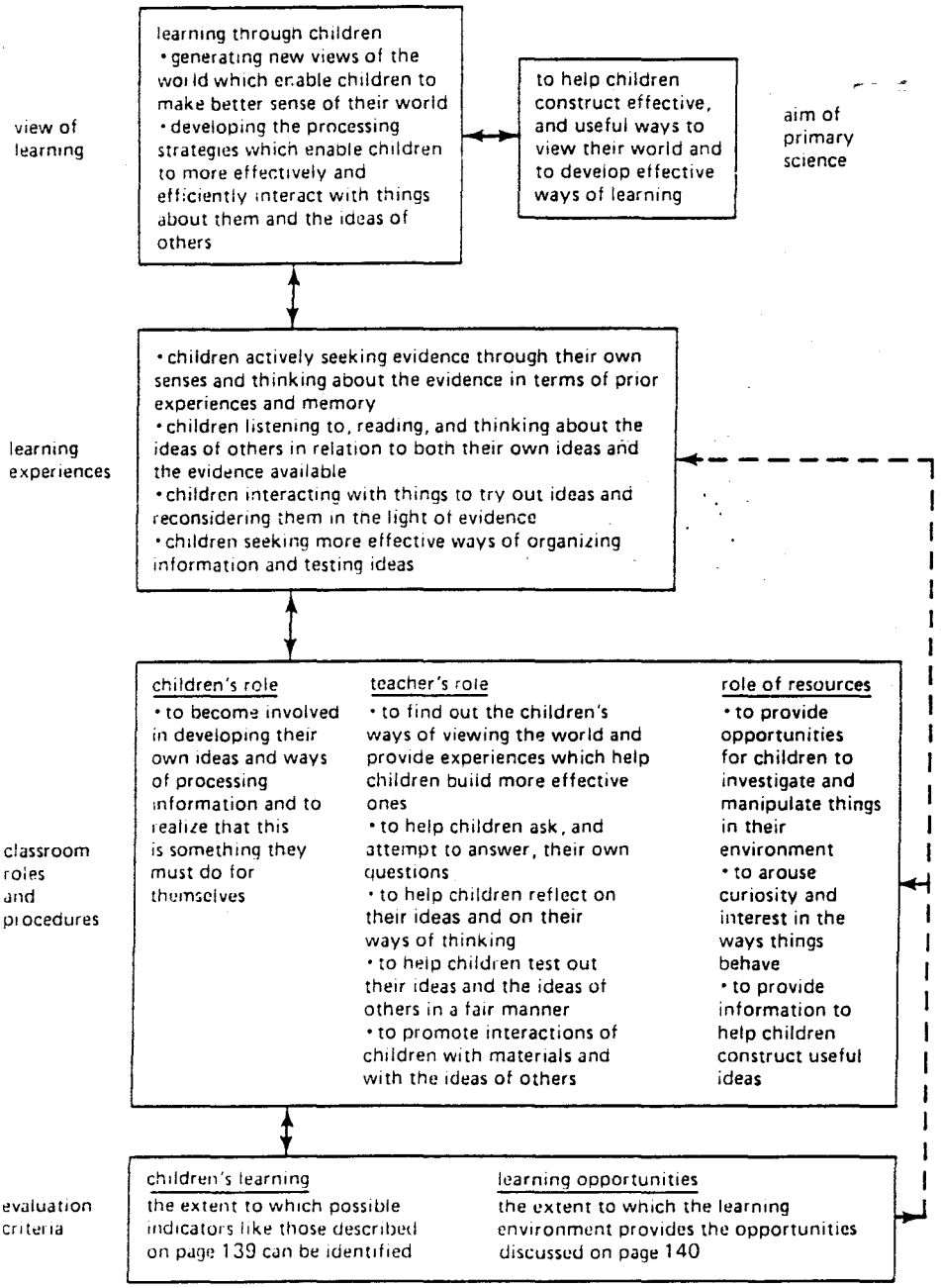
Explanation of symbols on model:

The two headed arrows ◂-----▸ signify that there should be consistency between the linked features.

The broken lines -------- and single arrows ----▸ suggest feedback to various parts of the model.

MODEL FOR LEARNING AND TEACHING

GENERATIVE MODEL



(Harlen, Osbourne, 1985)

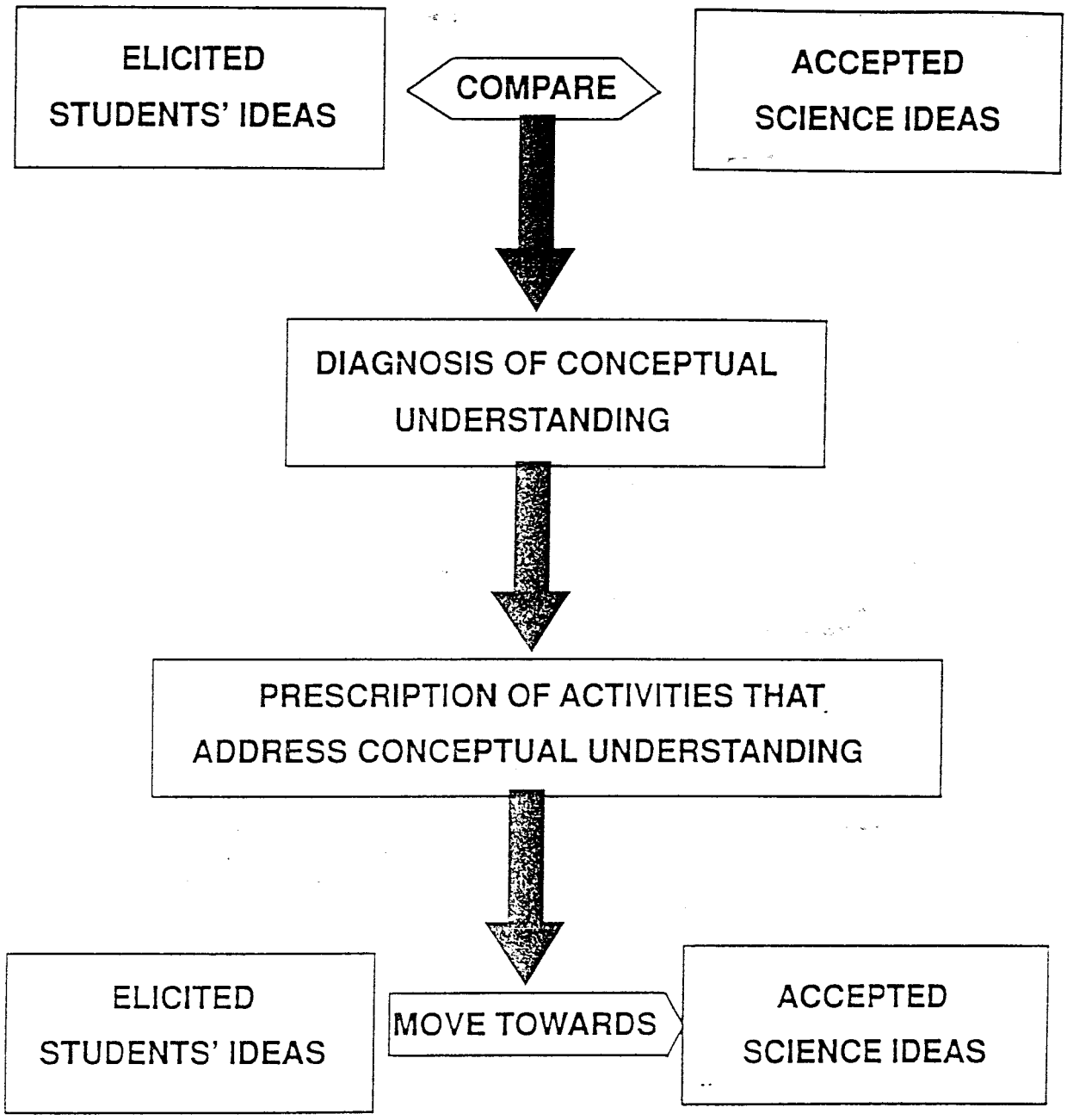
Explanation of symbols on model:

The two headed arrows ◂------▸ signify that there should be consistency between the linked features.

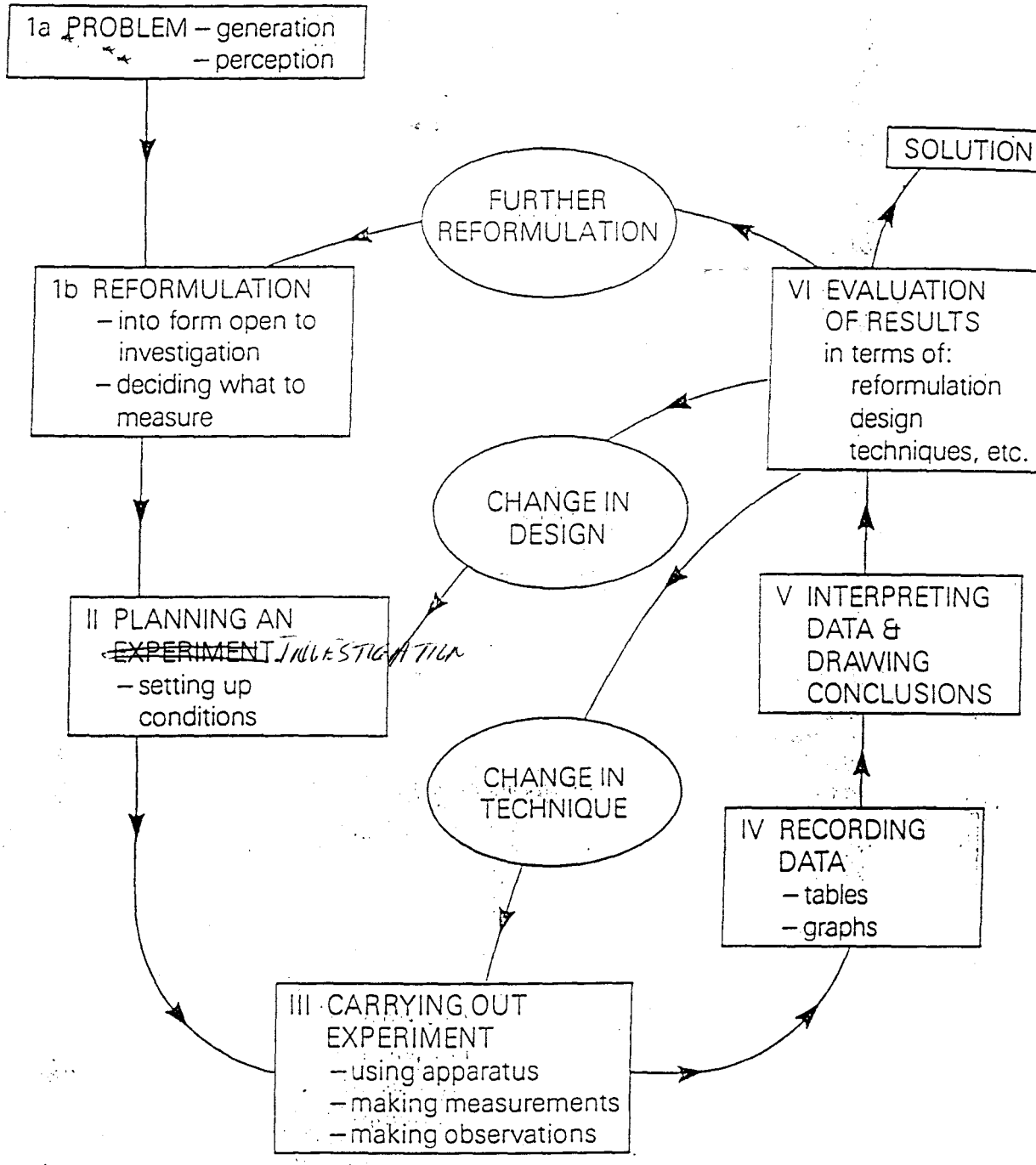
The broken lines -------- and single arrows ----▸ suggest feedback to various parts of the model.

4

DIAGNOSTIC TEACHING MODEL

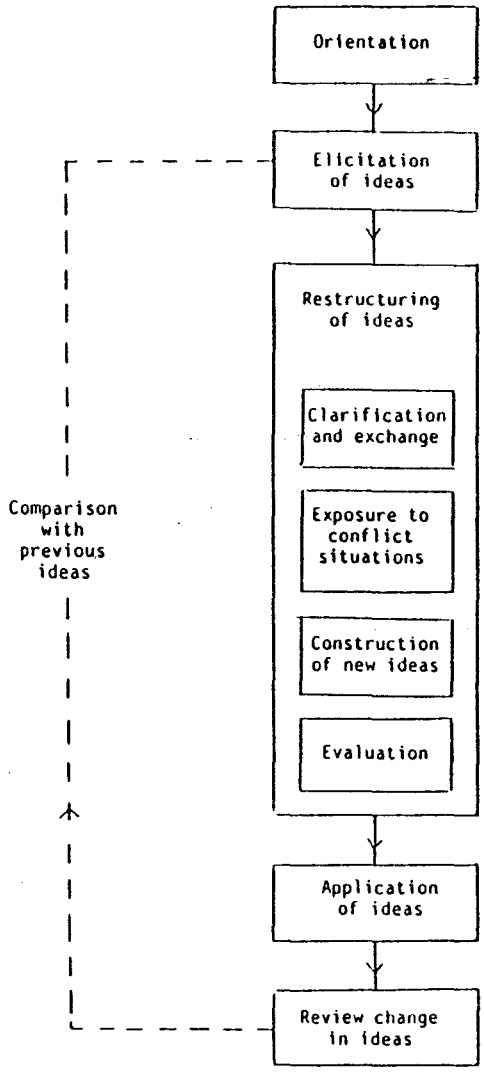


Problem solving model



(This model was described in detail in the 1981 survey reports (DES 1984 a, b) and is further amplified in The assessment framework for science at ages 13 and 15 (Science Report for Teachers, No. 2).)

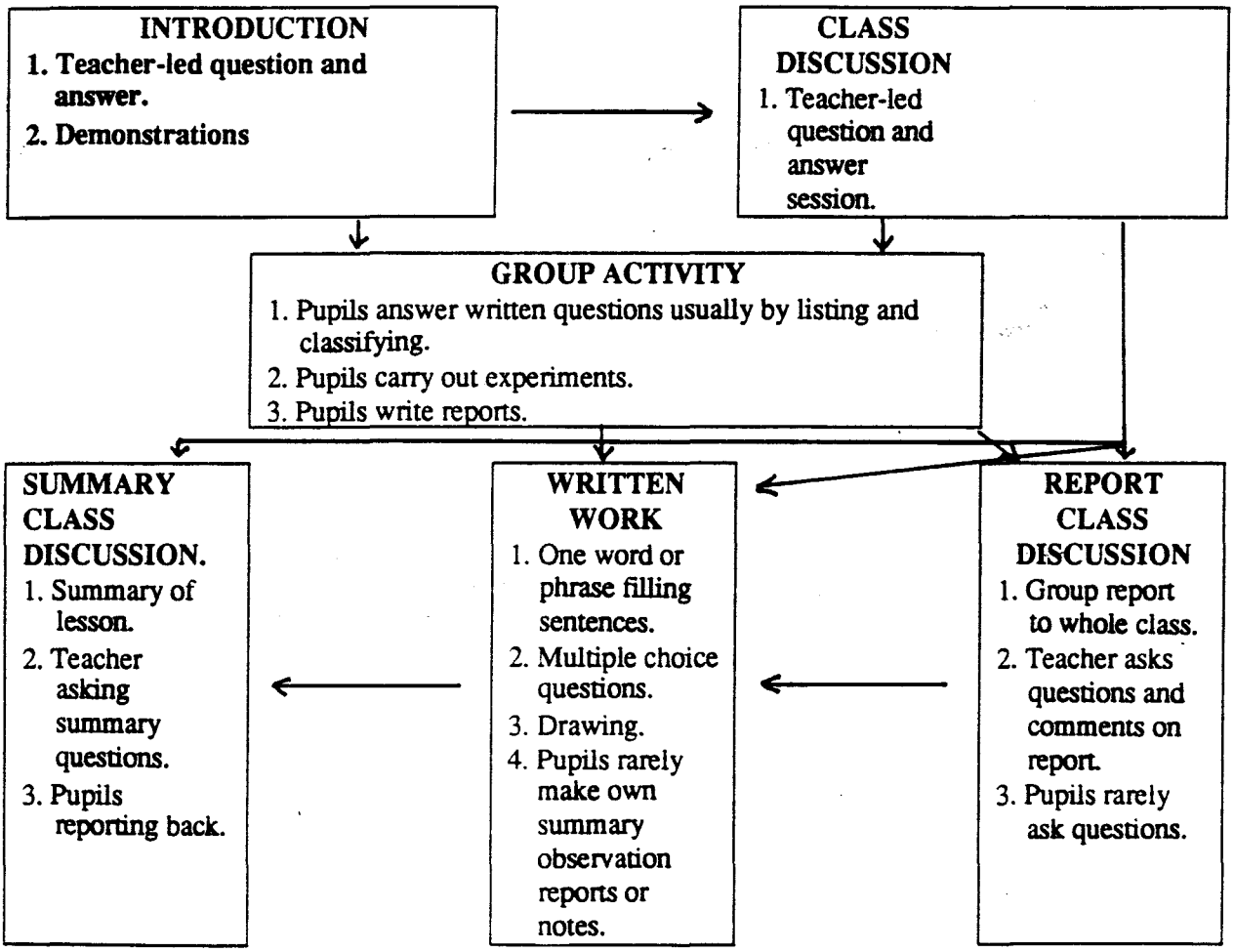
A constructivist teaching sequence



from: Driver, R., Oldham, V. (1986). A Constructivist Approach to Curriculum Development in Science. Studies in Science Education, 13, 18.

APPENDIX 2.2

General pattern of lessons seen in Primary Environmental and Agricultural Science (Bhunhu, N. 1992:13)



APPENDIX 3

3.1 Observation Guides

3.2 Background Questionnaire

APPENDIX 3.1

- Observation Guides used by two Teacher Colleges
- Observation Guides used by the UZ Project

NYADIRE TEACHERS' COLLEGE

STUDENT TEACHER SUPERVISION FORM

PARENT COLLEGE:..... STUDENT'S NAME.....YEAR.....

HOST COLLEGE..... SCHOOL.....DATE.....

SUBJECT..... TOPIC.....CLASS.....

ASSESSMENT OF TEACHING SKILLS	Unsatisfactory	Weak	Satisfactory	Good	V.Good	COMMENTS ON LESSON
1. PREPARATION						COMMENDABLE ASPECTS
a. T.P. File						
b. Schemes of work						
c. Plan book						
d. Records						
2. PLANNING						
Objectives clear and sensible						
Introduction						
Selection and sequencing of content						
Knowledge of content						
Appropriateness of activity						
Closing of lesson						
3. TEACHING PROCEDURES						
Generating class interest						
Aid/Apparatus/Blackboard						
Teacher's use of language						AREAS TO ATTEND TO
Teacher/Pupil interaction						
Pupil/Pupil interaction						
Questioning						
Pacing of lesson						
4. CLASSROOM MANAGEMENT & CONTROL						
Focussing pupils' attention						
Closing the lesson and follow-up						
5. LESSON OBJECTIVES ACHIEVED						
MARKING CONSTRUCTIVE AND UP TO DATE (6)						
7. OVERALL COMMENT AND ADVICE						

8. At this stage of your training this lesson was: Unsatisfactory/Weak/Satisfactory/Good/V.Good.

9. PERCENTAGE MARK:

Name of Supervisor:_____ Signature:_____
(Please print)

Education Officer/Headmaster/Teacher/Lecturer(Tick applicable)

(For elaborate comments, please use the back side of this form).

SEKE TEACHERS' COLLEGE: TEACHING PRACTICE SUPERVISION FORM

STUDENT'S NAMES:- _____ FILE NO.: _____

SCHOOL: _____ GRADE: _____ DATE: _____

SUBJECT: _____ TOPIC: _____

ASSESSMENT OF TEACHING SKILLS	unsatisfactory	weak	satisfactory	good	very good		GENERAL COMMENTS
1. PREP. & PLANNING							
a) T.P. FILE							
b) SCHEMES							
Complete/Appropriate							
detailed							
evaluation							
c) LESSON PLANS -up-to-date							
clear behavioural objectives							
adequate content							
pupils activities							
useful levaluation							
d) RECORD: SOCIAL							
attainment/progress							
remedial							
Exercise books and marking							
e) CLASSROOM ORGANISATION							
charts, displays							
chalk-board work							
cleanliness							
3. CLASS MANAGEMENT							
a) LESSON INTROD. approp.							
b) MOTIVATION							
c) PACING & SEQUE OR LESSON							
d) AIDS-AVAILABLE & APPROP							
effective use							
e) CONTENT: adequate & approp							
f) LANGUAGE: CHN. & Teacher							
g) QUESTIONING SKILLS							
h) ORGANISING CHILDREN P.P.I.							
rapport, discipline, gr. acts.							
i) WRITTEN WORK							
j) LESSON CONCLUSION							
k) OBJECTIVES ACHIEVED							
4. PERSONALITY & PROFESSION							
a) DRESS							
b) PUNCTUALITY							
c) CO-CURRICULUM							
d) ATTITUDE/CONDUCT							
4. SPECIFIC ADVICE/RECOMMENDATIONS/AREAS OF CONCERN							

At this stage of you training your performance is: unsatisfactory/weak/ satisfactory/good/V.good;

Name of supervisor: ..... signature: .....
Designation: Lecturer/E.O./D.E.O./Headmaster. College/region/School ....

.....

CLASSROOM OBSERVATION GUIDE

Name of the Teacher: _____

Class/Grade: _____

Subject: _____

Lesson Topic: _____

Date and Time: _____

CLASSROOM ACTIVITY	RATING OF ACTIVITY				
Teacher:	Very Poor (0)	Poor (1)	Average (2)	Good (3)	Very Good (4)
1. Does the teacher create a general atmosphere of warmth and make each pupil feel accepted and supported					
2. Does the teacher encourage the free exchange of questions and ideas among the pupils?					
3. Does he/she provide his/her pupils with ways to achieve recognition and success?					
4. Does the teacher help his/her pupils to achieve self-perception and self-actualization?					
5. Is the teacher tolerant of deviations of interests, values, intellectual capacities, creativeness and competencies?					
6. Does the teacher inspire the kind of confidence that enables a pupil to speak out his/her problem without fear of recrimination or humiliation?					
Content:					
1. Is the lesson flexible enough to give the teacher considerable latitude in the selection of experiences appropriate for each learner?					
2. Are the learning experiences organized so that pupils of varying abilities and interests can be assured of considerable success?					
3. Are the lesson objectives clear and appropriate for the target grade?					
4. Has the assumed knowledge been adequately identified and verified before new ideas are introduced?					
5. Is there evidence of adequate consultation of sources of subject matter and pedagogical methods?					
6. Are the selected class activities challenging but solvable?					
7. Does the homework set reinforce developed skills and/or processes?					
Instructional Methods:					
1. Do the teaching methods stimulate the pupil to individual exploration and learning and lead him/her on to new and widely varied experiences?					

2. Does the method of teaching provide an active rather than a passive role for the pupils?

3. Is the teaching integrating small group, individualized, and large group approaches?

4. Does the teaching stimulate responses at various levels of ability?

5. Does the teaching stretch the thinking of pupils at all levels?

6. Does the way of teaching make learning a pleasant and exciting experience leading to the development of a love of learning?

7. Do pupils feel encouraged to ask questions?

8. Does the method of teaching increase individual responsibility and provide opportunities for each pupils to organize his/her own learning?

9. Does the method of teaching facilitate the development of process skills of observing, interpreting, hypothesizing, planning, measuring, recording, raising questions, and abstracting (generalizing)?

10. Does the teaching method promote reflective thinking/analysis?

Instructional Materials:

1. Are instructional materials selected to stimulate individual learning action?

2. Are the selected materials appropriate for the concepts/processes being developed?

3. Are the instructional materials adaptable for individual study and small-group study?

4. Are the instructional materials safe for the target group?

5. Are clear instructions given to pupils on the effective use of the materials to attain the stated objectives?

6. Are the content ideas successfully abstracted from the activities involving manipulable materials?

7. Is the chalk-board effectively used?

8. Are textbooks informatively used?

Time Management (Opportunity To Learn)

1. Does the teacher give the class enough time to work on learning tasks?

2. Does the teacher provide enough time for written class work?

3. Does the teacher provide enough time to review class work and the whole lesson?

4. Does the teacher firmly but fairly deal with disruptive students to prevent unnecessary time loss for learning?

5. Does the teacher provide enough time for guided pupil-pupil interactions and teacher-pupil interactions?

CLASSROOM OBSERVATION GUIDE

TEACHER:_____ GRADE:_____ DATE:_____

SUBJECT:_____ TOPIC:_____

	Classroom activity	yes	Comments
1	Does the teacher encourage the free exchange of questions and ideas among pupils?		
2	Is the teacher tolerant of deviations of interests, values, intellectual capacities, creativeness and competencies?		
3	Is the lesson flexible enough to give the teacher considerable latitude in the selection of experiences appropriate for each learner?		
4	Are the lesson objectives clear and appropriate for the target grade?		
5	Has the assumed knowledge been adequately identified and verified before new ideas are introduced?		
6	Are the selected class activities challenging but solvable?		
7	Do the teaching methods stimulate the pupil to individual exploration and learning and lead him/her on to new and widely varied experiences?		
8	Does the method provide an active rather than a passive role for the pupils?		
9	Is the teaching integrating small group, individualized and large group approaches?		
10	Does the teaching stimulate responses at various levels of ability?		
11	Does the teaching stretch the thinking of pupils at all levels?		
12	Do pupils feel encouraged to ask questions?		
13	Does the method of teaching increase individual responsibility and provide opportunities for each pupil to organize his/her own learning?		
14	Does the method of teaching facilitate the development of process skills of observing, interpreting,etc.		
15	Does the teaching method promote reflective thinking/-analysis?		
16	Are instructional materials selected to stimulate individual learning action?		
17	Are the selected materials appropriate for the concept-s/processes being developed?		
18	Are the instructional materials safe for the target group?		
19	Are clear instructions given to pupils on the effective use of the materials to attain the stated objectives?		
20	Are the content ideas successfully abstracted from the activities involving manipulable materials?		

APPENDIX 3.2

- Background questionnaire used by the UZ Project for teachers involved in the project.

- Graphs from Kuiper (1994) showing the level of education of the Project involved teachers.

Confidential information of teacher academic background :
(This information is needed for the project research and will be used only for this purpose. Any written documents or papers will not use names of the informants.)

NAME: _____

SCHOOL: _____

1. Where did you attend:

   Primary school _____

   Secondary school _____

   Teacher training _____

2. What is your highest academic qualification (ZJC, O, A, other)? _____

3. Which of the following did you pass? (yes or no)

   ZJC maths _____ "A" maths _____

   ZJC science _____ "A" science _____

   ZJC english _____ "A" english _____

   "O" maths _____

   "O" science _____ other _____

   "O" english _____

4. Were any of the above subjects studied by correspondence (Distance Education)? If yes please explain. _____

   _____

5. What type of Teaching Certificate do you have?

   PTL _____ T3 _____

   PTH _____ T4 _____

   T1 _____ CE (Inservice) _____

   T2 _____ CE (Preservice) _____

   Other (please explain) _____

6. What year did you receive the certificate in question 5 ? _____

7. Are you currently enroled in a DE (Diploma) or other course?_____

(If YES please explain)_____

_____

8. Pre-service training for Mathematics -

Main Subject (if maths was your main subject):
Hours/week _____ Weeks or years?_____

Applied Teaching Methods in maths:
Hours/week _____ Weeks or years?_____

9. In-service training for Mathematics:

Seminars _____

When? _____ Where?_____

Workshops _____

When? _____ Where?_____

10. Involvement in Maths curriculum development:
Have you been involved at any of these levels (please tick)

School ____ Regional _____

District _____ National _____

If the answer to any of the above is yes please explain: _____

_____

11. Pre-service training for EAS:

Main subject (if EAS was your main subject):
Hours/week _____ Weeks or years?_____

Applied Teaching methodology:
Hours/week _____ Weeks or years?_____

12. In-service training for EAS:

When? _____

Where?_____

By whom?_____

How useful?_____

13. Involvement with EAS curriculum development:
Have you been involved at any of these levels?

School _____ Regional _____

District _____ National _____

If yes to any of the above please explain. _____

_____

14. How many years have you been teaching ?_____

15. How long have you been teaching at your present school? _____

16. When did you become involved in the UZ Project? _____

17. What grade are you teaching now? _____

18. What grade have you taught longest? _____

19. What grade do you prefer to teach? _____

20. What was your subject of specialization at Teacher Training College?
_____

21. What subjects (english, maths, etc.) are you most comfortable teaching?

a._____

b._____

22. Which subject (or subjects) do you find most difficult to teach?

a. _____

b._____

23. Please explain your answer to question 22.

_____

_____

_____

24. Teacher Training(maths):
In college approximately how much of the Applied Teaching Methods course was 'activity oriented/hands on' and how much was lecture?

_____

Do you feel that the course above gave you an opportunity to expand your understanding of the concepts you are expected to teach?

_____

Do you feel that the course above prepared you for the teaching approach (child centred - problem solving) used in this project?

_____

25. Teacher Training (Environmental Science):
In college approximately how much of the Applied Teaching Methods course was 'activity oriented/hands on' and how much was lecture?

_____

Do you feel that the course above gave you an opportunity to expand your understanding of the concepts you are expected to teach?

_____

Do you feel that the course above prepared you for the teaching approach (child centred - problem solving) used in this project?

_____

26. The following questions pertain to teaching resources:

A. Books(maths) Teacher's Pupil's

Publisher?

How many?

Are these helpful for preparing 'problem-solving' lessons?_____

B. Books(EAS) Teacher's Pupil's

Publisher?

How many?

Are these helpful for preparing 'problem-solving lessons?_____

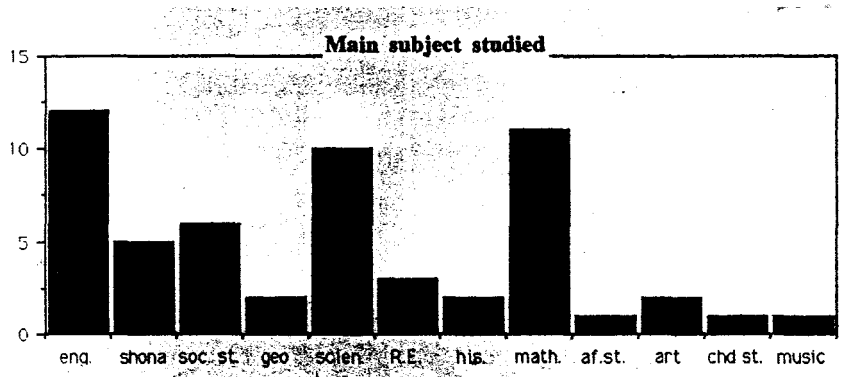
C. Do you have access to any other books (own, library), or resources for lesson preparation? _____

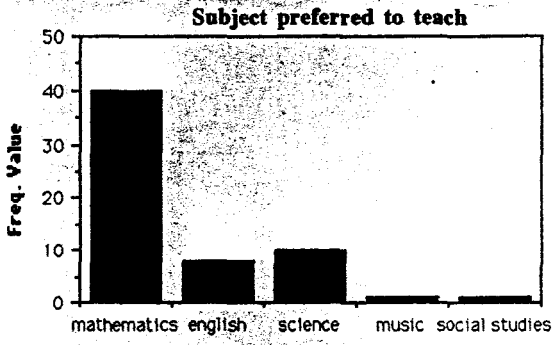
_____

Please explain_____

_____

The following graphs were the result of an analysis of the questionnaires on the previous page. The analysis was done in 1994 by Dr.J. Kuiper of the Department of Science and Mathematics Education, University of Zimbabwe.





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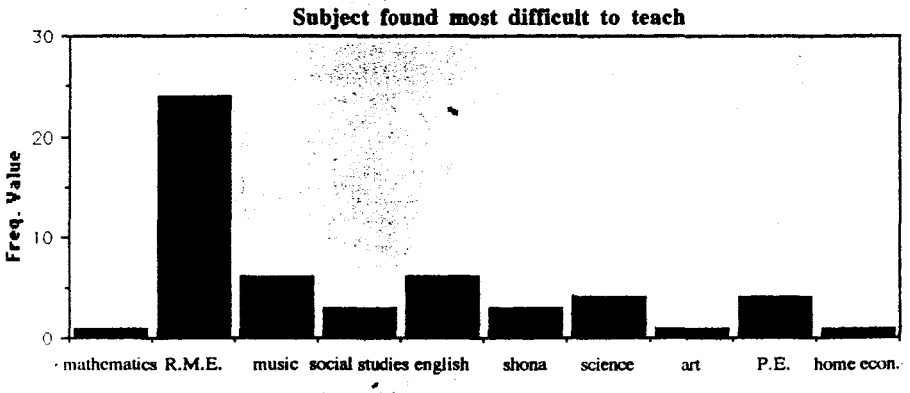

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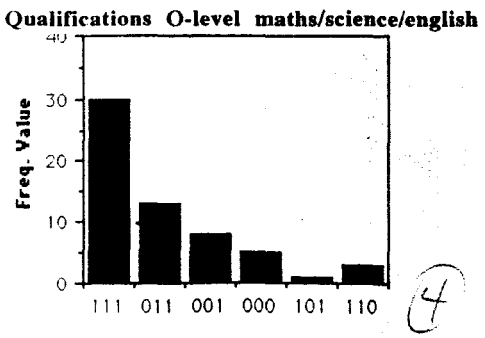

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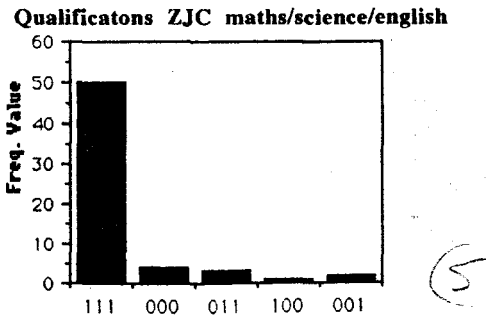

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APPENDIX 4

4.1 Ethnography of School Communities

4.2 Teachers' Autobiographies

4.3 Inhibitors - Charts

4.4 1994 Grade 7 General Exam

4.5 Equipment/materials List

4.6 Materials (Examples) Used in Workshops

APPENDIX 4.1

ETHNOGRAPHIC LOOK AT THREE PRIMARY SCHOOLS:

COMMUNITY CONTEXTS

This Appendix was written by the researcher to give an ethnographic look at the community contexts within which the transposed pedagogy was to be implemented. Appendix 4.2 includes autobiographical writings of some of the collaborating teachings.

It is important to see the three school environments as fairly typical of the environments within which the teachers represented autobiographically grew up and now live and work. The following is a description of three schools that are typical of the schools involved in this study. Two of the ten collaborating teachers teach in farm schools, three in the mine school, one in a mission school and four in rural district council schools. The first is a farm school, second a mine school and third is a district council school. The descriptions come from research notes and discussions with teachers at the schools. The farm school was visited six times during 1993, including one weekend visit to socialise with the teacher involved and her family. There were four other farm schools visited regularly as well and these are referred to where differences are noted. The district council school was visited eight times over 1993-94, with home visits to the teacher and village homes. The district council school description is a composite of several similar schools that this researcher has visited over the past seven years in the same district, as well as the fifteen other rural schools visited during 1993. The mine school was visited over 15 times in 1993 and again in 1994.

4.1.1 FARM SCHOOL - Beacon Hill

This farm school is similar to many the researcher has seen. There are some farms that have made an effort to provide upgraded accommodation and services for the labourers, but this description fits most of the workers' compounds that the writer has visited. Grove Farm is a medium sized commercial farm which employs about one hundred full time labourers and another hundred as needed. These latter may be migrant people for harvesting or the families, including children of the full time employees. The farm has one owner, whose family emigrated from England after the first world war. A farm manager, lives on the property as well, in this case one of the sons of the present owner. The owner and manager live in western style houses behind barbed wire fencing left from the war of independence. They have all the modern conveniences, including a pool and tennis court. Holidays are spent in Kariba on a houseboat, or hunting. The children of the owner and manager attend boarding school. The farm is run as a mixed farm, growing year round and using irrigation from its own dam for limited winter crops. Potatoes, beans, maize, are grown, along

with peas, cabbage, broccoli as winter crops. This farm does not grow any of the big export crops such as tobacco, cotton or flowers, but is considered a viable commercial venture.

THE COMPOUND: The labourers live in a compound within the farm fields. The houses are mud or brick rondevals with a shared water pipe and blair toilets (pit latrines). None of the homes have electricity. There is some space near and within the compound for small kitchen gardens where the families can grow vegetables. Chickens roam freely around the compound but any other livestock such as goats, are not allowed. Families may buy milk and occasionly meat from the farm at reasonable prices. Teachers have two or three roomed brick and cement houses next to the school. These houses as with most school compounds are set away from the rest of the village, with separate ablutions and water supply. They have no electricity or phone. There is a roofed, open air communal meeting room and a five roomed school within the compound. Slightly away form the compound and nearer the main road is a small shop for necessities such as mealie-meal, cooking oil, paraffin, and soap. This shop is run by the farm owner for his workers, often on a credit system.

Inside a thatched hut: The workers houses here are very neat, the clay around the huts swept clean every day, with marigolds in little clumps near the doors. The rooms are small, about three metres in diameter and are usually in clusters two or three per family, with a kitchen hut, sleeping hut for parents and babies and occasionally huts for the older girls and boys. Fired clay bricks from clay brought to the farm from across the valley are made by the farm labourers for housing. Inside the kitchen hut is similar to other rural Shona kitchens, though not as large. Polished floors made of mud from termite mounds, or very occasionly cement, are met at the walls by a solid raised seat made of the same polished material. At the far wall across from the door the raised seat area is slightly deeper and is used to store pots, water jugs, and some food supplies. Other cooking utensils are next to the fire or outside on a drying rack built on stilts away from chickens and dogs. On this farm the workers are encouraged to use paraffin for cooking as there is limited wood supply. This may be bought from the farmer at cost. There may be one or two wooden or cane chairs, reserved for the men or visitors, while straw mats are used by the women for seating. The sleeping hut will sometimes have a modern bed, but often sleeping mats. Blankets and clothing are folded and stacked or hung on the walls. Few of these workers have cupboards, though they may have a suitcase or trunk for locking.

The workers on this farm have rather poor accommodation. Other farm owners may provide cement block single, or double roomed row housing, or detached three-four roomed houses. Often there is quonset-hut type housing for single workers. Electricity is usually supplied to the manager's house and any offices or farm buildings where it is needed - not to labourers housing. Sometimes the school and teachers homes have been electrified, in which case teachers might be charged a small fee for housing.

Toilets are dug, blair type pit toilets. There is no ablution block as there is no running water. Water for washing and cooking is brought by women and young girls from a borehole tap next to the compound. There is a seasonal stream nearby that is used for

washing and bathing in summer. The dam is occasionally used for fishing but mostly reserved for the irrigation usage and the farm owner's children's canoe.

Food: The diet of the farm labourers is similar to rural people, except that occasionally more fresh vegetables are available from farm surplus than would be possible in winter in some rural areas without water for irrigation. The staple is maize meal porridge, soft for breakfast, and a stiff porridge for supper. This is served with sour milk for breakfast (or any time for children) and vegetable 'relishes' at other meals. Meat or fish are reserved for holidays if there is no money, and more frequently if there is money. The vegetable relish usually consists of a cabbage type green, fried with onion, tomatoes and salt. Sweet potatoes, pumpkins, beans, and 'green' (young) mealies, are boiled or roasted next to the fire. This particular compound does not have clay ovens for baking bread, so this favourite food must be bought at the farm store.

The population: Farm schools are located on large commercial farms throughout Zimbabwe. Historically, when colonial farms expropriated land from indigenous people, those needed for the farm labour force might stay on the land, while others were removed to 'tribal trust areas'. Of the six farms whose schools were participants in the UZ project, all had farm labourers originally brought from Malawi, as well as Shona people. "Malawi workers were better... they were willing to work and not give any trouble," one farmer explained to me. At Beacon School teachers explained that there were now Mozambique refugee workers, though they were unsure of their immigrant status.

Economically, the farm labourers are among the poorest of Zimbabwe. They own no property, earn very low wages and have no social security. They have no security when land is reclaimed for resettlement and may be removed from their homes when new landowners arrive. Part of this has to do with the policy of resettling Zimbabweans first (and many farm labourers are not Zimbabweans) and resettling persons with experience or agricultural certificates. The farm labourers of Grove are mostly unskilled, minimum or part time employees, illiterate and non-english speaking.

The languages spoken are Shona and a mixture of Malawian dialects. Recently Mozambique languages have entered the compound but the adults have been forced to learn Shona for work. Language separates the workers by place of origin, which in a family centred society leads to lack of co-operation and harmony. On other farms the workers are all one village, related and with several generations of history on the farm. Teachers on this farm do not come from the farm, nor are they related to the people. Two of the women are from different tribes, being Ndebele rather than Shona.

Many of the young people had stopped school after primary grades, especially the girls. Young girls stayed with their families and worked part-time in the fields. Boys often left for Harare to try and find work, returning during busy farm seasons if they didn't get a job. Few elderly people were on the farm unless they had family to look after them. There is no retirement arrangement between farmer and labourers, however persons who have been there most of their lives, are allowed to stay in their

homes after they retire - if they have children who still work here. In other instances persons nearing retirement are encouraged to return to "historical home areas".

The student population: Due to the mixture of the farm labour population, the children were a mixture of Shona, Malawi, and Mozambique. There is no preschool, and the headmistress explained that the normal entry age for grade one is seven years rather than six since "the children have no discipline...it takes almost the first year just to get them to sit quiet." As she explained further " the children come from parents who do not understand school...most never went themselves since before independence this farm did not encourage school...they don't learn how to behave in school or why they should learn anything."

As explained further in Chapter 5, the background of these children provides a challenge for the teacher under any circumstances. For example the class of Mrs. G. which was the composite class of grade 4-5 had eight children out of thirty five who could not read or write english or shona. Some of this illiteracy is due to children of migrant workers or refugees entering school for the first time at ages of eight to nine years old, without shona or english as a spoken language. Other possible problems the teachers attribute to learning disabilities which none of the teachers at Beacon were trained to identify or work with. During the time of this research my visits an education officer came once to give a session on teaching remedial reading, but nothing was done to identify why the children couldn't read.

The children live only a few metres from the school so do not have the long walk to and from school that other rural children have. As the teachers explained this fact meant that children were often available after school to do school projects and sports. Each time this researcher visited the children were on the school ground, playing or doing some project for the teacher. There are other times when absenteeism is high. Although the government frowns on child labour the children usually help their parents during busy times. This helps with family income.

At home the children do not have desks, writing materials, or lighting after sundown, or parents who can act as resource persons for school projects. Some of the children were in school uniforms but others wore whatever they had.

The School Within the Community: The school is an old fashioned one story structure with the five classrooms opening onto a wide veranda, and the headmistress office in the centre of the block. There are no windows opening onto the veranda except one to the head's office. Each classroom has windows facing the door and looking out onto a school vegetable garden. Mrs G's classroom is rather dark, with only a few windows and dark polished cement floor, unpainted asbestos roof and open beams. The walls need paint but are as in most schools covered in posters and children's work.

Of the five classes one is 'composite' (terminology of the teachers), or as they are called in Canada, a 'combined' class of grade four and five. Some other grade five students are in the grade six 'composite class. There is no grade seven, as the farmer has refused to build another classroom and teacher's house. The older children go to

the next farm school about eight kilometres away. They walk, hitch or get a lift on a farm truck (not a regular occurrence).

Mrs' Gumbo's classroom: As one enters the room thirty-five children of assorted sizes stand up from their five long tables and benches to give the traditional greeting in unison " Good morning sir...How are you? ...We are fine." There is a single table and wooden chair for the teacher and a small set of shelves where class supplies are kept. Alongside the homemade beam balance the textbooks and children's exercise books are stacked when not on the five student tables. Another small shelf has been made to store bottles and a home made abacus. One corner of the floor has been turned into a nature corner since the start of the project, with a model village made of clay by the children. An aquarium made from a large plastic bottle contains some small fish from the farm dam.

The children share most texts and reading books. There is one copy of the EAS text for every three children. There are no resource books or workbooks, no science equipment, except the small kit given to the school for the project. This kit is kept in the head's office and has not been used so far. The teacher has made a beam balance from scraps of wood, and used plastic juice containers to make some funnels and containers. There is one world globe, kept in the head's office except when needed. There is no storage space in the classroom.

The teachers and administration: The school must be physically looked after by the 'responsible body' which in this case is the farmer. The teachers salaries, and a small annual grant to the school, come from the Ministry of Education and Culture. This goes to buy two exercise books per pupil, chalk and paper for the teachers, and a small travel allowance for head and teachers (if necessary) to visit the Ministry or attend a workshop at a nearby school.

The headmistress and one of the four teachers, have teacher college certificates. The other three are unqualified, what is called 'temporary'. One has 'O' levels but needs one more to get a position at a teachers college and the other has an unfinished course. The teachers are given free housing by the farmer. The two teachers with teacher college certification receive pay of approximately ZW$1200/month net. Their tax deductions would have been around 50%, since as women they pay more than men who would pay around 40% at the same salary level. A single woman with dependants can claim and pay less tax. The non-certificated temporary teachers earn under ZW$1000.

All the teachers were women, four of them married. Mrs Gumbo, her husband and three children live in three rooms plus a cooking area. All the teachers have a relative or a young girl from the farm to cook, clean and mind children. These workers are paid under the government legislated limit of ZW$160/month, but are fed with the family.

4.1.2 MINE SCHOOL - Goldtip

The mine compound: This primary school is situated within the living area or compound of the mine workers. This particular mine is a gold mine, located about twenty-five kilometres from Harare. There are several housing developments within the general compound, sports fields, a club for management, where there is a pool not used for school activities. There is a clinic and social services. There is a small service community within two kilometres for the mine workers and nearby farms. Here there is a post office and some general stores, mostly for food and hardware.

Housing is owned by the mine and rented for a nominal fee of around ZW$45/month depending on whether there is electricity. Water and electricity are free. Indoor plumbing exists only in management houses. Most houses are four or five rooms, comprising a living room, kitchen, and two or three bedrooms. There are some facilities for single persons, but most people either have families or share housing.

The population: The management population, now mostly indigenous, send their children to private or public type 'A' schools in Harare. These schools are usually originally 'white' schools with better facilities and material resources. The general labour force come from all over the country but are mainly Shona, with a mixture of immigrant workers, and other Zimbabwe tribes. The working language is english. The average wage for the non-skilled mine workers is around ZW$450 per month net. This is approximately the same or lower wage that a clerk in a grocery store makes, and less than a security guard. The minimum wage in Zimbabwe for domestic workers is ZW$210. The low rents and subsidized electricity, health care, are some of the perks that add to the real income. Most workers are unskilled, and functionally illiterate. There are no adult education classes though some mines encourage adult classes.

The School: The 'responsible authority' for the school is the Goldtip Mine Company. There is a Parents Association which is quite supportive of any changes that will help their children pass grade seven. Economically there is not much support the parents can give as can be seen by their wages. The school has sixteen rooms, including a library, and a special education class, now taught by Mrs Shumba. There is a pre-school for the five year olds, a few hundred metres away. The school compound has a few old buildings and two new blocks where the grades four-seven are housed. All the new classrooms have windows on two sides, making them quite light and airy. The newer classrooms have electricity outlets as does the administration block. Toilets are flush type in blocks for male and female, shared by students and teachers. Generally the school is well looked after by the mine.

The school yard has the usual hedges and flowers and trees that are exotic, as in colonial times. There is a large school garden with fruit trees, terraced vegetables and seedling trees. Crops grown in the garden are now for sale in keeping with the ministry suggestion for environmental science that there should be "education with production" . All classes from grade six and seven are expected to work in the garden. Until recently the garden was never the site of experiments with different

growing conditions or crops. Now there is some co-ordination between learning in the classroom and learning in the garden.

The students: The students are mostly from low income families whose parents may not have much schooling. Unlike the farm children, these have a relatively privileged home life. All families have at least one person employed at the mine, so there is a stable income. Families have luxuries like radios and televisions, lounge suites and electric hotplates. There is relatively easy access to the city of Harare. Their use of English was not as good as expected but teachers explained that many mine workers came from Malawi and Mozambique.

Teachers and administration: As in all government sponsored schools, teachers are paid by the government. Almost all teachers have certificates or the pre-independence primary PTL certification. Salaries range from ZW$ 2100 to 2400 gross, depending on qualifications and years of experience. The mine does not top up the salaries but does provide subsidized housing. Most of the teachers in this school have teaching certificates and there are only two "temporary" teachers substituting for teacher on maternity leave. These two temporary staff are children of other teachers, using this term of work to earn money for "A" level courses.

Except for the usual low salaries, working and living at this school, so close to Harare, is considered a good position. There is quite a lot of competition among the senior teachers to increase the pass rate for grade seven which is still very low. The headmaster is a respected member of the mine administration community. He was able to arrange dinner in the company club for visitors. He also had a small business that occupied his time off.

Visit to a teachers home: Teachers pay the same rent as mine workers, ZW$45/month. Mr and Mrs Shumba, both teachers, lived in a new development about two kilometres from the school along a rough dirt track, but still inside the mine property. Their rented house is cement block with a small veranda. It is unpainted on the outside, with five rooms, including a toilet/shower room. The living room is small and crowded with a two seat settee and two chairs, plus coffee table and a corner cupboard with radio and TV. Relative to teachers in rural areas they were well off with free electricity, and running water. Mr.and Mrs Shumba work hard to provide themselves with these comforts and luxuries, including beds and cupboards. Eventually they intend to replace the hotplate with an electric oven. Before moving here they had lived and taught at two rural schools with "poor accommodation" as they put it. They have two small children, and a domestic to mind them as well as do the housework and cooking. A few of the teachers live in the old "white" teacher's houses which are larger though rather run down now. Some of these old houses have large gardens which are used by the teachers to grow vegetables and fruit.

4.1.3 RURAL DISTRICT COUNCIL SCHOOL - Chiribo

Chiribo School is about three quarters of an hour drive from Harare, and ten minutes drive from the nearest 'growth point', where there are a few shops, post office, police station and a beer hall. This district has always been a 'traditional homeland', or 'tribal trust' as it was termed during colonial rule. Now the area is administered by a rural district council, while the chief also has jurisdiction over many matters such as land use.

The farms are all 'right to use' grants from the chief to families. Areas that are not fields are held in common for grazing of cattle and goats. Many of the farms are run by women, as the men are working in towns, mines and even farms. Family compounds are often seen with unused houses that are actually built and owned by mine or city workers and left for holidays and retirement. Older wives return to the homes to stay, while younger ones return to plough and then return to their city lives, paying another member to maintain the crop.

The agricultural value of the land is marginal. The drought of the past few years has caused hardship which can be seen in feeding schemes for the younger school children. There are no dams for irrigation, and only a few deep wells used communally. Farming is mainly of maize and vegetables. This is not a good area for tobacco or cotton so there is little for cash cropping. There are few trees left except around the religious or chief's burial ground. Agricultural extension workers live in the community, as does a nursing assistant who operates the two room clinic. There is an electricity line along the main road to Malawi, but few businesses can afford to "hook up" to the line. The clinic has solar lighting and the school and community hall have no electricity.

Population: This area has a traditional rural agricultural population. About half of the men are working in the city or mines, while the women farm their husband's plots. The majority of the population is female or children. The lifestyle of rural peasants is described in several of the autobiographies. Many households depend on cash from family working away from home. Weekends buses come heavy with fathers, brothers, and wives returning with a portion of their husband's wages. The amenities are few, diet mostly maise porrige and vegetables, with minimum protein, especially in drought years. The children live at home and walk to school. Since independence there have been many new schools built, thereby lessening the travel distance for children. Some in this district walk up to eight kilometres each way. Children start school here at six or seven years old. There is a one roomed creche nearby where two young women mind forty five-year olds. Each parent pays a fee or shares in the work. Most of the families use the creche when the woman is busy with ploughing or harvesting.

School: The responsible authority is the district council, with the parents association playing a major role for repairs and fundraising. The parents made all the bricks to build this school and provided labour . The government and a foreign donor provided

the beams, cement, windows and roof. Tables and benches are made by a local carpenter and paid for by the parents' association.

The school consists of two single story blocks parallel to one another. Between the two blocks are small paths lined with painted white rocks, labelled exotic trees and flowers. In the dry season there is no grass and only a few aloes remain to bloom in June and July. There has been no attempt at this school, unlike some other rural schools, to decorate the outside walls with colourful graphics and wise sayings. There is a school garden which is only used in the rainy season, since the school well is not very deep and has trouble providing for teachers' houses and student drinking water. As in most rural schools the toilets are pit latrines, built by the parents with home made bricks and their own labour.

Teacher housing: Mr Nyathi lives in his own home near the school. Most of the other teachers live in housing provided by the school. The teacher housing next to the school has no electricity, with each teacher getting only two rooms plus a shared, open kitchen. Many of the windows are broken, and though the pit latrines are of the new 'blair' type, there is no running water for showers. The teachers complain that there is no incentive to stay at this school, with such poor housing. The parents complain that they have no money or time to build big houses for the teachers. Mr. Nyathi whose family comes from this district originally, has applied to the chief for land and been granted a smallholding to build on. His wife supplements his income by farming.

APPENDIX 4.2

ILLUMINATING TEACHER'S LIVES THROUGH AUTOBIOGRAPHY

INTRODUCTION

> Teachers' stories clearly illuminate the way in which teachers's early personal experiences and personal development have a profound influence on who they are and who they become as teachers...(and) the inevitable individuality of professional development is underlined. (Raymond et al 1992:159)
>
> ...we seek to reclaim the right to intelligently examine our own lives even as we are deeply and personally in our own context...As chroniclers of our own stories, we write to create ourselves, to give voice to our experience, to learn who we are and who we have been... (these) stories of our journeys through life, stories that are both instructive and transforming in the telling and the listening." (Cooper 1991:111).

The chapters that address factors that can inhibit change or professional development, will be better understood if seen through an introduction to the teachers whose lives are presented by themselves in this chapter. The following autobiographical accounts include comments by this researcher that are biographical and compliment the self writing. This commentary is based on conversations with these persons over a period of almost two years. As Goodsen (1992) points out teachers constantly use examples from their own lives when in discussion groups or in conversation with researchers. This is usually left out of the research results thus giving no importance to what teachers believe is important - their own lives.

The autobiographies were not structured by the researcher, thus leaving what would be told up to the individual. There was much variation, both in what was told and the storytelling ability of the persons. Critical reflection of their lives and teaching was also quite individual, as the aim for the autobiography was to present their lives with more reflection and analysis to come at a later stage. All of the nine teachers who wrote for this researcher expressed a desire to continue with a biographical approach to their in-service. They were quite excited with this beginning. As the collaborative group wrote:

> You (the researcher) grew up in a place like we see in our texts. you did not grow up during a war... most of us rural teachers were from peasants...very poor. You (researchers) come to our schools and bring us to the workshop and we talk about teaching but not about ourselves...It is nice when you ask us about ourselves, and have tea in our

> house...then we are proud that you want to know us...not just as teachers... Writing about ourselves we want to do each in our own way first, then later we will write together. It is important that people in your countries know who is going to have to use these new innovation ways...perhaps it will help to explain why things don't happen here just the way you want (Collaborative teachers, 1994).

How to arrange the autobiographical writings has been a difficult decision. One way would have been to draw a composite picture of the teachers lives by breaking them into segments, putting all early, middle and later episodes together. The researcher decided to illustrate the individuality of teachers by giving examples of life stories as told. This means that some stories cannot be told here; however the other teacher's stories are used as commentaries throughout the other sections.

"HERE WE ARE: LISTEN TO US WITH YOUR EYES AND YOUR HEART" (Mrs G 1995 pers. comm.)

• TEACHER A: Ms Kandikita

I was born in May, 1967 in M...under the C...district of Mashonaland West. I am the fifth child in a family of six which is made of up four boys and two girls. My parents are peasant farmers, though my father was once a teacher in his early age, but was forced to retire due to poor health. He retired before I was born. My mother told me that I developed so fast that I walked at the age of six months.

Researcher comment:

Shortly after we started to visit Ms Kandikita, in 1993, she "inherited" a baby boy from her brother's wife who had recently died. This small infant was given to her since she only had one child of her own, was unmarried and employed, therefore could afford to take care of this extra child. Being her brother's son the boy would in any event look upon her as "mother" and have some responsibility for her in her old age. Her daughter, born in 1897, sometimes attended project meetings at UZ with her mother, especially if they were visiting friends in Harare after the workshop. Ms Kandikita never explained her marital status, but was emphatic about her status as an independent woman.

Life as a student: I attended primary education at M... Primary school, in the C...district in Mashonaland West. I started grade one in 1973 and was forced to repeat grade seven in 1980 due to political instability. Since I started grade one up to Form Four I was either number one or two in place. I never dreamed of being number three or four. In 1981 I started form one at M.. as one of the Upper Ten Pioneers. I sat for my "O" level exam in 1984 and managed to pass five subject, although most of the teachers in those days were unqualified "temporary" teachers.

I then worked as a temporary teacher from 1986-1988. From 1989-1991 I was training as a primary teacher at M... Teachers College where my main subject was Art and Design.

Speaking of frustrations: I was greatly frustrated in 1980 when I failed to do form one. I had to spend most of my time crying. Fortunately, in the second term of 1980 I managed to repeat grade seven. This was all due to political instability for the struggle for Zimbabwe, that many of us were forced to wait for secondary school places and/or repeat grade seven. When I was at secondary school, most of the teachers were unqualified; others were holders of J.C. certificates (Junior Certificate which was equivalent to two years study beyond grade seven). We had to work very hard in order to pass. Again, I sweated in order to enrol at one of the teachers's colleges in Zimbabwe but always got negative responses. I even visited M..., N... and others, but it was a waste of time. Finally in 1989 I got a place in M...College of training as a Primary Teacher.

Aspirations: Now, I want to further my education, both academically and professionally. I want to write `A' level so that I can strike a chance to enrol with the University of Zimbabwe. I also intend to be a prosperous businesswoman in the years to come.

Researcher Comment:

Ms. Kandikita lived in a rural community about an hour from Harare. She had been assigned to the school which was not in her home district. Her school was similar to the one described earlier, with absolutely no amenities other than a shared community well. Housing provided by the school consisted of two rooms, sparsely furnished but spotless. She had her own garden plot (besides the school one used by pupils), and kept the rabbits her class were raising for an environmental science project, in a shed near her house. She employed a young girl from her extended family as domestic worker and to look after the baby.

Professional life and relation to the project: Ms Kandikita was one of the teachers with least teaching experience; two years as a temporary teacher before her teacher education, and two years as a certified teacher. Her time as a temporary teacher she described as difficult financially, yet providing her with independence after the birth of her child. Temporary teachers, she explained, were used as a stop-gap for teacher shortages after the expansion of public schooling with Zimbabwean independence. Many were poorly educated at the start, as were her own secondary school teachers. Others, like her, were used for several years after passing "O" levels to teach primary or secondary. During the time they were teaching they could continue to apply for a place at a college and usually did get one after a few years. The government provided a bursary for all students at the college, so for her the two years were like a pre-payment for the teacher education.

Professionally, she was one of the more assertive, and co-operative persons in the group. Some of this seems to be explained by her position as an independent woman

in terms of marital status. Further, she was the first woman to show creative imagination and ability to use "problem solving" as a teaching method. Her diary included children's responses, alternate conceptions and her strategy to "get them on the right track". She was the first teacher to use folk tales and indigenous knowledge, during lessons, especially as introduction.

During the last "enrichment workshop", which was on the human immune system and AIDS, Ms Kandikita was asked to act as facilitator for the final session. The teachers were to present short plays or other participatory teaching resources to show how the immune system worked and/or how AIDS interfered with the normal system. She had the same facility to lead, to speak humorously and encouragingly to the groups, as she had started to do in the cluster meetings. Her polite assertiveness did not seem to create jealousy among the other teachers. As with Mr Musoro's speech that last workshop, she showed to the university staff a maturity and self confidence that would not have been exhibited in a group setting the previous year.

Ms Kandikita is studying for "A" levels by correspondence. She wants to have two courses before she applies for university entrance. She isn't sure if she really wants to study primary education but is aware that is probably her easiest entrance to higher education.

- **Teacher B : Mr. Zimudzi**

Personal history: I am a married man, aged thirty-three. I have three children, two boys and one girl, aged respectively seven, three and one. I am the third in a family of five; two girls and three boys. I grew up in the rural areas. Most of my experiences are rurally based although I later came into town in search of employment. Both of my parents are still alive although they separated many years ago when we were still kids. This contributed slightly to the fact that most of my brothers and sisters did not get the best opportunities to do higher education. I am the only one in the family with such a high qualification and maybe a stable job. Had it not been for the separation I would have had the opportunity to proceed to high school and to the University because that was my greatest desire.

Education: In school I liked science and Mathematics most. I did not do very well at Maths as I would have wanted. My worst subject was history though I passed with a weak grade. I feel I did not like History as it did not offer any challenges. I enjoy mechanical, thought provoking subjects...My highest level of formal education is "O" level which I passed generously in six subjects. After I started teaching I then obtained an additional "A" level qualification in Shona. I attempted Accountancy but did not pass. I have always wanted to pursue further studies in Maths but I have no one to assist me as I am unable to attend formal lessons or lectures.

Professional History: I trained as a primary school teacher from 1982-1986, with Morgan Zintec College and obtained a Certificate in Education. Since leaving college

I have taught for seven years now. I have always preferred to be uppermost in a group. I normally do not like low achievement. I realise my own abilities and contribution in a group and am not shy to speak. I have enjoyed being a leader of the Zimbabwe Teachers Association and Vice Chairperson and an Acting Deputy Head for a long time. I am rather frustrated though that I have been in an "acting" capacity for too long a period than I had anticipated.

Frustrations and vocational plans: It is my long range objective to at least have university qualification. My current status has been purely opportunistic in that it was not my wish to become a teacher. Teaching was then the only other career opportunity available other than nursing. The colonial master did not allow us to engage in other vocational training. I remember way back in 1980 after completing my "O" levels I had got an opportunity to train in the Air Force of Zimbabwe. Although I qualifies in the initial stages, the later stages of the selection procedure were never communicated to us because we were black.

I am currently training as a Personnel Officer, with an Institute of Personnel Management. This complete change in preference comes in the wake of frustration within the teaching profession. Most of my frustrations stem from the long awaited promotional prospects with monetary benefits; and the poor salary and benefit programmes within the Government Services in general. It is my hope that as soon as I have completed the Diploma course I will look for alternative employment.

Researcher comment:

Though he does not mention it in his autobiography, he was accepted into the first group to do a diploma in administration through distance education at University of Zimbabwe in 1993. He discussed with this researcher at the time, his decision not to seek finance for this expensive course. His autobiography explains reasons for this decision as part of his career change plans.

Watching Mr. Zimudzi teach was always a little disappointing. He seemed less at ease than some of the other teachers - more distanced from the pupils. It wasn't until this researcher read his autobiography that she understood some reasons his "performance" was not in line with the expectations based on his workshop participation. He was competent and conscientious, but really not interested in teaching as a career. His present life was preparation for a change in career - a way to earn a living while preparing for the change. The observed lack of "change" in pedagogy in the light of getting to know him better, seems to stem more from lack of interest in classroom teaching that lack of understanding of the epistemology involved. As with other teachers, it was important for him to be involved with the project and he did not disclose any feelings that might jeopardize his position until he felt at ease with this researcher.

In our small group, and in cluster meetings, he was very much a leader. Outspoken and analytical of situations and teachers, he was an important group member. His

ability to critically reflect on what the project was doing, and to speak out, were most important to this researcher when forming the small collaborative group.

- **Teacher C: Mr. Chiruma**

Researcher comment:
There were several older teachers involved in the project two of whom were in the school (Besa) that got thrown out of the project when the expected changes did not occur. University researchers exhibited a negative attitude toward the older rural teachers when decisions were to be made about further inclusion in project work. In the end I pushed to include Mr. Chiruma in the writers group, based on what I saw of his enthusiasm and efforts to be creative, as well as his rapport with his students. He was always open and easy to talk with - perhaps because we are the same age.

Personal history: I was born on 17 August,1945, in G..., 100km north of Harare. I am the eldest son in a family of five. Two are females and three are males. Unfortunately, my mother died in 1955 when I was in Grade 2. The incident was indeed a pour pill to swallow. My father was then working for Mr. and Mrs. B.... as a gardener in the low density area of Mabelreign. Father's wages were very low. He was earning something like half a crown which is today twenty-five cents. Primary school fees were £2 a term, the equivalence of $2 today. Life was difficult beyond mentioning. Apart from that, there was building fee, stationary and sports fees. My poor father could not keep up.

Education: Fortunately, my father sent me to M... Mission where I was brought up and educated by Catholic priests and nuns. After completion of my primary education - standard 6, they instantly sent me for a Teacher Training Course in 1962 at K... College for blacks. The two year training course was called "P.T.L." (Primary Teacher's Lower Certificate). The holders of those certificates taught in the infant classes only.

I had serious financial constraints after obtaining a teachers certificate, because I looked after my brothers and sisters. I paid fees for them. That was a heavy load task. As a result I delayed marrying considerably. My colleagues nicknamed me "Senior Bachelor" or "Father Bachelor". However, I quickly realised the need to advance my education and probably achieve a better status. My monthly wages were $40, too meagre for anything. In 1969 I completed my "Junior Certificate" through private studies. I also worked indefatigably to obtain my "O" Levels which I accomplished in 1990. Unfortunately, one of my "O" level certificates got burnt in my grass thatched house at home during a crossfire. In 1991, I passed my first "A" Level subject. I am still pursuing a few more subjects at "A" Level.

Teaching career: I have taught at various schools in the area of M Mission to show my sincere gratitude to the missionaries for having uplifted me so much. From 1975-1978 I was head of M Primary School. In 1979 I was displaced by the War when the school closed down. I am currently teaching at A Mine school as a grade 6-7 teacher. This year I had my best results from the grade 7 class.

In the long run of my career as a teacher, I have enjoyed and experienced the handling of children ranging from Grades 1-7. I have also experienced syllabuses and textbooks with their old methodologies that are now extinct to some extent. But, the most exciting and current methodology, which is constructivist, is the "Problem-solving Approach initiate by Profs, Dr.H, Dr.J., Dr.K and Dr.S. and the teacher researchers. In my own perspective, the old method was and still is not child centred. It advocated informative aids and approaches. Unlike the old method, I speculate clearly that the "problem solving approach" or "strategy" seeks to explore through the use of manipulatives outright solutions to problems determined by our children. Therefore the inservice seminars based at the University have significantly improved my teaching . I am a better teacher than ever before. My ambitions have therefore narrowly closed up somehow.

Future hopes: I feel my health is sound enough to render more and impact service to my country. Therefore, each day and every moment of my life my ambitions are gradually building up. I hope my dreams will come true one day. I certainly want to obtain a bachelors degree in education so that I become more useful than I am today.

Researcher comments:

Mr. Chiruma's classroom is always a pleasure to enter. The children are smiling and expectant - waiting for the newcomer to engage in conversation with them. Mr. Chiruma admits that he has become much more "active" in his teaching and has made some of the more creative attempts at environmental science resources production since becoming involved with the UZ project. Further he has involved the parents in building models, such as the solar system, simple balances and bug cages. He and the deputy head took the researchers' suggestion to use the school garden as a place of learning, and started terracing, and using experimental trials of crops and plant needs.

"The children never liked environmental science the way it was taught before...now they...and I, look forward to a new lesson." Though he was unsure how much better the children would perform on their grade 7 exams, there actually was a noticeable improvement in the 1994 results (Mr Chiruma 1995 pers.comm.). In his school there were three teachers involved in the project and he felt that they supported one another well, while he worried about other teachers very much alone in their school. Finally in all our conversations, he was anxious to explain how his involvement in the workshops and my school visits, gave him a chance to "break out of old ways...like habits" and get new enthusiasm for teaching. He never spoke of changing careers, but often spoke of continuing learning. We often spoke of the older teachers and the

struggle they had before independence. His latest trouble was to persuade the university to allow him to apply for the one distance course while a continued effort was made to get a new copy of the burned "O" certificate.

He was very useful to the other teachers when they were working in groups, because of his long teaching experience and ability to think creatively. Unlike the young teachers he did not have the "correct" terminology for expressing himself epistemologically and so got lumped with many other older teachers as not understanding what changes were expected in their teaching. I found these criteria frustrating because as a whole person Mr. Chiruma was benefiting very much from his involvement with the whole research team, and exhibited a clear understanding of himself as a person continuing to develop - even in his "middle age" as he put it.

- **Teacher D:** **Mr. Nyathi**

Researcher Comment:

Right from the beginning Mr. Nyathi kept a journal that was reflective and captured what the children thought, as well as his own ideas on how to facilitate their learning. In the last workshop of 1994, he spoke to assembled teachers and visiting researchers, about the project and the writers group. He "blew away" the visiting researchers with his understanding and facility with extemporaneous speaking. Two researchers tried with no success to have him sent to Kenya on a writer's course reserved for "senior researchers". Mr. Nyathi was instrumental in this researcher's coming to an understanding of the development that teachers were undergoing even during periods of no classroom change. His school was about an hour from Harare, in a rural communal area. This researcher had one of her best interviews with him the day she forgot to bring the interview schedule! He was the first person to openly show the critical reflection that drew this researcher from despair of the project to hope through the teacher development that had almost inadvertently occurred.

Personal History: I was born in a family of seven (including father and mother), in 1958 on 29 December, in a small remote village called C..., which was situated in the northern part of M district in the Zimbabwean province of Manicaland. I am the second born with one younger brother and three sisters. My parents were permanent village dwellers who practised peasant farming for survival.

Education: I started my primary school education at an age of nine at St.M primary school which was nearly 15 km away from our home. Despite the long distance I travelled on foot to and from school each day, I enjoyed all my school days. I was very intelligent and obedient at school. The only stumbling blow throughout my education was finance. But in spite of all such hardships, I managed to sail through my primary education and passed with flying colours in Grade 7. I obtained two units that is Maths one and English one. This was in 1973.

I had no hope to go to a boarding school as I knew that my parents would not afford. Somehow miraculously my grade 7 teacher stepped in and persuaded my father to try. He was given an assistance that he would manage it. My father agreed and my teacher telephoned to several boarding schools footing the phone bills himself to secure me a place because I had not applied. A vacancy opened up at St M secondary in N town of Manicaland province.

I started form one in 1974 and completed "O" level in 1977. It was not an easy journey because of finance. My parents had to sell most of the livestock they had and they had to suspend the education of my young brother at grade 7 level so as to create enough money to get me through. Finally I crossed the river with good passes at "O" level - that is Maths A, Physical Science B, Latin B, Geography B, History B, and English Language C.

The waiting: After "O" level I knew certainly that is was impossible for me to go for "A" level education because of finance. So in 1978 I left home for Harare to seek for employment. It was not until September of 1979 that I got employed at Scottish Jewellers in M as a clerk, It was hard for me to get employment because employers wanted to employ only people who had served in the national army. Personally I did not want to join the army so I decided to stay.

Teacher education: I worked at Scottish Jewellers up to December 1980. In 1981, January, I left and joined Morgan Zintec college to train as a primary school teacher. During the next four years I did teaching practice at three different schools. I graduated in August of 1985 and was posted to G.. primary school to start my teaching career.

At G.., where I am still today, I have gone through various walks of school business. I have taken responsibilities in training athletics, football, physical education, gardening, tree growing, and I have been an outstanding remedial teacher in the past years. Now I am the senior teacher in the school, one who works hand in hand with the head and his deputy in running school affairs and making decisions.

I am also the school's representative in the group of teachers who are pioneering the new teaching approach called constructivist approach. I joined this programme in 1993 in January, I am doing well having been promoted to part of the teacher writer group and most recently to become an editor of other teachers work. ...It has been beneficial to me...Personally I have been transformed to a new teacher, a teacher who now draws his lessons from pupils prior ideas and a teacher who poses challenges for the children to learn rather than tell them what to do.

Researcher comment:

Mr. Nyathi did not comment on future plans in his autobiography which most other persons did. From other conversations with him this researcher is aware that he has put down roots in the school community, owning a house and land that his wife farms. He wants to move into the deputy head position eventually and sees his commendation

from the project as helping with his future role in the school. Unlike some of the younger teachers he does not talk about changing career.

- **Teacher E: Mrs. Shumba**

Researcher comment:

Mrs Shumba was first involved with the project in 1992 and when she went for maternity leave introduced her husband to the project. They changed schools after the first term but their new school (the mine school described earlier) was added to the growing list of involved participants. Mrs Shumba is a storyteller. She and her husband took their autobiographical writing very seriously and presented this researcher with two exercise books , each containing photocopies of photos, and lengthy but fascinating stories of their lives. Mrs Shumba shows through her writing the caring and understanding attitude that drew Dr. Jaji to her at the beginning of the project. Her transfer to working with children in a remedial class separated her from the project, but visits to her school kept us in touch and as often as possible she tried to attend workshops. When visiting in her home it was obvious that her husband kept her informed of what was happening and she explained to this writer how her use of child centred, active teaching, was very appropriate for her class. Her own background experience of failure and struggle helped her to understand the children with learning difficulties. She was given only one week training before starting up the special class at A school.

This researcher cannot give all Mr. Shumba wrote (a full exercise book of stories), but will include some of the anecdotes that add such good explanation of teachers lives. The reader will also find examples of her stories in other sections.

My Early Childhood: Francisca is the name that my parents gave me at birth in 1963. I was their first child...My father was an assistant extension officer (agricultural) and my mother was a full time housewife. As a result she was living in a changing world of the educated. Full time housewife as she was I remember I always remember how well she did on her own...washing our clothes and keeping chickens and pigs for sale...She had eleven children because my father had made a mistake of doing away with family planning.

My Life in School at Secondary: In 1980 I began my Form One. I did not enjoy the beginning of the new term because I knew I would be sent home for fees (in 1980 all secondary students paid government fees, while primary schools were free). We were now ten in the family and were heavily depending on my father's salary which was peanuts. My mother never stopped her business of keeping chickens for sale to subsidise Father's salary. Each time I was sent home for fees I would get it from my mum's income even though my dad was away from home. My father was no longer

living in his work area but was lodging in R Town. Too much money was spent on bus fares, rent and food. Children at home needed money to buy at least sugar and salt as well as soap. I never remember a time I used to go to school with enough pocket money. The highest figure our dad and mum could afford for myself and my brother was $2, a tin of beef and packet of sugar probably with the smallest size bottle of mazoe (juice concentrate).

This alone was an encouragement for me. I strived to have better results. When I was doing my Fourth year at M High I was nominated a prefect. I was quite strict about whatever we were told to do. I had no problem with discipline.

Fortunately whilst in Form 2 I became friendly to a girl called Resi M. who was doing Form 1. We were of almost the same age. We became close to each other. She was the daughter of a businessman. Food was not a problem now for she was generous. She understood I was from a poor family. We all loved God and we feared to sin. I again was playing netball and running. I was also a javelin thrower.

My best subjects at school were Mathematics, Fashion and Fabrics, Shona and Religious Moral Education. In science I liked the physics part of it. I hated Biology and Chemistry. But in my fourth year at Secondary school it became my best subject because of the teacher. He used to give us tests on work previously done (from other years) before he started on new work! If you got less than half he would beat us with a rubber bung. This made me to read it and study it in fear of the rubber bung. By the end of 1983 when we finally wrote our examinations my fourth subject to register me a pass was Science. I failed to come up with five `O' levels at once. All the subjects I had hope like Literature in English I had failed.

After writing my `O' Level I went to my home area to help my mother who was struggling with the keeping of chickens and ploughing in the fields. She had a very big garden. My brother remained at M High. He had been joined by my young sister and I was now home waiting for the results. I had nothing to do to amuse me or occupy myself with. The day it was announced that the `O' Level results were out I never talked to anyone. I went inside the blankets and slept in broad daylight. My father had heard the news on his way to work. This time he was now using a motor bike. He diverted his journey and went to M High to collect. I got the shock of my life. I had managed to come up with four passes only. This irritated my to the extent of wanting to kill myself. I was comforted by every member of my family. I cried the whole night - I could not think of anything to do with four passes. Finally my father suggested that I go for temporary teaching - a thing I never wanted. But because I wanted to help my father to look after the family again and to get money to write the remaining subjects I was compelled to look for a place to teach.

Researcher comment:

The "temporary" teaching Mrs Shumba describes below, was very common until recently. With independence in 1980, education was expanded without sufficient qualified teachers. "Temporary" teachers, especially in the rural areas were often

young persons who had finished `O' levels without enough passes for college or were simply waiting to get a place in the overcrowded teacher colleges and `A' level schools. Teacher training colleges were subsidized by the government, thus encouraging students from poor families without `A' level scholarships, to apply for primary school training. Several of the younger teachers write of being taught by untrained "temporary teachers" at secondary school - quite similar to Mrs Shumba. The reader should keep in mind that at the start she had only four passes at `O' level.

My life After Form Four: Though finding a place for temporary teaching was a bit difficult I finally got a place. ..My parents rejoiced and the following morning I came back to the District Staffing Office with all my little belongings. The school I went to teach was a secondary school K. I was asked to teach Religious and Moral Education and Shona to the `O' Level pupils. Straight away I registered to write these two subjects Maths an History because I really wanted to have a full certificate. I really wanted to study the fifth subject because I wanted to go for Teacher's Training where most of my friends had gone.

Mr. Shumba became a nuisance he started to worry me. We started off as friends and later degenerated to an affair. As a result I could no longer concentrate. At the end of the year I wrote and failed totally all the two subjects. How could I pass most of my time I was paying attention to Abel. The following year 1985 I registered again for June exams. My boyfriend was now being frank with me. He always told me he was not prepared to marry someone who had no qualifications. It really pained me so much that I started to be really serious. I got help from the Maths teacher at this school. In June I wrote my exams at M High. I did not want people to laugh at me that's why I registered as far away as all that. When results came I had made it. I had written Maths only and had come up with B. I couldn't believe myself. I wrote my parents and to my brother who was now doing Apprenticeship. he replied with a card which had $10. My parents were the happiest - they had lost hope in me going to College. Abel at seeing my results went with them to S Teacher's Training College to look for a place for me using his old acquaintances. Fortunately he was helped out and was given forms for enrolment. Had it not been for him I would not have been in a position to secure a place for this.

Whilst doing temporary teaching I was quite effective in the home. I was helping my parents with some school fees for my young sisters. We were eleven in the family now and being the first born I hardly got money to buy luxuries as other girls.

I went to college in 1986 and had to complete my training in four years. I had no money to buy fifteen box files that were required by the college. I needed pocket money that I had failed to save since I was paying fees for my sisters. My brother then who was an Apprentice took over. He helped me with the pocket money. Abel supplied the files but he was still a boyfriend.

Life at College: First year at College was tiresome. We did a lot of theory. In 1987 I was posted to S area at C school. I was teaching grade four for my teaching practice. I enjoyed this year because I was being paid. I managed to pay school fees for one of my sisters and even bought a 3/4 bed and three door kitchen unit for my

mother. I did very well this year in my practical. In the end I returned to College. All the year I was going home on holidays. I would help my parents in the field and the home. Occasionally Shumba visited me and helped me write my college assignments. In December after closing schools I went home with all my belongings. That was the whole of 1987.

1988...This was my third and final year at College It was a busy year I enjoyed it a little. I was preparing examinations. I never had problems at College with staff. I had a lot of friends, we used to discuss matters pertaining to College staff. . Finally I wrote my finals in Theory if Education and my main subject English. I remember myself coming from the last paper which was my main subject. I got it in the exam room at exactly 8 o'clock in the morning and the examination took about two hours. After writing the paper I couldn't tell whether it was still morning or noon. It looked to me as if it was noon time. It was only after I had slept on my bed for five minutes that I came to my senses, that I realised it was still morning. I left the College after submitting each file to each department. I went first to see Mr.Shumba - by that time I called him Abel. He was now teaching in S rural area. I did not spend a lot of time with him since I was heading for the new school I was going to teach in the following year, 1989. I arrived at the school and I was welcomed nicely by the school head. He gave me syllabus to help me to do my preparations. I left for rural areas in M where my parents were. My fourth year was teaching practice. I was just applying all the theory I learned the two years in college. I completed it without any complications. I had written all major assignments and projects and had posted them to their various departments.

Life After College: In January of 1990 Abel and his relatives came to our place. I was married on Jan 6 and became known as Mrs.Shumba. I felt I had achieved a difficult goal in life according to our culture. ...After the first term of 1990 I managed a transfer to join my husband at the school he was teaching. I had a nice experience in June 1991. I gave birth to our first daughter Violet Simbisai. We were delighted with everybody else. During this year my brother who was next to me and had done apprenticeship was wed in a church. I remember giving my brother a present for appreciation of $2000 with my husband. These were happy times.

Involvement With the UZ Project: I met Dr Hodzi at the time I was doing my first year at S. Teacher Training College. He was my personal Tutor. When in 1992 I was acting Deputy Head at D. School I met him again this time selling the Problem Solving Method in Teaching Science and Maths. I liked the project as the D.E.O. had asked me to be involved. I enjoyed how children reasoned and the idea they had about scientific concepts. In 1992 we were transferred from D and we came to A Mine School. I started the project again at this school with the help of my husband. At first my head didn't like the idea but as time went by he began to like the idea. During the first part of this year we held a science fair at the school which everyone appreciated.

Mid last year when I was coming from maternity leave I was asked by the school head to take a Special Class which is backward children. He said he had chosen me because I was involved in the Problem Solving Method. He later said I could not do both since the special class was too involving. I can't express how I felt about this and

just because he is my superior. I then encouraged my husband to take a leading role and now he is doing quite well. Now in teaching my special class I try to use some of what I learned and am getting used to the children.

APPENDIX 4.3

Chart No 1 This list of identified inhibitors was used by the Writers Group and the Collaborative Group for workshop sessions. The chart was developed by K Stiles in 1993.

Symbols for identification methods: tc = teacher comment; r = researcher; eo = education officer; h = headmaster; cdu = curriculum development personnel; obs = observation by self; l = literature

INHIBITOR	IDENTIF	SUPPORT
lack of understanding and belief in the epistemology of the project (constructivism, diagnostic teaching, generative learning, science as both knowledge and behaviour(processes), problem solving)	r,tc,obs	workshops (see schedule), workshop and peer teaching (learning by example) printed handouts,
pedagogical constraints (familiar teaching style not same as that advocated by project)	obs, tc, r,r, tc	workshop teacher (teacher try out activities and interview etc) trails in own class and by demonstration to peers peers observe model lessons on film(future) teacher college material production(future) sessions and support to teacher trainers
external - national syllabus **competition** between teachers to finish syllabus and to have pupils pass national exams	l, tc, h tc	cdu revision, discussion and examples of how to use project e. and p. within national syllabus.
external - ministry directives and requirements	tc, h,r	approval from both ministries, e.o. workshop head. workshop e.o. and heads presence at tch. wkshop

Chart No 1 continued

time daily allocation (exter) and time to cover syllabus - organizing of time	tc,h,eo,-obs, cdu	workshop and cluster discussion/peer support good examples from demo teaching ; workshop for eo's and heads to convince
student writing and recording	tc	eo's and h's to encourage variety and integration(?)
classroom organization lack of teaching aids inappropriate use of manipulatives and aids	tc,h,obs, r	demo of simple aids workshop making of aids workshop appropriate use critique of cluster demo teaching
classroom organization group teaching and organizing	obs,tc	workshop critique of demo and class teaching
teacher background science content and process	r,cdu,obs,tc,h	enrichment at workshops, cluster meetings, written material (future?)
language: teacher pupil	r,l,h,obs,eo	workshop for eo's and h's encourage use of vernacular where needed making quest. and ans understood (change phrase etc)
pupil resistance to change cultural conservatism/comfort with old methods	tc,r,l	
Teacher resistance to change (same as pupil? also stress of req'd change; attitudes and belief or non-belief in the advocated change		research needed continued support and persuasion?(?)
External - size of group in project and ratio to # of of support persons	r,tc,cdu	creation of smaller working groups for specific research or function (eg, writers group)

APPENDIX 4.3

Chart No 2 Modified from Chart No 1 by the Collaborative Group of teachers in 1994

Identified Inhibitors to Teaching Change

INHIBITOR -EXTERNAL ENVIRONMENTAL	INHIBITOR - INTERNAL
Ministry directives and requirements	
1. a. national syllabus b. national exam (grade 7)	alternative epistimology of teachers (not same as that of project frame-work)
2. time a. daily school schedule b. extra organizing time c. time to finish syllabus	pedagogical constraints a. familiar teaching style not same as that advocated by project b. teachers own alternative style
3. directives on student writing and recording	competition with other teachers to finish syllabus and get good exam results
4. language a. english as second language b. english as language of science c. final exam in english	English as a second language for the teacher. (difficulty expressing concepts so that child with language difficulty will understand)
5. requirements to use set method for term and lesson planning.	environmental and science back-ground limitations/deficiency
School/community	personal (and group) expecta-tion/dissappointment re financial remuneration for project participa-tion
1. classroom size	normal(?) resistance to change as going from one of comfort with old methods to the unknown
2. classroom organization a. lack of teaching aids/resources b. teaching in groups - size, pedagogy involved c. time constraints	support structure effectiveness and applicability 1. lack of regular feedback on student learning progress (from perspective of project work)
3. other teacher duties and involvements	2. high ratio of teachers:support research staff.
4. student population / sociocu-ltural and economic back-ground	3. infrequent personal school visits by support staff
5. parent/community involvement	4. expansion of teacher group from 20 - over 70

APPENDIX 4.4

Zimbabwe Ministry of Education and Culture

Grade 7 Examination, 1994

General Paper (which includes EAS questions)

Printed by the Government Printer, Harare

MINISTRY OF EDUCATION AND CULTURE

Z I M B A B W E

GRADE SEVEN EXAMINATION, 1994

GENERAL PAPER

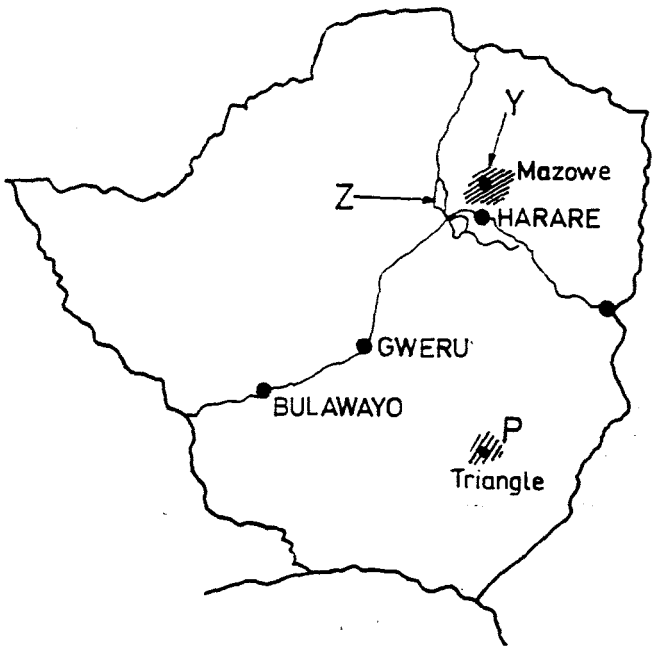
Date: Wednesday, 19 October 1994 Time: 2 hours

INSTRUCTIONS TO CANDIDATES

1. Read ALL the instructions carefully.
2. DO NOT open this booklet until you are told to do so by the invigilator.
3. Use ONLY a 2HB pencil for all entries on the answer sheet.
4. If you wish to change your answer, ERASE it COMPLETELY with a pencil rubber and then shade the new choice.
5. If MORE than ONE circle is shaded for any one answer, that answer will be regarded as WRONG.
6. When you are told to start, choose ONE correct answer from the suggested answers and shade it VERY DARK.
7. If you DO NOT understand the instructions ask the invigilator to explain them to you BEFORE you start.
8. Answer ALL the questions on the separate answer sheet provided.

This question paper comprises 18 printed pages.

Use the map of Zimbabwe shown below to answer questions 16 to 18.



16. What is the name of the lake labelled Z?

A. Mutirikwe (Kyle).
B. Chivero (McIllwaine).
C. Kariba.
D. Ncema.
E. Manyame (Robertson)

17. The product we get from the place marked P is

A. beans.
B. fish.
C. fruits.
D. maize.
E. sugar.

18. Name the kind of fruit grown in the area marked Y.

A. Citrus.
B. Deciduous
C. Apples
D. Bananas
E. Vines

19. What is the healthiest type of toilet encouraged in rura areas.?

A. Blair.
B. Bucket.
C. Bush.
D. Chamber.
E. Flush.

20. What do we call people who prepare and use natural medicines

A. Patients.
B. Grandparents.
C. Gardeners.
D. Traditional healers.
E. Medical doctors.

21. Why did the Zimbabwe government introduce the minimum wage?

A. So that all people could have a better standard o living.
B. To give people money to go on holiday.
C. Because all people were paid a lot of money.
D. Because everyone does the same amount of work.
E. To enable all people to buy houses.

22. Leather comes from

A. rubber.
B. plastic.
C. paper.
D. animal skin.
E. plant fibre.

23. A squatter is a person who

A. lawfully lives in a residential area.
B. breaks into other people's houses.
C. builds a shelter where he is not allowed.
D. has a lot of money to buy goods.
E. sells vegetables at the market.

24. Which one of the following is a good health habit?

A. Washing hands after using the toilet.
B. Washing hands before greeting visitors.
C. Sneezing without covering your nose.
D. Coughing with your mouth uncovered.
E. Ironing clothes after wearing them.

Use figure 1 to answer question 31.

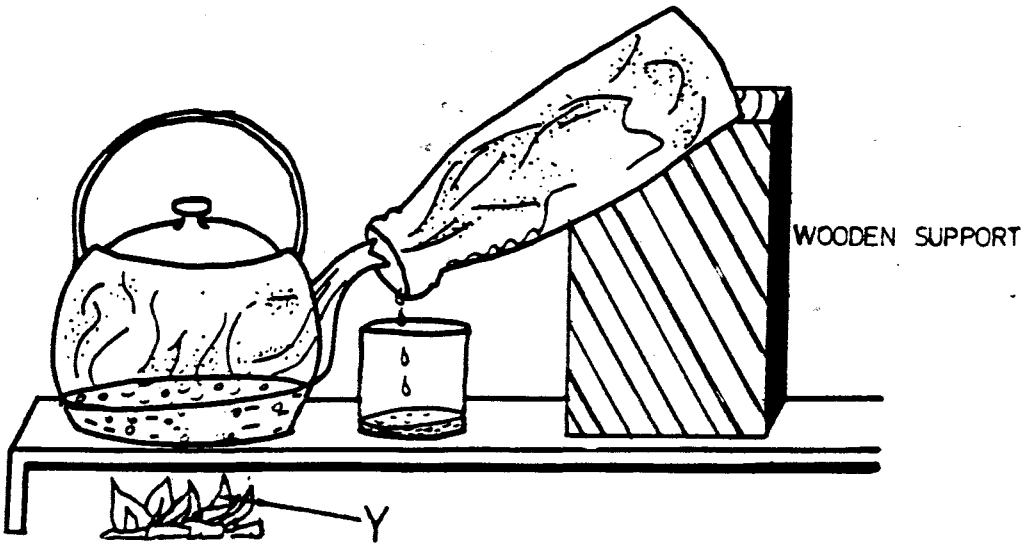


Figure 1

31. What is produced at Y that causes the water to boil?

A. Heat.
B. Light.
C. Smoke.
D. Steam.
E. vapour.

32. Which of the following is a water-borne disease?

A. Cold.
B. Dysentery.
C. Malaria.
D. Measles.
E. Tetanus.

Use figure 2 to answer question 33.

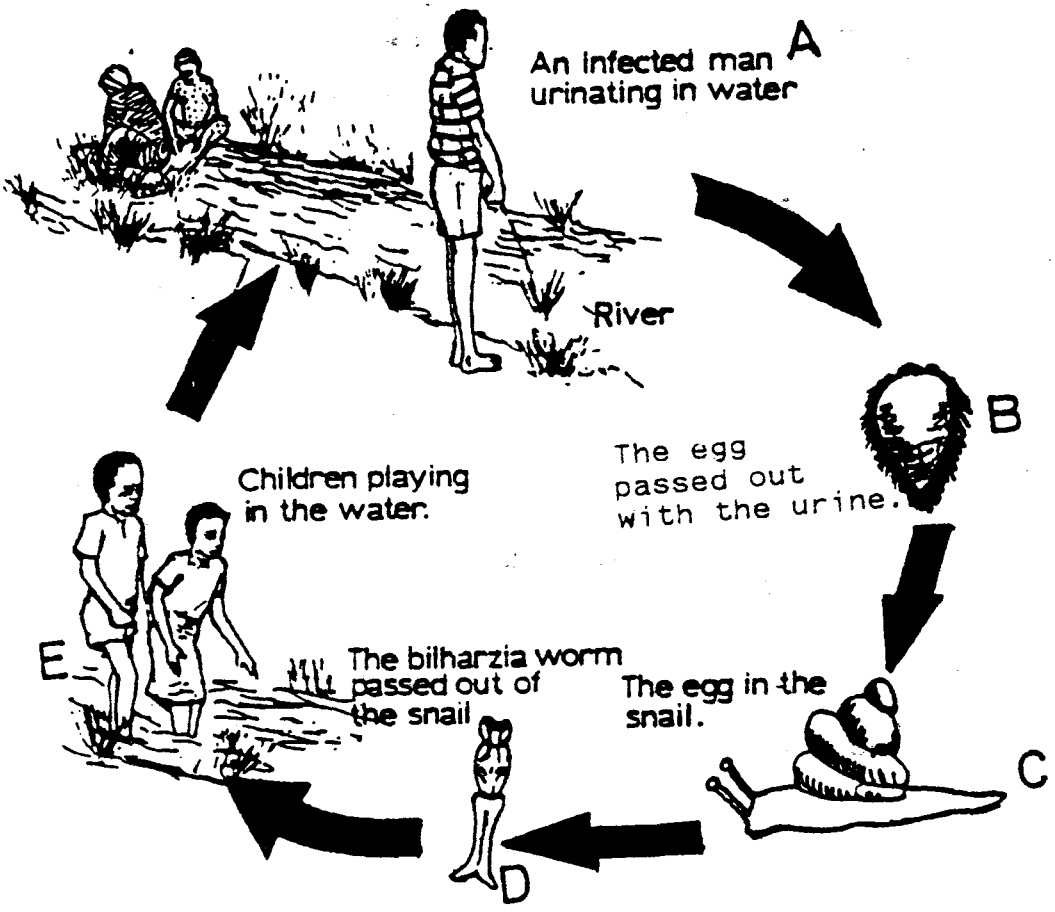


Figure 2

33. At which point of the bilharzia cycle A, B, C, D or E does the bilharzia parasite enter the body?

Use figure 3 to answer question 34.

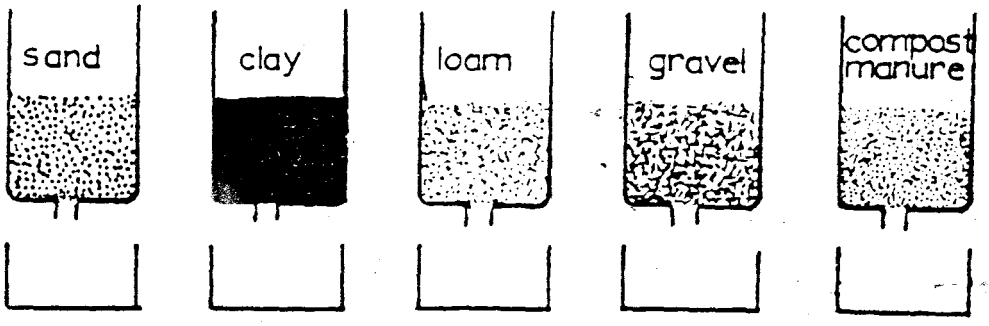


Figure 3

34. Equal volumes of water are poured into equal volumes of different kinds of substances. After a set time, which substance will have allowed the least amount of water to go through?

A. Clay.
B. Gravel.
C. Loam.
D. Manure.
E. Sand.

Use figure 4 to answer question 35.

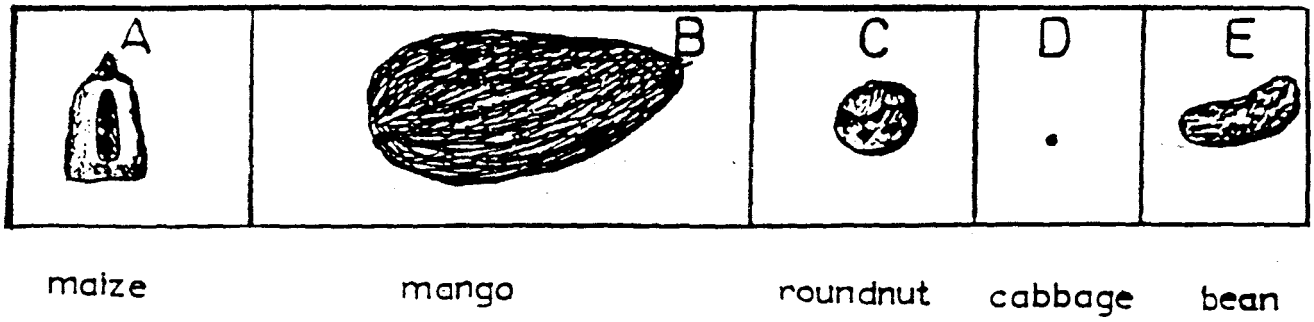


Figure 4

35. Which seed is likely to germinate last under the same conditions?

Use figure 5 to answer question 3.

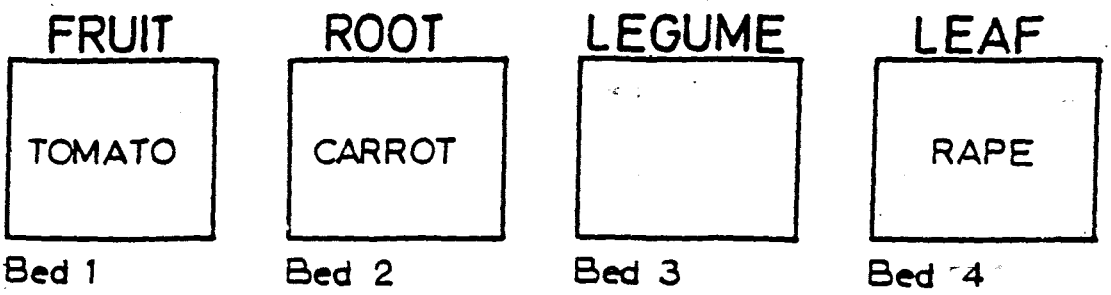


Figure 5

36. This diagram shows a four year crop rotation for a garden.

In this rotation which crop would be in bed 3?

A. Beans.
B. Cabbage.
C. Lettuce.
D. Onion.
E. Spinach.

37. Which weather condition is best for transplanting seedlings.

A. Cool and dry.
B. Hot and humid.
C. Cloudy and damp.
D. Dry and calm.
E. Windy and dry.

38. To which plant family do maize, rice and wheat belong?

A. Grass.
B. Fruit.
C. Legume.
D. Tuber.
E. Vegetables.

39. Green plants need the following to make food and grow

A. Bees, sunlight and air.
B. Soil, worms and water.
C. Sunlight, air and water.
D. Manure, air and sunlight.
E. Clay, water and air.

40. Mulching helps the soil to

A. lose a lot of water.
B. shelter the roots.
C. keep moisture for a longer period.
D. lose water at a faster rate.
E. become water-logged.

Use figure 6 to answer question 41.

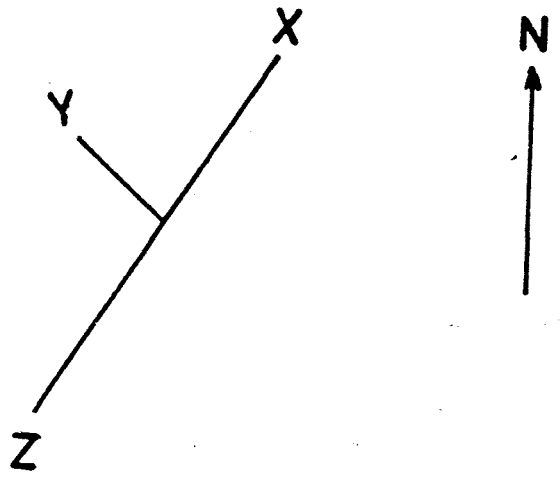


Figure 6

41. The direction of X from Y is

A. North.
B. North East.
C. North West.
D. South.
E. South West.

42. If a transparent plastic bag is tied over some leaves of a living plant what will be seen in the plastic bag after several hours?

A. Air.
B. Dry leaves.
C. Insects.
D. No change.
E. Water drops.

Use figure 7 to answer question 43.

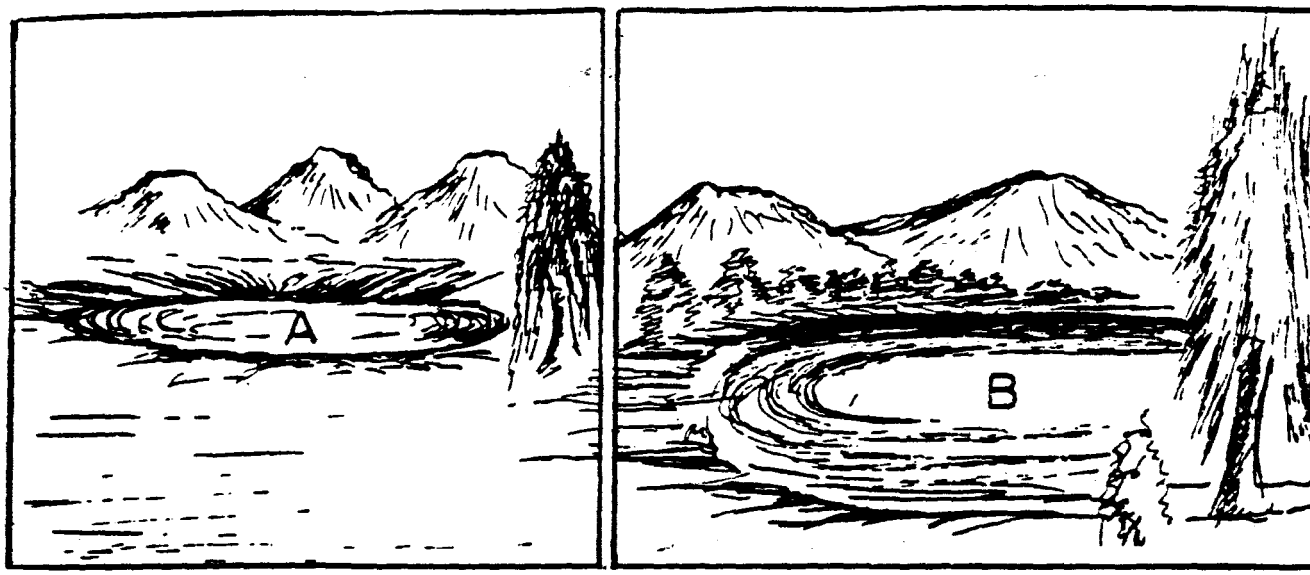


Figure 7

43. Pools A and B are in the same area. They have equal amounts of water. Why does pool B lose more water by evaporation than pool A?

Because pool B

A. has strong winds over it.
B. is in a very dry place.
C. stores much more water.
D. is not sheltered by the hills.
E. has a bigger surface area.

44. What type of fuel do steam engines use?

A. Coal.
B. Diesel.
C. Electricity.
D. Paraffin.
E. Petrol.

The diagrams in figure 8 show simple electric circuits.

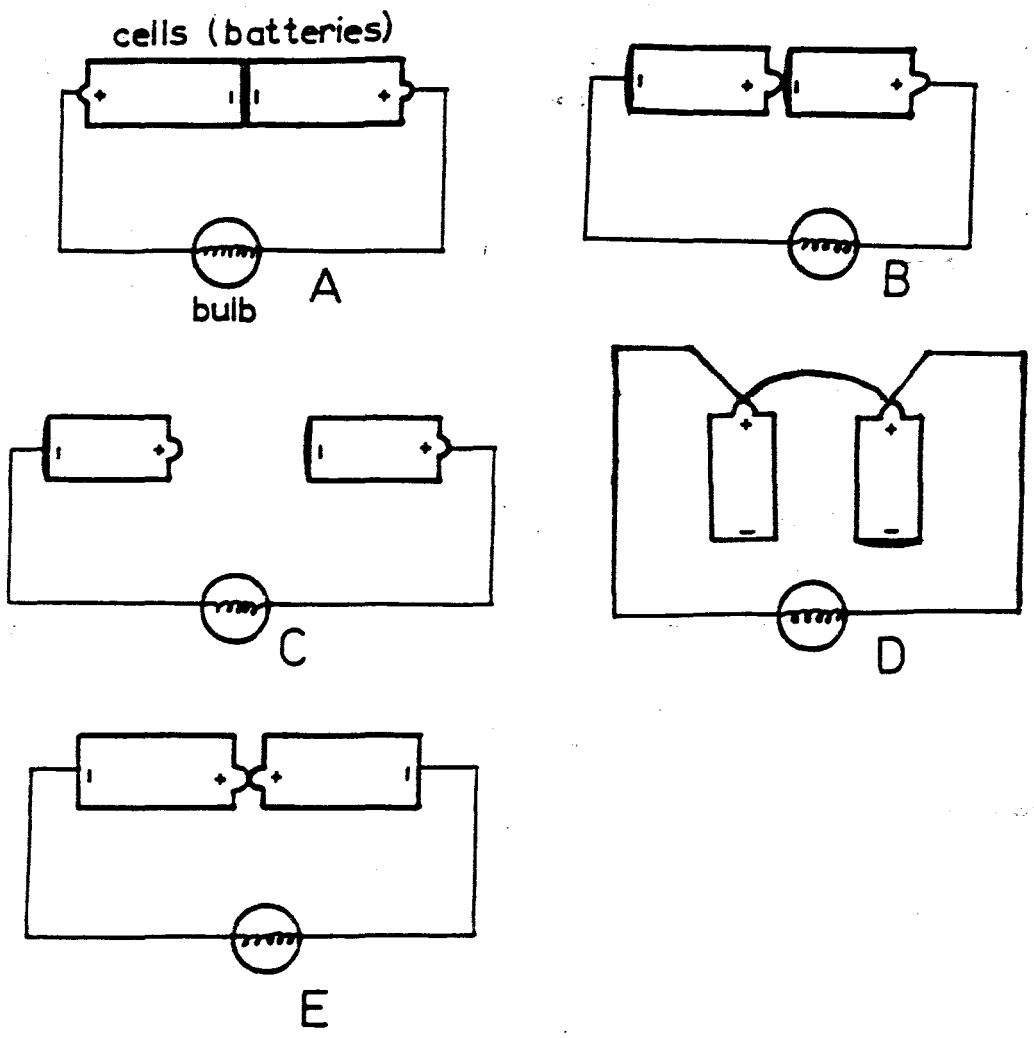


Figure 8

45. Which bulb will light up?

Use figure 9 to answer question 46.

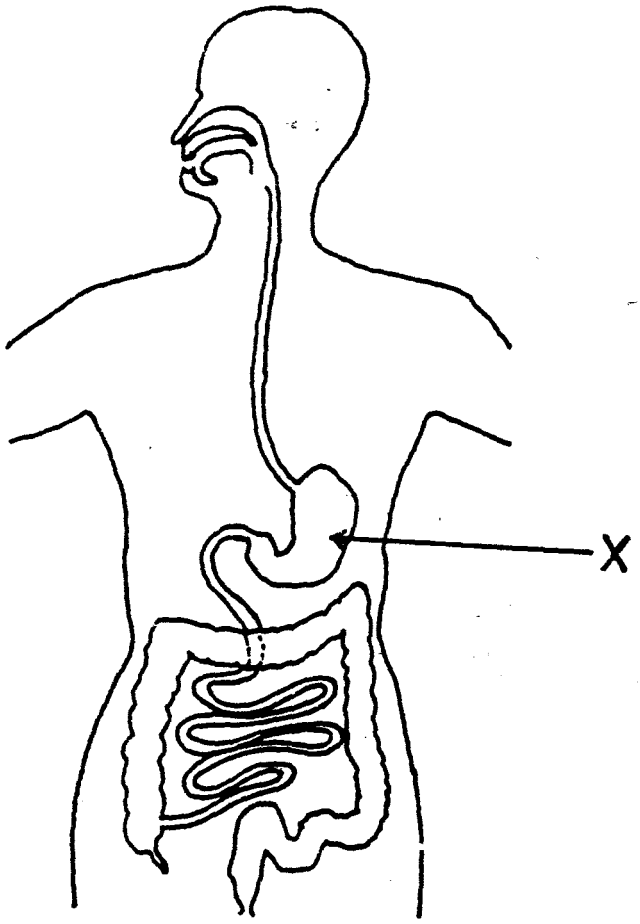


Figure 9

46. Name the part labelled X.

A. Heart.
B. Intestines.
C. Liver.
D. Lungs.
E. Stomach.

Use the map of Zimbabwe in figure 10 to answer the question that follows.

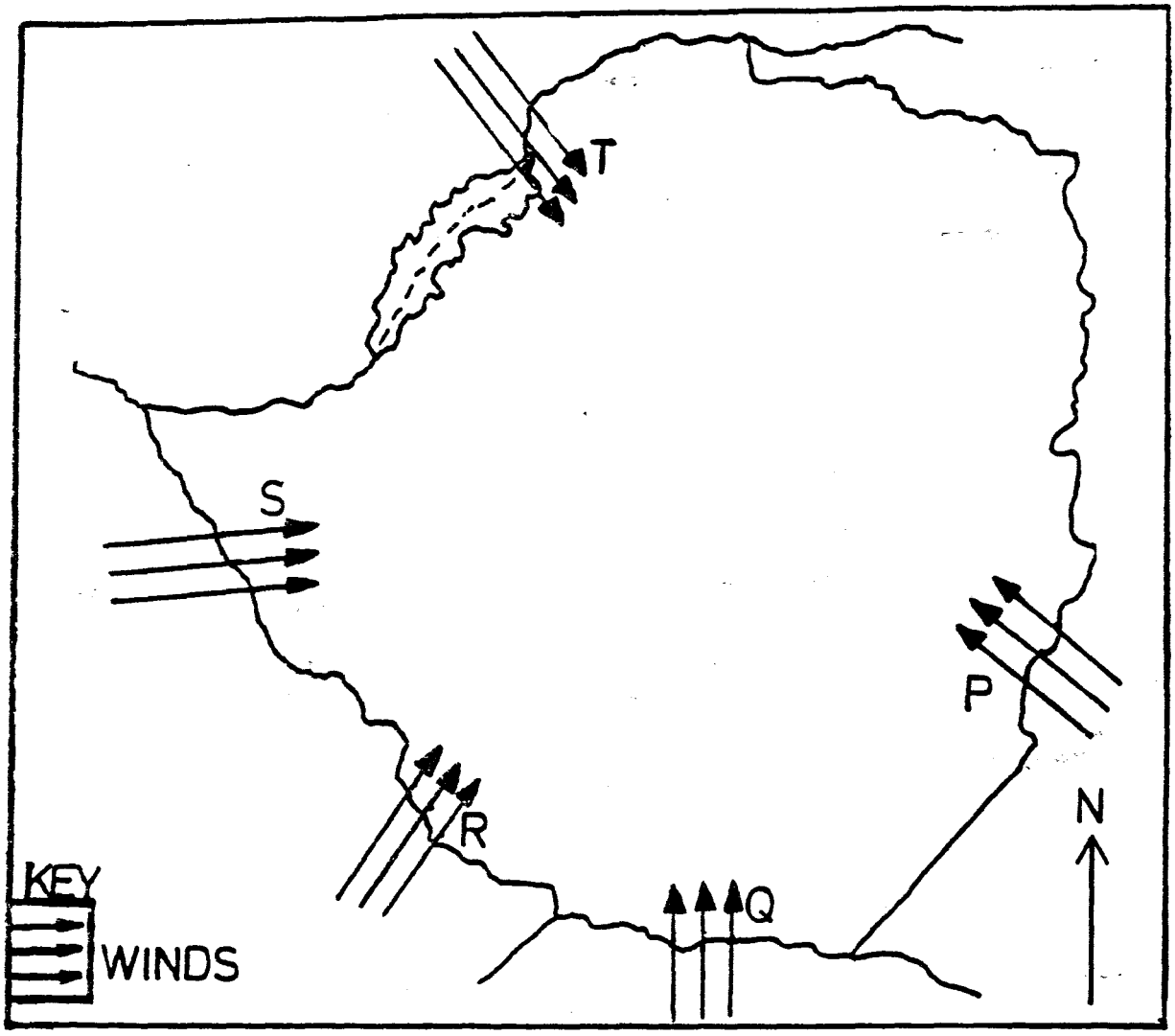


Figure 10

47. Which of the winds P, Q, R, S or T bring most rains to Zimbabwe when they meet:

A. T and S.
B. R and S.
C. R and Q.
D. R and T.
E. P and T.

Use figure 11 to answer question 48.

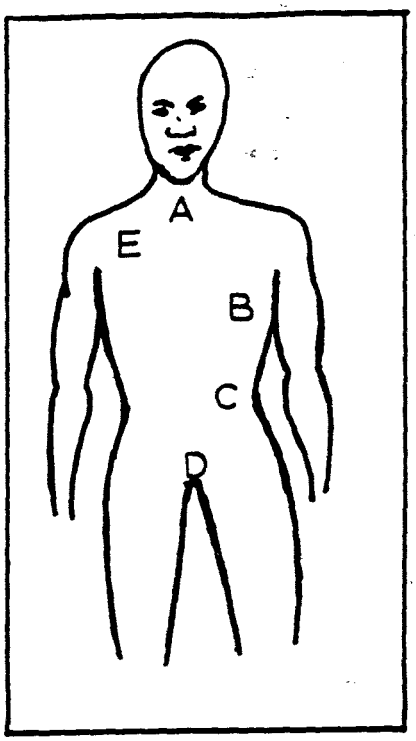


Figure 11

48. Which letter shows the position of the heart.

49. What should people do to make unprotected water safe for drinking?

A. Boil it.
B. Add salt.
C. Keep it cool.
D. Let it settle.
E. Sieve it.

Use figure 12 to answer question 50.

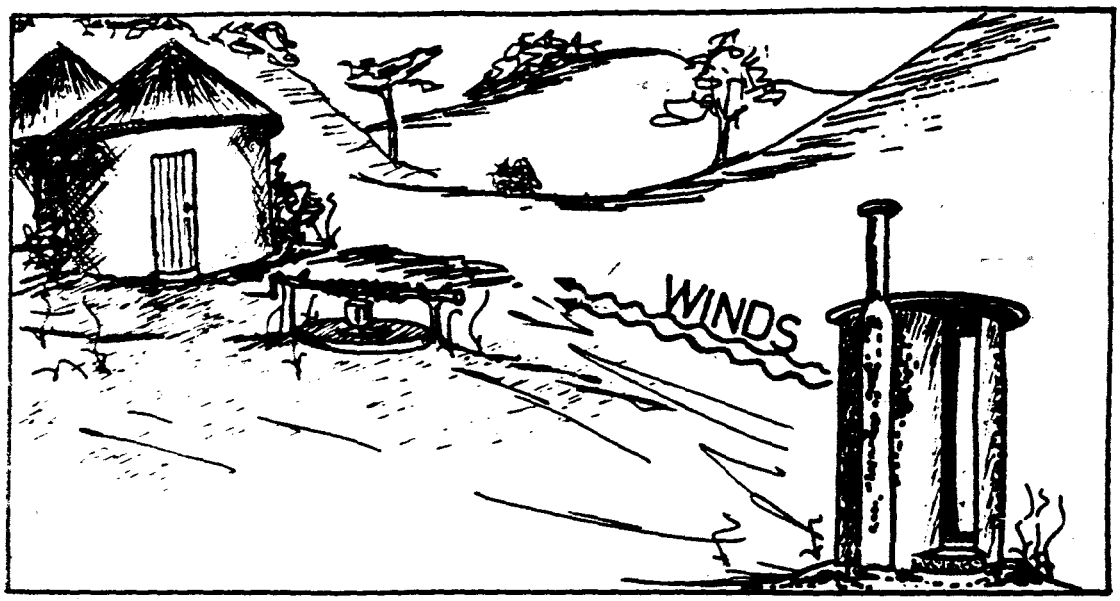


Figure 12

50. The winds of the area shown are mostly coming from the east. The set up of the home is wrong because the

A. living huts are far from the toilet.
B. protected well is not supposed to be between the huts and toilet.
C. smell from the toilet is continuously blown to the huts.
D. toilet water will flow to the well.
E. toilet should be nearer to the well.

1. Most religions in Zimbabwe agree that the Supreme Being is

   A. very near to us all.
   B. the Creator of us all.
   C. uncovered only in the Koran.
   D. best worshipped in the Matopos.
   E. discovered only in the Bible.

2. If someone does something wrong to you, you should always b ready to

   A. fight him.
   B. punish him.
   C. ignore him.
   D. forgive him.
   E. praise him.

   Read the story below and answer question 3.

   Once upon a time there was a man who had three sons. H became very sick and knew he would soon die, so he called hi sons around his bed. "My children, he said, "I have no mone here to give you, for all my wealth is buried in the groun in a place near this house." Soon after saying these words the father died. After a time of mourning, all three sons go hoes and began to dig around the house. They dug, and du until all the land the father owned had been dug up, but the found no wealth buried in the ground. When they saw how muc digging they had done the three sons decided they had bette plant some crops in all that soil. The plants grew well an the harvest was the biggest the family had ever reaped.

3. It was then that the three sons realised that their wealth wa

   A. the money which they were looking for.
   B. the savings account their father had left them.
   C. hard work and the fertile soil.
   D. looking to the Government for famine relief.
   E. selling the farm and going off to town for work.

4. Sin is

   A. the same as temptation.
   B. breaking moral Law.
   C. becoming angry.
   D. not understanding the Bible.
   E. missing a church service.

5. One way used to praise the Supreme Being by all religions is to

A. preach in the streets.
B. cry in public places.
C. complain about the priests.
D. listen to the Supreme Being.
E. sing for the Supreme Being.

6. The only sure way to avoid 'AIDS' is to

A. use birth-control methods.
B. be careful about personal cleanliness.
C. pray for protection.
D. be faithful to one partner.
E. avoid being bitten by mosquitoes.

7. When someone wants to copy my homework I should

A. make an excuse not to give it to him.
B. give it to him because everyone else copies.
C. tell him to ask someone else.
D. refuse to let him copy, but offer to help him.
E. allow him to copy on condition he pays.

READ THIS STORY AND ANSWER QUESTIONS 8 AND 9

Ngoni went to a town where the most holy place of his religion is. He fell asleep with his feet pointing towards the holy shrine.

"How can you sleep with your feet towards God?" he was asked.

"Show me the place in this world where God cannot be found, "he replied, "and I will sleep with my feet towards that place."

8. If Ngoni is right we can pray

A. only in holy cities.
B. anywhere in the world.
C. nowhere but in religious buildings.
D. when we are asleep.
E. only at time chosen by God.

9. The holy shrine in the story

A. has special meaning to Ngoni's religion.
B. has the holy spirits there.
C. is part of Africa north of the Sahara.
D. is a government building without offices.
E. was built by living saints.

10. All religions in Zimbabwe teach that in order to become a g person one must try to

A. pray with the eyes closed.
B. pray with eyes open.
C. live a perfect life, free of sin.
D. forget about the world around him.
E. hate other religions in Zimbabwe.

11. The main religions in Zimbabwe teach that The Supreme Be can be worshipped

A. at any time.
B. only on special holy days.
C. only in a holy building.
D. only in the morning.
E. only in the evening.

12. A good friend is someone who

A. agrees with everything you say.
B. is not jealous.
C. keeps secrets from you.
D. talks about you in your absence.
E. you can always rely on.

13. If you meet a beggar in the street you would

A. tell the beggar to go to hospital.
B. take the beggar to the police station.
C. laugh at the beggar.
D. beat up the beggar.
E. help in any way you can.

14. Killing another person is bad because

A. life is precious and should not be destroyed.
B. the dead person's spirit will revenge.
C. the relatives will demand a wife.
D. no one wants to kill other people.
E. there will be fewer people in Zimbabwe.

15. You should stick a red reflector on the rear mudguard of yo bicycle to

A. decorate it.
B. be seen at night.
C. be like your friends.
D. show the police.
E. please your school head.

25. Why do people from different parts of the world wear different clothes? People

A. want to show that they are rich.
B. have different shelters and resources.
C. have different cultures and religions.
D. are told by their friends what to wear.
E. are not united.

26. The government gets most of its money through

A. fines.
B. taxation.
C. income generating projects.
D. co-operatives.
E. renting property.

27. The United Nation's Headquarters is in

A. France.
B. Netherlands.
C. Switzerland.
D. United Kingdom.
E. United States of America.

28. An area represented by a member of parliament is a

A. branch.
B. constituency.
C. district.
D. province.
E. village.

29. Which professional people decide where residential and industrial buildings should be sited in a city?

A. Town Councillors.
B. Large Industrialists.
C. Provincial Governors.
D. City Mayors.
E. Town Planners.

30. United Nations International Children's Emergency Fund (Unicef) is one of the branches of the United Nations whose special interest is in the

A. Economic development of poor countries.
B. Military strength of poor countries.
C. Social welfare of poor countries.
D. Welfare of children in all countries.
E. Welfare of children in poor countries.

APPENDIX 4.5

Chart representing results of a questionnaire given to UZ Project involved teachers in November 1993. Teachers were asked if they had items of the EAS list of recommended equipment. Fourteen schools were involved at that time in the UZ Project.

Curriculum Development Suggested list of equipment needed for EAS teaching (from Lewin, 1990,p28)

equipment for EAS	# yes /14 schools	comments
measuring cylinders	3	donated - 1 or 2 per school
balances	14	home made wood beam type
bathroom scales	0	not available
mirrors	1	not available
magnifying glasses	2	not available
magnets	2	not locally available
wire	4	borrow when needed
steel wool	0	borrow when needed
nails	0	borrow when needed
pliers	0	borrow when needed
cutters	0	borrow if possible
microscopes	0	not available
thermometers	2	not available
rain gauges	3	not available or home made
wind vanes	5	home made
stop watches	0	not available
mathematical instruments	14	simple ones for maths
torch	0	borrow if possible
torch cells	0	borrow when needed
bulbs	0	not available
bulb holders	0	not available
rock/ore samples	1	not available
bare copper wire	3	not available
insulated copper wire	3	not available

compasses	2	not available
gas or paraffin burner	14	many homemade
wood samples	10	local samples
models of : machines, satellites, telephone receivers, the heart, animals, insects	0	not available unless homemade
bio viewers	0	not available
pairs of scissors	14	several pairs to share
paint brushes	14	several to share
glass tubes	2	borrowed from secondary school
beakers	2	from donor project
consumable items: candles, paints, glue, plasticine, string, paraffin, methylated spirits, iodine,-dyes	8	difficult to get unless out of own pocket
classroom general items		
radio	5	for school programmes
electricity	2	one high density school and one mine school
T.V. /video cassette recorder film projector slide projector photocopy machine	0	not available
duplicating machine	5	expensive and hard to get
newsprint	11	buy in rolls and cut
chalkboard and chalk	14	one wall painted
bulletin board	4	usually use section of wall
library facilities	4	only a few old books from donors
teacher resource books	6	no books other than own or teachers guides
storage for equipment	5	no cupboards - use head's office for special equipment

APPENDIX 4.6

Examples of materials used in S Teacher College and with UZ Project teachers in workshops. These are:

- activities concerning light
- examples of activities on soil
- handouts on questioning and problem-solving

TEACHERS WORKSHOP - AUGUST

DAY 1 - 8:30-11:45

TOPIC: PROBLEM POSING IN SCIENCE

WHY TOPIC IS INCLUDED: teachers have difficulty posing problems; relevancy, working, connection to child's previous experience. April workshop addressed 'what is a problem', teachers are trying to develop some problems and now need to clarify and practice problem-posing.

SOME IDEAS FOR SESSION:

Where does the problem come from?
syllabus topic------- concept --------- develop thru:

diagnostic investigation of childs ideas

may be teacher or child posed

For teacher posed:
What relevancy does it have to required concept development?
How does it fit into the child's immediate world?
Is it understandable to the children?
Is it child-cedntered and activity based?
Do you have materials locally available?
And.....

For child posed:
How will you get the children to pose the problem?
How much help should you give, ie what is your role?
Is their proposed investigation safe? Fair? etc....

For all problem posing sessions how will teacher organise their classroom in time, planning, groups etc.?

THE SESSION WILL INCLUDE PROBLEM POSING BASED ON SELECTED SYLLABUS TOPICS. THESE WILL BE PRE-CHOSEN FOR GROUPS OF GRADE LEVEL (1-4) AND (5-7). PROBABLY FROM 'SUN AND COSMOS' (LIGHT) AND WATER CYCLE(EVAPORATION, AND CONDENSATION).

SOME EXAMPLES OF PROBLEMS TAKEN FROM JOURNALS AND LESSONS MAY BE GIVEN FOR CRITICAL LOOK AS WELL AS SOME BEING DEVELOPED DURING THE SESSION.

HANDS ON ACTIVITY TO GO WITH THIS MAY INCLUDE USE OF MIRRORS TO ILLUSTRATE REFLECTION - EXPANSION TO MOON'S REFLECTION ETC.
(USE ACTIVITIES FROM TEACHER DEMONSTRATIONS ON SHADOWS, DAY AND NIGHT, CONDENSATION FOR AFTERNOON SESSION ON USE OF TEACHING AIDS)

Environmental and Agricultural Science - LIGHT

THE FOLLOWING EXERCISE WILL HOPEFULLY:

BE FUN!

GIVE YOU AN EXAMPLE OF APPROPRIATE USE OF QUESTIONS AND TEACHING AIDS (APPARATUS) IN A PROBLEM-SOLVING ACTIVITY.

ALLOW YOU TO EXPERIENCE THE EXERCISE FIRST HAND.

CONCEPTS TO BE DEVELOPED:

Light travels and travels in straight lines.

Light can be bounced off mirrors.

Light cannot be seen travelling from one place to another.

PRE-ACTIVITY QUESTION: (to get ideas of children and allow them to question their own ideas)

USE ATTACHED DIAGRAM FOR THIS ACTIVITY

• What do you think will happen to the light when the torch is shone into one of the small holes?

LIGHT BOX ACTIVITY:

Work in pairs - one person to look through the viewing slot, preferable in a shaded room. The other person shiner the torch into one of the holes, first directly across the box, then at an angle onto the mirror. Swop places and do the activity again.

• Have you changed your mind from your original guess? (How would a child answer?)

Repeat the activity , looking into different holes.

POST ACTIVITY SUMMARY AND EVALUATION:

Now make drawings of the inside of the boxes showing where the light is. (Children would be asked to explain if they changed their minds after the activity).

THE LIST BELOW REPRESENTS A LIST OR MAP OF CONCEPTS THAT A CHILD MAY BE EXPECTED TO DEVELOP BY AGE 11, AND NEEDS FOR THE DEVELOPMENT OF A SCIENTIFIC WORLD VIEW.

1. Light travels

2. Light normally travels in straight lines and can be represented by lines.

3. Light is produced by a range of sources and travels outward from the sources.

4. Many objects reflect or re-emit light as well as mirrors.

5. Primary sources of light emit light which travels long distances till it interacts with matter.

6. Vision occurs because light enters the eye from the object.

7. Shadows occur because the light is blocked by the object from travelling. A shadow should be seen as a lack of light rather than a 'reflection of' the object.

THE LIST BELOW IS EXTRACTED FROM THE EAS SYLLABUS AND CONCERNS LIGHT (SUN AND COSMOS).

PROBLEM: can you show where the concepts fit into the syllabus topics? where they should be learned?

GRADE 3

Objects which stand in the sunshine make shadows. Shadows may be long or short depending on where the sun is in the sky.

GRADE 4

Sun brings light and warmth to the earth.

GRADE 5

Mirrors are designed to reflect things. Mirrors reflect things in reverse. Reflective surfaces can distort reflections. Sunlight can be reflected...

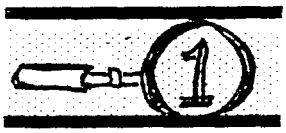
GRADE 6

The earth spins round and round. This causes day and night.

The moon reflects the light of the sun. The moon travels round the Earth. It takes 28 1/3 of our days for the Moon to travel around the Sun.

GRADE 7

Stars are suns. Moons are associated with planets. Only suns/stars give light and heat.Vast distances separate suns, moon and planets.



The following problem solving activity involves "bouncing light around a table".

• The groups will be given a torch, small mirrors and sticky-stuff.

• **Problem posed is:**
"How can you make the light go round every side of the table?"

Student teachers:

1. please use two tables - one with three sides and one with four sides. Draw a diagram to show a groups possible solution. The children would also draw a diagram and show on it how the light goes around the table.

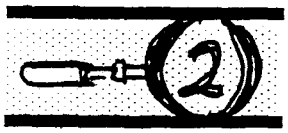
2. what concept(s) of light is hopefully being developed in this problem-solving activity?

3. Where does it fit into the syllabus?

4. What process skills do you think might be used by children in this activity?

Extension to the problem:

"How can you use mirrors to see who is outside the door without going outside?"(i.e. how can you see around a corner?)



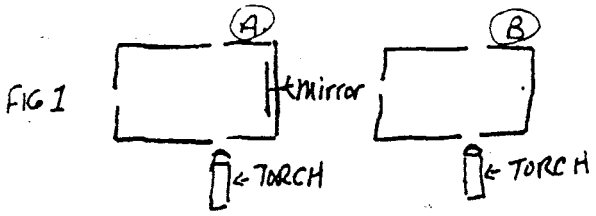
The following problem solving activity involves "Passing light through boxes".

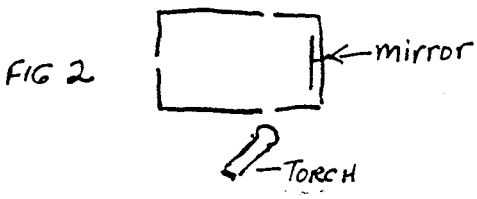
• The groups will be given a small box (shoe type) with small holes positioned on each side, a small mirror and a torch or candle.

• **Problem posed:**

1.Predict where the light will go when the torch is turned on in fig.1. and then in fig.2.

2.Test and evaluate your ideas.





Student teachers;
Try to analyze the problem-solving activity as in activity no.1.

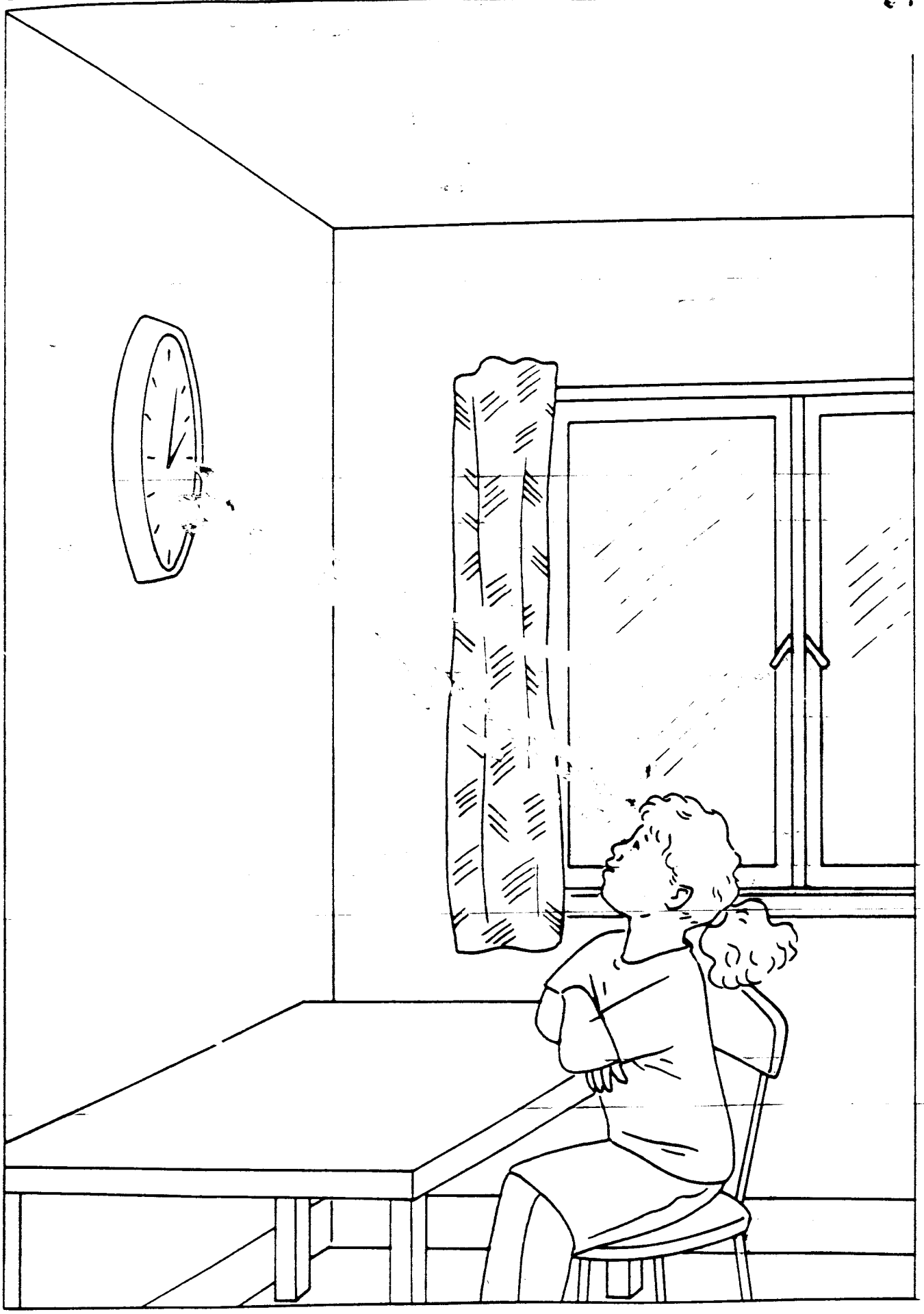
A FEW OTHER PROBLEM-POSING QUESTIONS INVOLVING TORCHES AND MIRRORS:

1. How can you see the torch behind you without turning around?

2. What do you see when you look in a mirror? What is a mirror-image?

3. Would you be able to use a mirror in the dark? Why?

How does the child see the clock?



Environmental and Agricultural Science - LIGHT

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POST ACTIVITY SUMMARY AND EVALUATION:

Now make drawings of the inside of the boxes showing where the light is. (Children would be asked to explain if they changed their minds after the activity).

ALL CLASSROOM ORGANISATION

AND MANAGEMENT

IS BASED ON THE PREMISE THAT THE LEARNING WILL TAKE PLACE IN A CHILD CENTRED, ACTIVE ENVIRONMENT

Children 'doing things themselves...not watching someone else' means providing and organising materials and it means organising groups.

Objects and materials from the environment, and low cost equipment for use in investigating them, are the basic essentials for scientific activity in primary school.

- selecting
- storing
- outside the classroom
- safety

ORGANISING FOR PROBLEM-SOLVING

In order to maximize the childrens experiences in problem-solving, the teacher has to give careful consideration to classroom organisation and management

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SOME QUESTIONS TO BE CONSIDERED:

- THE POSSIBLE TIME REQUIRED
- THE BEST GROUP SIZE AND COM-POSITION
- THE SKILLS REQUIRED
- THE RESOURCES NEEDED

TIMING

WHAT NEED TO BE CONSIDERED?

1. IN TERMS OF THE PROPOSED PROBLEM-SOLVING ACTIVITY:
   Some examples:
   - Preparation and planning
   - research
   - collecting information
   - trying out ideas
   - instruction
   - evaluation

2. IN TERMS OF 1/2 HOUR TIME SLOTS
   - carry over the activity to another day
   - block teaching

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WAYS OF CATEGORISING QUESTIONS

•• PRODUCTIVE AND UNPRODUCTIVE QUESTIONS

Example: A child was reflecting sunlight onto the wall with a mirror. The teacher asked:'Why does the mirror reflect sunlight?' The child had no way of knowing, felt bad about it and learned nothing. Had the teacher asked:'What do you get when you stand twice as far away from the wall?' the child would have responded by doing just that, and would have seen the answer reflected on the wall.

Much unproductive questioning emerges from what is called 'testing reflex' of teachers. It is important to control this strong urge in ourselves and concentrate on working out the purpose of questions in planning a lesson. The following is a sequence of productive questions roughly in the order in which they could be used to encourage a child's investigation.

1. Attention-focusing questions
   eg. 'have you noticed...', 'What do you think of that?'

2. Measuring and counting questions.
   eg. 'How much?','How long?'

3. Comparison questions.
   eg. 'In what ways are these leaves different?','What is the same about these two pieces of rock?'

4. Action questions.
   eg. 'What happens if you shine light from a torch onto a worm?','What happens when...?','What happens if...?'

5. Problem-posing questions- give children a challenge and leave them to work out how to meet it.
   eg. 'Can you find a way to make your string telephone sound clearer?','How can you make a coloured shadow?'

•• OPEN AND CLOSED QUESTIONS

Open questions give access to children's views about things, their feelings and their ideas, and promote enquiry by the children. Closed questions, whilst still inviting thought about the learning task, require the child to respond to ideas or comments of the teacher. For example these questions:

'What do you notice about these crystals?'
'What has happened to your bean since you planted it?'

are more likely to lead to answers useful to both teacher and pupils than their closed versions:

'Are all the crystals the same size?'
'How much has you bean grown since you planted it?'

Closed questions suggest that there is a right answer and children may not attempt an answer if they are afraid of being wrong.

•• PERSON-CENTRED AND SUBJECT-CENTRED QUESTIONS

Another way of avoiding the 'right answer' deterrent is to recognise the difference between a subject-centred question, which asks directly about the subject matter, and a person-centred question which asks for the child's ideas about the subject matter.

•Subject-centred example: 'Why do heave lorries take longer to stop than lighter ones?'
'Why did your plant grow more quickly in the cupboard?'

•Person-centred example: 'Why do you think heavy lorries take longer to stop than lighter ones?'
'Why do you think your plant grew more quickly when it was in the cupboard?'

QUESTIONS TO PROMOTE THINKING AND ACTION

Here questions are classified according to their purpose; the questions may be from any of the above categories.

•• QUESTIONS FOR FINDING OUT CHILDREN'S IDEAS

eg. 'What do you think is coming out of the potato?'
'What do you think is happening inside the potato?'
'Why do you think this is happening to the potato?'
'Do you think the potato plant will go on growing?'
'Can you think of anything else that this happens to?'

They can be readily seen to be open, person-centred questions, since there was a need for children to be given every encouragement to express their thoughts at that time, before investigations started, so that the teachers would know the children's initial ideas.

•• QUESTIONS FOR DEVELOPING CHILDREN'S IDEAS

According to the kinds of ideas the children start from, activities to develop them may take various forms: testing ideas by using them to make predictions and then devising an investigation to see if there is evidence of the prediction being correct, applying ideas in problem-solving, making further observations or comparisons, discussing the meaning of words, consulting secondary sources. Questions can be used to initiate these activities and children's participation in planning them.

Encouraging children to test their ideas means that these ideas have first of all to be in a testable form. 'It's the rudder which makes this boat far better than before' is not testable until the particular aspects of the rudder and the meaning of 'go better' are specified. Questions of the kind:

'How would you show that your idea works?'
'What would happen which showed that it was better:'
'What could you do to make it even better?'

require the specification of variables which are only vaguely identified in the initial statement.

•• QUESTIONS FOR DEVELOPING PROCESS SKILLS

Observing:

- What do you notice that is the same about these seeds?
- What differences do you notice between seeds of the same kind?
- Could you tell the difference between them with your eyes closed?
- What happens when you look at them using the lens?

Hypothesizing:

- Why do you think the seeds are not growing now?
- What do you think will make then grow faster?
- Why would that make them grow faster?
- Why do you think the soil helps them to grow?

Predicting:

- What do you think the seeds will grow from?
- What can we do to them to make them grow faster?
- What do you think will happen if they aren't in soil but get some water in another way?
- What do you thing will happen if we give them(growing plants) more (or less) water/light/warmth?

Investigating:

- What will you need to do to find out...(if the seeds need soil to grow)/
- How will you make it fair (i.e. make sure that it is the soil and not something else which is making the seed grow)?
- What equipment will you need?
- What will you look for to find out the result?

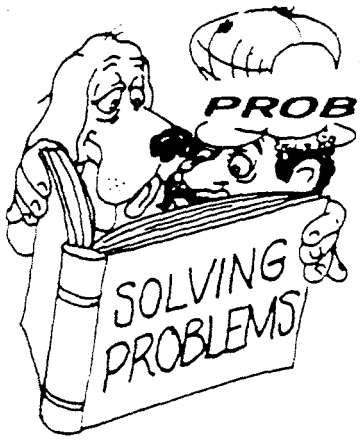
Interpreting findings and drawing conclusions:

- Did you find any connection between...(how fast the plant grew and the amount of water/light/warmth it had?)
- Is there any connection between the size of the seed planted and the size of the plant?
- What did make a difference to how fast the seeds began to grow?
- Was soil necessary for the seeds to grow?

Communicating:

- How are you going to keep a record of what you did in the investigation and what happened?
- How can you explain to the others what you did and found?
- What kind of a chart/graph/drawing would be the best way to show the results?

This paper is abridged from Wynne Harlen's The Teaching of Science. (1992). London, David Fulton publishers.pp 109-115.



PROBLEM SOLVING IN PRIMARY SCIENCE

Science is too often thought of as the memorization of endless facts and formulas. But this need not be the case...Science in the primary grades can be a joyful experience for teachers and pupils when the emphasis is on creative approaches to problem solving and critical thinking. (Bass, 1981)

•• WHAT DO WE MEAN BY THE TERM "PROBLEM SOLVING"?

Here are some examples of current educational definitions of "problem solving":

• As being able to draw reasonable conclusions about scientific data when no step-by-step procedures existed for making such conclusions.

• The solving of a 'problem' or goal which cannot be achieved directly.

• Another name for 'enquiry-based learning'.

•• CAN PRIMARY SCHOOL PROBLEMS BE CATEGORISED?

There is enormous variety in the types of problems seen fit for solution and there have been several attempts to categorize problems. They have sometimes been classified as 'open' or 'closed', 'formal' or informal', as more or less 'curriculum dedicated'(Munsen, 1988).

Another distinction is useful; that between 'given' problems, where the solver is given the goal and strategies, 'goal' problems, where the solver is given the goal and nothing else (they have to decide and develop their own strategies), and 'own' problems, where solvers decide both the goal and the strategies.

•• WHY USE PROBLEM SOLVING STRATEGIES

Here are a few reasons given by educator and environmentalists. Can you think of any others?

• Virtue of problem solving is that it is a means of transferring some of the responsibility for learning to the learner.

• Problem solving involves 'higher order' thinking skills.

• Involves child in 'process' skills as steps in 'behaving as scientists in the world.

• In terms of environmental education the child is beginning the lifelong process of problem-solving in his relationship with his/her environment. He/she is learning the many possible strategies that can be used in the complex nature of real-life problems.

•• APPROACHES TO SOLVING A PROBLEM

The most generally accepted 4 step approach is :

1. Understand the problem.
2. Plan how you can solve the problem.
3. Carry out the plan.
4. Look back over the problem.

There are other variations of this approach. Can you see the similarities in them? Since there are many different problems, there are many different suitable approaches.

- Recognising problems
- Discussing/thinking about solutions
- Trying out one solution
- Testing/assessing the result
- Getting results.

The following approach is written to show how one might interpret the above 4 step approach in 'true problem-solving' situations.

1. Understand the problem by examining each component carefully and the relationship of each component to the whole problem. That is, perform analysis and synthesis.

2. Develop a plan for solving the problem. Have you seen a similar problem before.

3. Carry out your plan. Are you satisfied that you've gained an answer to the problem.

4. Look back at the problem itself and how you solved it. What are the characteristics of the problem that encouraged you to do it the way you did? Do you see any extensions of the problem that seem inviting to consider?

•• SOME EXAMPLES (SEE THE PHOTOCOPIED PAGES) OF PROBLEM SOLVING

•• TEACHERS ROLE IN PROBLEM SOLVING APPROACH

- Recognising and creating learning opportunities.
- Advisor to experimental design.
- Asking challenging questions
- Providing appropriate resources and facilities.
- Monitoring progress (advisor to evaluation)