# The Influence of Science Teacher Preparation Programs on Instructional Practices of Beginning Primary School Teachers in Malawi

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Dissertation submitted to the faculty of
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
in
Curriculum and Instruction

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October 17, 2006
Blacksburg, Virginia.

Keywords: science instructional practices, science teaching and learning materials and strategies, scientific (process) skills, learner-centered approaches

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**(ABSTRACT)**

The purpose of this study was to observe the science teaching practices of six primary school teachers in Standards 5 through 7, to learn about their perceptions of teaching science and to examine whether or not their teaching practices were in keeping with what they were taught during teacher preparation as well as Malawi's educational expectations for primary school science based upon MIITEP (Malawi Integrated In-service Teacher Education Program) handbooks. Three research questions were posited: (a) What is the teacher preparation program for primary teachers in Malawi? (b) What were the instructional practices of the six beginning primary school science teachers who were prepared in the teacher training college programs? (c) What connections were evident between what beginning primary school science teachers were expected to learn and what they demonstrated in the classroom? All of the six participants (5 males and 1 female) had completed MIITEP in the past three to five years. The data sources for these science teachers included a self-assessment form, pre-observation interviews, post-observation interviews, and lesson observations. Data were also gathered from MIITEP handbooks and three science teacher educators who were interviewed. The data were analyzed using descriptive analysis. The study revealed that there were matches, partial matches, and mismatches between what the six primary school teachers demonstrated in their classroom as compared with the Malawi Ministry of Education science teacher preparation expectations. Of particular interest were that science teachers did not fully engage pupils in most of the process skills for science teaching, nor did they utilize a variety of appropriate teaching and learning strategies and materials for teaching science. In addition, allotted time for teaching science lessons was not fully utilized due to, among other factors, time conflicts with other official and community welfare duties, and mixing English with vernacular during teaching. Implications for practice and for further research have also been suggested.

## DEDICATION

To my loving and caring parents, my son Pericles, aunts, cousins, brothers and sisters and my teachers at all levels. I also dedicate this work to all aspiring primary school science teachers.

## ACKNOWLEDGEMENTS

I would like to thank all those who contributed directly or indirectly during my studies. Special thanks should go to colleagues and my professors at Virginia Polytechnic Institute and State University who were both stimulating and supportive and to the Virginia Tech library staff who continually assisted me.

Many thanks should go to my research participants who gave me valuable information for this study. Many thanks should go to Nelson Kaperemera, Vincent Chalila and Anna Kanyimbo Sichinga, who were my references and encouraged me to work hard all the time.

Special thanks should also go to my academic supervisors: Dr. Josiah Tlou, Dr. Jerry Niles, Dr. Mary Alice Barksdale, and Dr. Patricia Kelly. They provided me with valuable advice and worked so hard without tiring. I encourage them to do the same with other students.

It would be wrong not to mention the financial support given to me by USAID/Malawi, which allowed me to pursue my studies with few problems. Special thanks also go to the Africa America Institute (AAI) for their financial and administrative support for to me during the last two months of my studies in the USA.

Special thanks go to members of Blacksburg Presbyterian Church for untiring support during my studies. In particular, I would like to mention the family of Elva and Dr. Herbert Miller for hosting me during my final write-up.

I would like to thank the principal and staff of Domasi College of Education in Malawi for providing a favorable environment for my on-the-job studies. In addition, I would like to thank heads of various education institutions in Malawi that supported me since the onset of my research.

Lastly I would like to thank all friends, colleagues and relatives who supported me whose names would form an endless list. However I would like to give special thanks to the following: My brothers Euclid and the late Xylo Mtonga and my nephew Harold Ngulube who bought the newspaper, saw the advertisement of the program that brought me to the United States, and finally gave it to me. In addition, I would not have gone for the interview if it were not for Dr. Peter Mvula who processed my academic transcript and Mr. M. Nkhoma who edited and delivered my application letter. May God bless you all.

## TABLE OF CONTENTS

## LIST OF ABBREVIATIONS

| | |
|---|---|
| DEM | District Education Manager |
| DTED | Department of Teacher Education and Development |
| FPE | Free Primary Education |
| ITEP | Initial Teacher Education Program |
| MIE | Malawi Institute of Education |
| MIITEP | Malawi Integrated In-service Teacher Education Program |
| MOE | Ministry of Education |
| MOEC | Ministry of Education and Culture |
| MOHRD | Ministry of Education and Human Resource Development |
| PCAR | Primary Curriculum and Assessment Reform |
| PEA | Primary Education Advisor |
| PIF | Policy and Investment Framework |
| PSLCE | Primary School Leaving Certificate examinations |
| PIF | Policy Investment Framework |
| TDC | Teacher development Centre |
| TDU | Teacher Development Unit |
| TT | Temporary Teacher |
| TTC | Teacher Training College |

## LIST OF TABLES

# CHAPTER ONE
# INTRODUCTION

The purpose of teacher education is to produce effective practicing teachers (George, Worrell, Rampersad, & Rampaul, 2000). The question of how trainees can best be prepared to become effective classroom practitioners has been on the minds of teacher educators world-wide for many years (George, et al., 2000). Review of the literature about teacher education and classroom practice shows that, so far, there is very little known about how teacher education affects practice (Allen, 2003; Cochran-Smith, 2005; Tsang, 2003). To achieve the goal of training effective teachers, different approaches to teacher education have emerged in teacher preparation schools around the world. Most teacher education programs include both in-college courses and field experiences (practicum) in selected schools. Malawi is no exception. To prepare teachers for primary schools, Malawi has relied on several innovative programs and among these was the Malawi Integrated Teacher Education Program (MIITEP).

Producing effective teachers has proved challenging in Malawi. These challenges are immense due to the lack of books and average class sizes of over 80 pupils in primary school classrooms (Malawi Ministry of Natural Resources and Environmental Affairs, 2002). The introduction of Free Primary Education in 1994 raised primary enrollment by about 70% from 1.9 million in 1993/94 academic year to 3.2 million in 1994/95 Academic year (Teacher Development Unit, undated; Ministry of Education, 2001). With the introduction of Free Primary Education, the Ministry of Education recruited about 22,000 untrained primary school teachers to join the ranks of primary teachers in schools across the nation. MIITEP emerged from the need to train these untrained teachers to become qualified teachers within a relatively short period of time. The new recruits were to be trained in 6 cohorts of 3000 each within a 3-year time period. The MIITEP program required that the new recruits be trained in methods for teaching all of the primary subject areas including Chichewa (the national language), English (the official language), mathematics, science and health education, general and social studies, agriculture, religious education, creative arts, music, physical education, home economics and needlecraft.

This study focuses specifically on primary school science teaching. Unfortunately, science is among the subjects most poorly taught in Malawi (Ministry of Education Science and Technology, 2001). In Malawi, primary school teachers hold either a T3 teacher certificate (for

those having two years of secondary education, the equivalent of grade 10 in United States) or a T2 teacher certificate (for those having four years of secondary education, or the equivalent of grade 12 in the United States). Some teachers are unqualified (untrained) and start teaching with the hope that they will one day be selected to attend a teacher preparation program at one of the TTC's in Malawi. This means that teachers in the primary schools in Malawi do not hold a diploma or bachelor's degree from a college.

Furthermore, the demonstration of knowledge of science is not a requirement for receiving a secondary school certificate in Malawi. Some candidates for primary school teaching may not have taken science during their secondary education programs. As a result of the fact that many primary teacher candidates have not studied science in secondary school, they do not have the background knowledge needed for teaching science. Thus, the MIITEP program for training primary school teachers included the science content that is supposed to be taught in primary schools and training in pedagogical methods for science instruction. However, there is doubt as to whether or not the many topics to be covered in the primary science teacher preparation program covering content and pedagogy can be taught effectively in the time period allotted for this instruction in the Teacher Training Colleges. The primary teaching candidates spend only three months (one semester) in college for their residential course, which includes preparation for science teaching.

## Purpose of the Study

Logically, one would assume that what beginning teachers learn in their preparation programs should be evident in their instructional practices. However, there is evidence that teachers generally teach as they were taught when they were students, apparently ignoring much of their training for teaching (Grossman, 1990; Ware, 1992) There is little research that has explored the relationship between expectations for teachers, their preparation for teaching, and their teaching practices in the Malawian schools. A study of this phenomenon has the promise of providing a perspective on this complex problem in the Malawian context.

Thus, the purpose of this study was to observe the teaching practices of six primary school science teachers, to learn about their perceptions of teaching science, and to examine whether or not their teaching practices were in keeping with what they were taught during teacher preparation and Malawi's educational expectations for them based upon the Malawi

Integrated Teacher Education Program (MIITEP) Handbooks. At the time of this study, primary school teachers in Malawi were trained in teacher training colleges in the MIITEP program that involved one semester of residential instruction. Science teacher preparation occurred in one course during the MIITEP residential period at the teacher training colleges. Science content in the areas of chemistry and physics and pedagogy were included in this course of study. There was the expectation that students would continue their learning under the guidance of experienced professionals over the following five semesters. Biology topics were to be learned independently during this five-semester time frame by the primary teacher candidates.

Science and health education are taught in the primary schools in Standards (grade) 5 through 8. It is expected that science and health education topics will be integrated within general studies in Standards 1 through 4. The purpose of the science emphasis in these lower classes is to introduce basic aspects of human health and care of the surrounding environment. Study of science and health topics is expanded in Standards 5 through 8. Five out of seven of the major themes in the primary school curriculum for science deal with the environment, health, and care of the human body. Primary school science is covered under seven main themes: (a) Living Things and the Environment, (b) The Human Body, (c) Nutrition, (d) Common Diseases, (e) Safety and First Aid, (f) Matter, and (g) Machines (Ministry of Education and Culture, 1992)

It should be noted here that the whole primary curriculum is currently in the process of reform (Ministry of Education, 2004). The current effort to reform the science curriculum was necessitated by several factors that include political, social, economic, and educational concerns. The Malawi Primary Education and Curriculum Reform (PCAR) project will be implemented soon. At the time of this study, teaching syllabi and other instructional materials were being developed. In the future, science will be taught in Standards 3 and 4 in a content area called Agriculture, Science and Technology (AST). In the senior classes (Standards 5-8), Agriculture will be taught separately from Science and Technology. This curriculum reform effort will lead to changes in teacher education that will match the new expectations for primary school teachers. Thus, gaining an understanding of the nature of teacher preparation and teachers' practices is particularly relevant at this time in Malawi.

## Research Questions

In order to understand the teaching practices of six primary science teachers in Malawi, three research questions were posited.

1) What is the science teacher preparation program for primary teachers in Malawi?
    a) What is the curriculum for the science teacher preparation program?
    b) What were the perceptions of selected science teacher educators in the teacher training colleges about the science preparation program?
2) What were the instructional practices of six beginning primary science teachers who were prepared in the Teacher Training College programs?
3) What connections were evident between what beginning primary science teachers were expected to learn and what they demonstrated in the classroom?

Calderhead and Sharrock (1997) noted that making a distinction between teacher education and teacher training is not particularly useful because the process of learning to teach involves aspects of both education and training. Thus, for the purpose of this study, the terms teacher education and teacher training will be used as equivalent terms.

## Introduction to the Study

What beginning teachers know and practice is based on knowledge of both content and pedagogy, the school context, and beliefs about teaching. Teachers need to have a thorough knowledge of the subject matter in order to teach effectively. Besides this, teachers require the knowledge of how to deliver that subject content knowledge during the practice of teaching. Shulman (1987) identified three main categories of knowledge necessary to a teacher. These are the subject matter content, pedagogical content knowledge, and curricular knowledge. Grossman (1990) expanded further on pedagogical content knowledge as inclusive of understandings of students to be taught, knowledge of the curriculum, and knowledge of instructional strategies that are appropriate for both the students and the curriculum content to be taught. Initial teacher preparation contributes to this acquisition of knowledge regarding students, curricula, instructional strategies, and the match between these three areas. However, it should be noted that time, skill and experience, as mentioned by Grossman (1990), is required to gain this knowledge.

Teacher beliefs also influence instruction provided to pupils in the classroom, although there are instances in which teacher beliefs contradict their classroom practices. Teacher beliefs include the perceptions teachers have developed about the act of teaching and the teaching profession during their own schooling experiences. In some situations, teacher beliefs can hinder the acquisition of new innovations. It is because of this effect that Pajares (1992) suggested that teacher beliefs should be not be ignored when thinking about improving preparation of teachers.

Content and pedagogical knowledge are the focus of this particular study, which examined the content and pedagogical knowledge demonstrated by six selected primary science teachers. These teachers all had between three and five years of teaching experience after their initial teacher preparation. During interviews with the teachers, their beliefs about teaching and the conditions in the schools where they taught also emerged.

## Limitations of the Study

This qualitative study had limitations that preclude generalizing the findings to all beginning primary teachers in Malawi. However, the study can provide important information on which to base recommendation for improving science education as it is taught in the teacher training colleges.

First, the sample size was small compared to the many beginning primary school teachers in the country. There were only six beginning science teachers selected to participate in the study, and those teachers were from the Central East Education Division, one of six educational divisions that exist in Malawi. Therefore, the findings of the study cannot be considered representative of all beginning science teachers in Malawi.

Second, the sample consisted of five males and one female. Given the criteria for selection of the teachers from the Central East Education Division, more males than females resulted. In Malawi more males teach in the middle and senior levels of primary schools, and females tend to allocate themselves in the infant levels, or Standards (grades) 1 and 2.

Third, the study was conducted in a one-semester period, which is three months in duration. Although this time frame fit the needs of the study as conceptualized, it could be argued that a longer time frame for the study might have yielded different results.

Fourth, there was not a match between the teachers selected for the study and the teacher educators who taught them; that is, the teacher educators who participated in the study were not

the instructors who had taught the six teachers. In addition, the six teachers were not all trained in the same teacher training college. Therefore, there could be differences in the ways in which the six teachers were prepared for teaching. There also could be differences in the expectations of the teacher educator participants as compared with the teacher educators who actually prepared the six teachers.

Finally, data collected from the teacher educators were based on interviews only. There were no observations of the science teacher educators, as was the case with the six teachers. Therefore, what the science teacher educators reported might have differed from their actual practices.

## Organization of the Study

In the first chapter, I have presented the purpose of the study and a framework for the study as well as the research questions. Limitations of the study have also been described. A review of the literature as it pertains to the study is presented in Chapter 2. The methodology for the study is described in Chapter 3. Chapter 4 contains the findings of the study, and in Chapter 5 these findings are discussed in relation to the literature, the needs of primary science teacher education in Malawi, and the need for further research.

# CHAPTER TWO
# LITERATURE REVIEW

Teacher education programs should help to shape teachers. Johnston (1992) argued, "There is little doubt that education programs have an important role to play in developing within student teachers images of good teaching" (p. 14). However, initial preparation represents only the first phase of learning to teach.

Beginning teachers learn in individual university courses and in their student teaching placements. But they also learn from other teachers during initial teaching experiences and from a multitude of other sources such as their interactions with students, the professional reading that they do, and various in-service workshops and other professional development activities they experience during their initial years of teaching (Borko & Putnam, 1986).

Therefore, although recognizing that teachers grow as they continue to learn within the profession, it is the focus of this study to look at initial teacher preparation, specifically primary science teacher education.

## Importance of Content and Pedagogy in Teacher Education Programs

Teachers need to understand the subject matter they teach. According to Ball and Cohen (1999), teachers need to have in-depth understandings of meanings and connections in subject matter and not just procedures and isolated information. Teacher education matters a great deal as stipulated by Linda Darling-Hammond (1997) in her follow-up study for the National Commission on Teaching and America's Future (NCTAF). She observed that teachers who are fully prepared in both their content and pedagogy are highly rated and are more successful with students than those without preparation. Goodlad (1999) argued that "an ill-prepared beginning teacher is likely to be the ill-prepared experienced teacher" (p. 693). In support of this view, Griffin (1999) reported that the contribution of teacher education is becoming a powerful lever for change in schools. It is for this reason that science teachers should be well prepared in their teacher preparation programs.

There seems to be mixed evidence about subject matter learned during teacher preparation programs. Borko and Putnam (1986) found that novice teachers learned new content as they prepared to teach. In some cases, "participants in science and social studies found themselves preparing to teach material they had never studied themselves" (p. 687). The

National Science Teachers Association (NSTA, 1998) has pointed out that science content should be specifically selected to meet the needs of prospective teachers. In the same report, NSTA went on to assert that science content should be provided by science faculty in science courses. Having content knowledge is one piece of a science education program. Teachers also need to connect students with content effectively by using appropriate teaching approaches**.** They should have the capacity to adapt and shift modes of response to students on a moment-to-moment basis as they engage in continuous assessment during teaching. In teacher preparation programs, subject matter and pedagogy become intertwined. Thus, the two aspects depend upon each other.

Shulman (1987) identified three main categories of knowledge necessary to a teacher. These were: (a) subject matter knowledge or content, (b) pedagogical content knowledge, and (c) curricular knowledge. He argued that it is the pedagogical content knowledge that distinguishes the understanding of a content specialist from that of a pedagogue. Generally, in Malawi and perhaps elsewhere, most university professors, though well prepared in academic content in their disciplines, do not know how to teach because they lack pedagogical content knowledge for that particular subject. Tom (1997) differentiated the two "knowledges" by asserting "not everyone who knows a subject can also teach it" (p. 114).

Secondary sources of knowledge identified by Shulman (1987) (besides the three mentioned above) were: (a) knowledge of the learners, (b) knowledge of the educational context, and (c) knowledge of educational aims and values. Pedagogical content knowledge, according to Grossman (1990), involves an understanding of students to be taught, knowledge of the curriculum, and knowledge of instructional strategies. To acquire such knowledge requires time, skills, and experience, and not everyone who is a discipline major has acquired this knowledge. In support of this same contention, Clermont, Borko, and Krajcik (1994), in their comparative study of pedagogical content knowledge with regard to novice and experienced teachers in chemistry, found that in the absence of a mentor, such knowledge was gained slowly through trial and error, and resulted from continued efforts and gradual successes. Learning to teach is a slow and complex process and involves error, success, and refinement as teacher knowledge grows (Shulman, 1987; Labaree, 2000).

Bainer and Wright (2000) in their study of teachers' choices about their own professional development in the teaching and learning of science, noted that "in a constructivist theory, a

good learning environment includes time for mental processing, other learners with whom to interact, collaborate, and reflect, and a variety of alternatives for reaching the learning outcomes" (p. 46). Their findings suggested that science lessons that were more student-centered and student-directed were more meaningful to students. These findings are similar to the objectives of the National Science Education Standards (1998), which emphasize the use of constructivist teaching approaches in all United State schools. It is, therefore, imperative that teacher education programs model these effective teaching approaches.

In a three-year study on beginning science and mathematics teachers at the high school level, Simmons, Emory, Carter, Coker, Finnegan, and Crotchet (1999) concluded that, although teachers reported that their teaching was student-centered, classroom observations demonstrated that they were actually more teacher-centered in their teaching. However, it was noted that as beginning teachers gained more teaching experience from first year to third year, their teacher-centered actions in the classrooms declined. Similarly, in an analysis of elementary teachers' beliefs regarding the teaching and learning of science, Levitt (2002) found that teachers believed that science teaching should be student-centered. However, he observed that memorization of bits and pieces of information, recitation, and reading were emphasized in most science lessons "at the expense of exploration of questions, critical thought, understanding in context, argument, and doing science" (p. 2). It seems, therefore, that teachers are usually aware of what is recommended for good classroom practice although other factors may prevent them from implementing such practices. Consequently, there is frequently a dichotomy between what teachers know to be good practice and what they do in the classroom. On the other hand, it also appears that, if beginning teachers are prepared well, they may with experience make changes to their practices to incorporate those pedagogies they learned in their preparation programs.

## Beginning Teachers and Science Teaching and Learning

Martin, Chany, and Chiodo (2001) noted that the concerns of beginning teachers tend to be universal in the United States as well as in other countries of the world. In the first years of teaching, teachers tend to have more problems relating to managing classrooms than experienced teachers may face. These authors described three stages that all beginning teachers go through. The first stage centers on survival concerns, such as classroom control, a feeling of being observed, and getting the opinions of supervisors. The second stage involves task concerns such

as lack of materials, strategies and time. Finally, concerns emerge about the impact of instruction on students in relation to issues such as suitability of materials and fairness.

Veenman (1984) identified this dramatic and traumatic transition from teacher training to first year of teaching as a "reality shock." Her observational data revealed that when beginning teachers reach the third year of teaching, they begin to show responsible, systematic, kind, understanding and friendly behaviors. It has been noted that one of the major problems for teachers is insufficient preparation for the job of teaching (Veenman, 1984). Liston, Whitcomb and Borko (2006) noted that most studies of beginning teachers present a progression towards mastery or expertise, which is achieved in the first four years of teaching or beyond. However, Liston, et al. (2006) asserted that, although we expect beginning teachers to face difficulties, "there is emerging evidence that those teachers prepared in powerful teacher preparation programs seem to manage the vicissitudes more adeptly than others" (p. 351).

Pre-service teachers generally have difficulty with science and avoid teaching it. The findings of Appleton (2003) on beginning teachers confirmed this view. He found that pre-service teachers avoided teaching science and that most of them were not knowledgeable and lacked the confidence to teach it. However, his findings also revealed that there were some beginning teachers who taught science regularly and effectively. These beginning teachers might be said to show an aptitude for science literacy.

Deboer (2002) reported that the term, "science literacy," has been used since late 1950 to describe general familiarity with basic scientific concepts on the part of general public (p. 582). He further said that many attempts have been made to define science literacy, but there has been no universal acceptance of a specific definition because "it is a broad concept encompassing many historically significant education themes that have shifted over time" (p. 582). In relation to science teaching, Hanrahan (1999) argued that the major obstacle to in-depth approaches to learning in science classrooms is that in-depth study of science tends to send messages to students that science is authoritarian. That is, students are not to question what the teacher tells them and students are not given chance to question or express their feelings. Lack of time and space in the curriculum were said to be the major contributing factors to this student perspective that science has "an authoritarian quality" (p. 700). However, Hanrahan's observations revealed that the introduction of journal writing in a science classroom allowed a dialogue to develop between the teacher and the students. The dialogue helped teachers better understand and

accommodate students' needs, which resulted in students' having more positive perceptions about science learning.

Beliefs related to science and mathematics teaching are the primary factors that teachers use in determining the instructional practices to be used in the classroom (Nespor, 1987; Lumpe, Haney, & Czerniak, 2000; Tosun, 2000). Teachers' attitudes toward science and mathematics influence their teaching practices (Mulholland & Wallace, 1996; Stevens & Wenner, 1996). Nespor (1987) found teachers' decisions about instruction and classroom environment were influenced by either positive or negative past experiences. To reduce the impact of unsuccessful experiences in mathematics and science, Tosun (2000) suggested active participation of teacher candidates in science and mathematics lessons and repeated opportunities for successes in field experiences. Some studies have shown that there is little time spent on teaching science by both pre-service and in-service teachers in elementary schools in the USA (Roychoundhury, 1994; Sivertsen, 1993).

Science literacy involves knowledge about science. *Science for All Americans* (1989) contended that science teachers should help students to acquire both scientific knowledge of the world and the scientific habits of mind. This construct involved knowing, doing, and talking science. Lee (1997) argued that students can be engaged in doing scientific inquiry by "manipulating materials, describing objects and events, making explanations, verifying evidence and constructing and organizing ideas" (p. 220). However, it should be noted that the traditional Western view of seeking to understand how the world works differs from other ways of knowing that relate to personal beliefs, myths, religious values, and supernatural forces. Studies by African scholars (Dzama & Osborne, 1999) suggested that the African has his or her own method of interpreting events in the world and that this perspective differs from the individual who is a product of Western culture. These authors argued that the majority of students and adults in Africa have very little appreciation for science and understanding of science. Knowing science in a formal academic sense does not necessarily mean that individuals will be able to make sense of it in the social world. Science educators need to emphasize inquiry-based teaching that, according to Deboer (2002), involves "problem solving, project-based teaching, discovery learning and guided discovery" (p. 407). He further stated that at the foundation of inquiry-based teaching is the notion that "students can be scientific inquirers in the classroom and generate meaning more or less independently of the teacher" (p. 407). Deboer (2002) did report that there

were some problems with inquiry-based teaching. In his study, students complained that they were not learning the materials they would be tested on. In addition, students depended on the teacher to frame questions to explore and design.

In connection to acquiring scientific knowledge, Anderson (2000) argued that science literacy comes from doing science and not reading about science. He emphasized that science can be done anywhere, with or without expensive equipment, which implies that science teachers can use the materials that are readily available around them in their environment. In Malawi, one of the education policies as stipulated in the Policy and Investment Framework (PIF, 2001) recommends teaching and learning using locally available resources (TALULAR). It was noted by Chakwera, Thawe, Banda, Matemba, January, Saiti, et al. (2001) that **"**TALULAR ideas can assist in making teaching and learning effective and making the education system more sustainable by introducing important cost-effective classroom technologies" (p. 103). These locally available resources may include: (a) human resources such as guest speakers; ( b) material resources such as charts, diagrams, artifacts and models; and (c) non-material resources such as individual talents (Chakwera, et al., 2001). It should be noted that knowing how to make and use locally available resources requires teacher creativity and innovative skills. The teachers are required to know: (a) types of locally available resources that can be used for teaching and learning; (b) how to use the locally available resources effectively; and (c) understand how these resources can be used in a variety of subject areas.

Flores (2001) noted that beginning teachers believe that professional learning is the result of experience. They learn by doing and making continuous decisions about teaching and other job-related roles and, in most cases, these decisions are influenced by prior experiences as students. Lortie (1975) referred to this phenomenon as the "apprenticeship of observations" (p. 61), a professional knowledge base that is attained through many hours of classroom observations. However, the apprenticeship of observation does not provide beginners with a true vision of the nature of teaching because beginning teachers only understand instruction from the side of a student and not a teacher. When beginners observe, their perspective is based more on the experience of being a student, and they are unable to perceive of the thinking that guides the actions of the teachers they observe. This limited initial stance makes learning to teach a very complex process which requires time and experiences in the teacher's role (Borko & Putnam, 1986; Labaree, 2000). Many other scholars have reported on the fact that previous life history

and experience as a student has the power to impact teacher behaviors and beliefs in strong and enduring ways (Waller, 1932; Lortie, 1975; National Center for Research on Teacher Education, 1988; Florio-Ruane & Lensmire, 1990; Calderhead & Robson, 1991; Richardson, 1996; Zeichner, 1980). It is, therefore, important that beginning teachers be provided with many opportunities to teach science because these experiences are necessary in the development of confidence and persevere in teaching science.

Gibson and VanStrat (2000), in their study on the impact of instructional methods on pre-service teachers' attitudes towards teaching and learning, found that inquiry-based science activities had positive effects on students as a whole as compared with students taught using traditional approaches. These effects include science achievements, attitudes towards science and school, laboratory skills, science process skills and understanding of scientific knowledge. While inquiry-based approaches give rise to the stated positive effects, sometimes teachers may not apply them due to certain factors. For example, Chang, Hua, and Barufaldi (1999) observed that in Taiwanese schools the teachers were not free to organize their own schedules and teaching content. He found that many factors, such as time, national examinations, and parental preferences contributed to the failure to adopt constructivist, inquiry-based approaches to teaching.

In summary it can be said that beginning teachers experience problems as they go through the process of learning to teach. The behaviors of beginning teachers change toward being responsible, systematic and friendly as years go by. In connection to science teaching, most pre-service teachers find difficulties and avoid teaching it. In order for one to know science, science literacy is required, which involves manipulative skills and explanations about science. Scientific literacy can be achieved if teachers emphasize inquiry-based teaching approaches so that pupils learn by doing. Learning to teach is a complex process and requires time and experience, hence the need for beginning teachers to be given opportunities to teach.

## Teacher Beliefs As They Impact Teaching and Learning

Klepper and Barufaldi (1998) posited that much evaluation, compromise, and adjustment is engaged in by beginning teachers during the first years of teaching. It is at this time that behaviors and beliefs about practice are being established. Shulman (1987) noted that instruction involves the observable performance of a variety of teaching acts, which include major aspects

of pedagogy. In trying to examine teachers' actions, Kagan (1992) further argued that researchers must understand the role of beliefs. Hollingsworth (1989), in her study of fourteen pre-service teachers on their prior beliefs and cognitive changes in learning to teach, noted that students entering teacher education programs have definite ideas about teaching and learning. These beliefs are the result of years of being a student and observing their teachers teach.

The beliefs that teachers hold influence their behaviors in the classroom. It is for this reason that Pajares (1992) suggested that teacher beliefs should be the focus of educational inquiry in order to improve the professional preparation of teachers. Because research suggests that science should be taught through student-centered approaches, and yet most beginning teachers have been taught through teacher-centered approaches, it is important for science teacher educators to model good instructional practices for pre-service teachers with the hope that these teaching methods will be emulated by them (Ware, 1992; Anderson & Mitchener, 1994). However, Grossman (1992) contended that, because students have these beliefs, it is difficult for them to accommodate new information, especially information that contradicts beliefs they already hold about teaching and learning.

## Summary

Three key ideas have been identified in this literature review. First, the literature demonstrates the importance of content and pedagogy in teacher education programs. Teachers need to understand the subject content knowledge and how to teach that content. Second, the chapter looked at beginning teachers and science teaching and learning. It has been observed that beginning teachers face more problems relating to management of classrooms than experienced teachers. However, as years go by, experience is gained and teachers tend to change for the better. There is evidence that many pre-service and beginning teachers have difficulties teaching science and hence they avoid it. Finally, teacher beliefs were examined as they impact teaching and learning. Research has shown that teacher beliefs influence teacher behaviors in the classroom. It was also noted that these beliefs might sometimes hinder a teacher in utilizing different approaches to teaching. Research also has suggested that student-centered approaches in the teaching of science should be modeled during teacher preparation in order to provide pre-service teachers with the knowledge they need to teach effectively.

# CHAPTER THREE
# METHODOLOGY

The purpose of this study was to observe the teaching practices of six primary school teachers and to examine the match between their practices, what they were taught during teacher preparation, and the expectations for primary science instruction of the Malawi Ministry of Education. This chapter provides a description of the qualitative methodology used in this study, including the primary science teachers and science teacher educators who participated in the study and the criteria for selecting these participants. Next, the data sources used in the study are described, followed by a detailed description of how the data were analyzed.

Three research questions guided the investigation. These were:

(1) What is the science teacher preparation program for primary teachers in Malawi?
   a) What is the curriculum for the science teacher preparation program?
   b) What were the perceptions of selected science teacher educators in the teacher training colleges about the science preparation program?

(2) What were the instructional practices of six beginning primary science teachers?

(3) What connections were evident between what beginning primary science teachers were expected to learn and what they demonstrated in the classroom?

## Participants

### *Access to Participants*

The identification of participants began with a permission letter to the Ministry of Education Headquarters in Malawi (see Appendix A). Having received no response, the researcher decided to negotiate at the divisional level. This effort was successful, and permission to conduct the study was granted. After getting permission from the Education Division Manager for the Central Eastern Education Division, the District Education Manager for Kasungu (a district in central region of Malawi) wrote a letter of introduction to the primary schools (see Appendix B). This letter requested access to participants in several Kasungu primary schools, and it was presented to the head teachers by the researcher personally.

***Primary Science Teacher Participants***

Six primary school science teachers were selected as participants. These teachers taught in from different primary schools in Malawi's Central Eastern Education Division. Two participants were selected for each of the Standards (grades) 5, 6, and 7. The participants included five males and one female, making a total of six. These participants had teaching experience of between three and five years after their completion of their initial teacher preparation program. Prior to their teacher preparation programs, all six participants had been teaching as unqualified (untrained) teachers in primary schools in Malawi.

This study focused on beginning teachers with between three and five years of experience. When teachers have taught for 3-5 years, they have gained confidence in teaching and are following routines that work (Steffy, Wolfe, Pasch, & Enz, 2000). The researcher did not include beginning teachers with the first two years of teaching because, generally, these are teachers who are still experimenting with what works and what does not work in the classroom. Many first and second year teachers are struggling to survive and gain confidence to teach, and they are moving through transitions in teacher development. Veenman (1984) identified this dramatic and traumatic transition from teacher training to first year of teaching as "reality shock."

Participants were selected from Standards 5, 6 and 7 because according to current primary school curriculum in Malawi, science is taught in Standard 5 through Standard 8. In this study, Standard 8 was eliminated because it is at this level that students write the national Primary School Leaving Certificate Examinations (PSLCE). Criteria for selection required that the teachers be currently teaching science in any of the Standards 5, 6, or 7 and that they had been teaching science continuously for the past three years. Choosing primary teachers who met these criteria provided a scenario in which the researcher could observe current science teaching practices of teachers who had completed their MIITEP teacher preparation programs (and therefore would remember their preparation fairly well) and who had survived the beginning years of teaching (and therefore would have developed practiced strategies for teaching science). Each participant signed an Informed Consent Form after reading through all the contents of the form and the head of each institution witnessed these signings (see Appendix C).

### *Teacher Educator Participants*

In addition to the primary science teachers, three science teacher educators were selected for the study. Two of the teacher educators came from a Teacher Training College (TTC) located in a rural sector and the other came from a TTC located in a more urban sector of Malawi. All of the three TTC's were located in the central region of Malawi. The choice of selecting teacher educator participants from different TTC's was based on the fact that two were located in a rural sector and the other in an urban sector of Malawi. The science teacher educators were all currently teaching science in TTC's.

## Data Sources

There were six sources of data used in conducting this study. Information gathered from the six primary science teachers included: (a) self-assessment forms on the use of process (scientific) skills, (b) pre-observation interviews, (c) field notes based on lesson observations, and (d) post-observation interviews. Each of the science teacher educators was interviewed one time for the purpose of gathering information on how primary teachers are prepared to teach science in the TTC's. Finally, the MIITEP Handbooks for Science in the Primary Schools were treated as a data source that reflected expectations for what primary science teachers should know and be able to do, with specific focus on pedagogy.

### *Primary Science Teacher Self-Assessment Forms*

Each primary teacher completed a self-assessment form at the onset of the study. The purpose was to obtain teacher perceptions of their use of process (scientific) skills in the teaching of science before any interviews or observations took place. The self-assessment forms asked about the process (scientific) skills in which primary science pupils were engaged in during science lessons. The process skills included on the self-assessment forms were based upon those stipulated in the MIITEP Handbooks. Each participant was asked to check against each process skill based upon which skills had been used in science lessons during the semester that had just ended. The form listed the process skills on the left hand side and had four columns with the

labels (a) not done, (b) rarely done (c) sometimes done, and (d) frequently done (see Appendix D).

***Primary Science Teacher Pre-Observation Interviews***

The pre-observation interviews were based on protocol questions that had been formulated to guide the interviewing process. The purpose of the pre-observation interviews was to provide teachers with the opportunity to discuss with the researcher their plans for teaching a science lesson, and their reasoning for the plans that had been designed. The interviews lasted for about 45 minutes, and were based on semi-structured protocol questions that had been phrased to suit primary school science teachers (see Appendix E). These interviews were audio taped and transcribed prior to analysis.

It should be noted that the protocol questions for the pre-observation interviews were based on questions developed for a pilot study that included interviews with two primary school teachers who were at close proximity to the researcher. The main purpose of this pilot study was to refine the data collection tools before the actual data collection. Revisions were made in the interview questions after the pilot study to improve the questions that would be asked for data collection purposes for the current study.

***Primary Science Teacher Lesson Observations***

A lesson observation form was created to record what transpired during the teaching of the science lessons. The form focused on the process skills that the students were engaged in during each lesson (see Appendix G). Additional field notes were written on the back of each form in order to capture all the activities that took place during teaching. Twenty-four lesson observations were conducted between January and early June 2004. There were four observations for each of the six participants. These were generally spaced at two-week intervals, and in some circumstances, one-week intervals for convenience.

***Primary Science Teacher Post-Observation Interviews***

After each lesson observation, the primary science teachers were interviewed for about 10 to 15 minutes using four guiding questions. These questions were designed to gather feedback

from the teachers on the lesson taught and plans for the next lesson (see Appendix H). The post-observation interviews were audio taped and transcribed.

### *Science Teacher Educator Interviews*

The three science teacher educators were interviewed to obtain information on how primary teachers were prepared in the TTC's under the MIITEP program for science teaching. The purpose of the interviews with the teacher educators was to gain an insight into the perceptions of teacher educators with regard to the content and methods they used in the preparing students to teach science in primary schools. The interviews with science teacher educators lasted for about 45 minutes and were based on semi-structured protocol questions (see Appendix F). The interviews were audio taped and transcribed prior to analysis. Two of the interviews for science teacher educators were conducted at the teacher training college where the teacher educators worked, and the third interview was conducted in a university setting.

The protocol questions with the teacher educators were designed based on a pilot study in which three different science teacher educators were interviewed. Based on this pilot project, the protocol questions were refined before the actual data collection procedures began.

### *MIITEP Handbooks*

Handbooks were developed by the Malawi Institute of Education to be used with the teachers who were trained in the MIITEP project. The handbooks were based on previously developed syllabi for primary science instruction. The Handbooks included the science content and pedagogy information that primary teachers were to be taught in the Teacher Training Colleges and, in effect, the handbooks set out the expectations for primary science teaching in Malawi. Thus, the MIITEP Handbooks were used as a data source that established Malawi's expectations for primary science teaching.

## Data Analysis

### *Self-Assessment Forms*

The data were analyzed by checking the short answers given by each individual participant in the columns of the Self-Assessment Form. Their check marks were based upon

what they remembered of the ways they had engaged students in learning the previous science lessons. The next stage was when the participants' responses were compared according to what was checked. This was done to discover the frequency of checks under each column and against each skill. The process skills were compared across all participants to discover a common pattern of those process skills that were not done, rarely done, sometimes done, or frequently done.

### *Interview Transcripts*

All of the pre- and post–observation interviews conducted with primary science teachers and science teacher educators were audio taped and transcribed by the researcher. The researcher benefited from the process of transcribing as supported by the recommendations of Seidman (1998): "Interviewers who transcribe their own tapes come to know their interviews better, but the work is so demanding that they can easily tire and lose enthusiasm for interviewing as a research process" (p. 98). The work was indeed demanding and time consuming; however, it provided the researcher with the opportunity to study the statements made by the participants and the contexts in which information was provided in an in depth manner. For purposes of confidentiality, pseudonyms were used at all times for all interviews. The primary teacher and science teacher educator interviews were analyzed separately.

After transcribing, the researcher identified common patterns emerging in each of the transcripts by comparing the responses given for each question asked during interviews. The first stage of analysis in this study involved reading individual transcripts, underlining important ideas throughout the transcript. These underlined ideas from each of the transcripts were compared to discover common ideas emerging from the transcripts. The common ideas were written in the margins of each transcript. Depending on the occurrence of the common ideas that were gathered, groups of categories of information emerged that made it possible to make sense of what came out of the transcripts (Merriam, 2001).

### *Lesson Vignettes*

A vignette was written based upon one of the four lessons observed with each of the six participants in this study. Main ideas of the lesson observation and the field notes that had been recorded were used to write the vignette. Each vignette was written in chronological order as the

lesson was presented from introduction to the conclusion. This researcher observed and recorded the processes that each teacher used in conducting lessons, the kinds of activities in which pupils were engaged, and provided insight into possible methods in which the teaching could be improved. The vignettes include: (a) general characteristics of the teacher, (b) a description of the classroom environment, and (c) a description of the flow of lesson activities from beginning up to the end. Information for writing each vignette was drawn from the lesson observation form and the field notes.

### *MIITEP Handbooks*

The MIITEP Handbooks were used as data sources in order to compare what was expected in terms of science preparation with what was demonstrated by primary science teachers. Stipulations in the MIITEP Handbooks in terms of pedagogy, content and other teaching skills were carefully studied by going over the topics covered and compared against what was either observed in the lesson or said by the participants during interviews.

### *Cross Case Analysis*

The researcher read through the data collected from all the data sources and identified common themes that emerged across the cases. The common ideas that emerged in each case were compared across all the six cases to discover the main themes. The themes that emerged gave a general picture that was learned from the information gathered across all the cases through interview transcripts, field notes and lesson observations. In this study, four primary themes emerged which are discussed in Chapter 4. In addition, the MIITEP Handbooks were examined to identify content and pedagogical expectations for primary science teachers.

# CHAPTER FOUR
# RESULTS

This chapter includes presentation of the findings from the research. First, there is a description of the science teacher preparation curriculum in Malawi. This is followed by the findings from the face-to-face interviews of the three science teacher educators who came from teacher training colleges in the central region of Malawi. Third, the cases of the six primary school science teachers will be presented in the following order: (a) a description of the classroom teachers' general characteristics, (b) a narrative vignette of one of the four science lessons observed by the researcher, (c) the teacher's perspectives on science teaching for each case, and (d) the researcher's summary of each case. Fourth, there is an analysis of the patterns identified across the participants. In this cross case analysis, five themes were identified and described. The chapter concludes with a summary of the major findings of this study.

## Primary School Teacher Preparation Curriculum in Malawi, 1987-2005

Before 1987, Malawi had a two-year teacher training program in all six teacher training colleges (TTC's) The total capacity of the six TTC's was 2760 with half first-year and half second-year students (Teacher Development Unit, undated). Students were engaged in primary teacher training at the TTC's for two years, including time spent taking residential courses and time spent in student teaching. Across all six TTC's, about 1380 teachers could receive a teaching certificate each year (at the end of the second year of training).

From 1987-1997, The Ministry of Education embarked on the development and implementation of a variety of innovative teacher training programs in order to meet the demand brought on by increases in primary school enrollment. According to the Teacher Development Unit (undated), the introduction of Free Primary Education (FPE) in Malawi in 1994 raised primary school enrolment by about 70% from 1.9 million in the 1993/1994 school year to 3.2 million in 1994/95. With so many new students entering primary schools, there was an immediate need for programs that could prepare large numbers of primary school teachers as quickly as possible.

The Malawi Integrated In-service Teacher Education Program (MIITEP) was designed to meet the needs for so many new teachers. The MIITEP is of particular interest in this study

because it: a) represented current teacher training expectations and practices in Malawi at the time of the study, and b) was the program in which the study participants had been trained. The objective of MIITEP was to train 18,000 untrained teachers within the shortest time possible. To meet this target, a total number of 22,000 untrained teachers were recruited under MIITEP. This program was designed to last for two years for each cohort of 3000 students**.**

Upon completion at the end of a two-year course, students were awarded a T2 or T3 Teaching certificates. The T2 Teacher Certificate was awarded to students who entered the program with four years of secondary education [having passed the Malawi School Certificate Examinations (MSCE), the equivalent to Grade 12 in the United States]. The T3 Teacher Certificate was awarded to those students who entered the program with two years of secondary education [having passed the Junior Certificate Examinations (JCE), the equivalent of grade 10 in the United States]. It is a common practice in Malawi for primary school teachers to take national examinations and upgrade themselves to the next level; for example, a teacher with T3 teaching certificate could be upgraded to T2 at any time after passing the Malawi School Certificate Examinations**.**

***MIITEP Training Design***

The design of the MIITEP course was such that primary teacher education topics were divided into zonal, residential, and self-study topics. Prior to the residential course (with the residential course being 13 weeks on campus at a TTC taking education and content area courses) students attended a two-week orientation on basic teaching practices. At this time the students were taught some teaching skills, for example how to prepare a lesson plan and how to handle large classes. According to Teacher Development Unit (undated), after the two-week orientation, the MIITEP training included the following components:

(a) Residential Study:

There was one term (13 weeks, 6 hours per day, 5 days per week) of residential training in TTC's. During this time, students took all of the coursework scheduled for the residential period. The students had daily classes and face-to-face interactions with their teacher educators. At the end of this term, students wrote end-of-residential course examinations in each of the subjects outlined in the curriculum. The curriculum subjects included: (a) Education Studies, (b) Agriculture, (c) Chichewa (a local language), (d) Creative Arts, (e) English, (f) General and

Social Studies, (g) English, (h) Home Economics, (i) Needlecraft, (j) Mathematics, (k) Music, (l) Physical Education, (m) Religious Education, and (n) Science and Health Education.

(b) Self-Study:

In general, self-study occurred after the residential period when the students were in the field teaching. One hour every day for five days each week was to be used for self-study for at least four terms of 11 weeks each, totaling 220 hours. The self-study time was designed for examination of content outlined as "self-study topics" in the MIITEP handbooks. The self-study topics included content material in every primary school subject area. Students were expected to read and master this content on their own through self-instructional print modules called handbooks.

(c) Seminars:

Each MIITEP student was required to attend twelve one-day seminars (5 hours per day) in sub-zonal centers. These seminars occurred during the time the students were teaching. Primary Education Advisors (PEA's) conducted these seminars. During the seminars, students were trained in all of the topics that were indicated in the handbooks to be taught during zonal seminars. These topics were related to practice in the field, such as "How to prepare science charts," and "Organizing practical science lessons."

(d) Student Teaching:

MIITEP students had five terms (11 weeks per term) of classroom teaching in primary schools. After completing the residential period, students were exposed to field experiences in which they were engaged in teaching all assigned primary school subjects in their primary schools. During this time, students were to be supervised in the following ways: (a) at least two periods every week by head teachers, deputy heads or other practicing teachers, (b) at least twice a term by Primary Education Advisors (PEA's), and (c) at least once by a college tutor from a TTC. During these five teaching terms, each student kept a Teaching Practice File that included a section on supervision. In this section, once the student had been supervised by any of the supervisors, that supervisor would indicate the dates, subject observed, comments, and the signature of the supervisor. Supervisors observed lessons in any subjects that were timetabled on the day of observation.

MIITEP Student's Handbooks 1 through 5 served as the foundation of the curriculum for this program. These handbooks were provided to students during the residential course or when

the students were in the field, depending upon the availability of printed handbooks. (It was common for students to not receive handbooks when they were most needed during the residential courses). These handbooks contained all of the information to be studied and learned during the residential, zonal and self-study segments of MIITEP. The handbooks were developed based on the Malawi Institute of Education (MIE) syllabi from the previously existing teacher education curriculum. The MIE already had developed syllabi to be used in all teaching preparation courses. No documented syllabi were developed for MIITEP; thus, the handbooks served as the syllabi and information sources for students. Teacher educators used MIITEP handbooks as guiding notes in preparing their instruction during the residential period.

Assessment in MIITEP incorporated continuous assessment and either end-of-course or final examinations. Selected teacher educators under the auspices of the Malawi National Examinations Board (MANEB) designed all the final examinations. For assessment purposes, subject areas in MIITEP were grouped into two categories, A and B, as outlined in Table 1**.**

*Assessment in Category A Subject Areas*. Each student wrote one paper for each of the subject areas in Category A. These papers accounted for 20% of the final grade. At the end of the residential period, students wrote end-of-residential course examinations for each subject area and these exams accounted for another 20% of the final grade. In addition, students took end-of-course (final) examinations at the end of two years of study, and these exams accounted for 60% of the final grade. In summary, grade distribution for subjects in Category A was as follows: 20% Papers, 20% End-of-residential course examinations, and 60% End-of-course final examinations.

*Assessment in Category B Subject Areas*. For the Category B subject areas, students wrote short papers and end-of-residential course examinations just as they did for Category A subjects. However in Category B, instead of end-of-course final examinations, each student completed four long papers (projects), one in each of the subject areas in category B. An example of a music project might be the one in which the students were asked to describe a traditional dance performed in their local area. The paper would include: (a) name of the dance; (b) the attire used; (c) how the attire was produced; (d) who performed the dance; (e) how many dancers were involved; (f) the style of dancing; and (g) how this dance could be incorporated in the primary schools to support student learning. Generally, these projects were written

**Table 1: Subject Categories**

| Category A | Category B |
|---|---|
| English | Music |
| Mathematics | Physical Education |
| General/Social studies | Creative Arts |
| Science/Health Education | Religious Education |
| Agriculture | |
| Chichewa | |
| Home Economics | |
| Foundation (Education) studies | |

during the self-study period and submitted for grading to college tutors through college assessment committee. In Category B subject areas, grades were distributed as follows: 20% Papers, 20% End-of-residential course examinations, and 60% Projects. The grades were then sent to Malawi National Examinations Board (MANEB).

## Overview of Primary Science Teacher Curriculum

At the time of this study, science and health education was one of the twelve teaching subjects in the Malawi Primary School Curriculum. Five Student's Handbooks served as the main source of course material for primary teachers in the Teacher Training Colleges and in the MIITEP program.

MIITEP students took one course that was designed to prepare them to teach science in the primary schools. This course began with introductory units about science teaching pedagogy and the remaining units involved content knowledge in the sciences. Table 2 outlines all the topics covered in the science course from the Student's Handbook 1 through 5, as recommended in the MIITEP program.

It should be noted here that science at the primary school level in Malawi covers topics in biology, physics, and chemistry and is taught in Standard 5-8 (the equivalent of U.S. grades 5-8). Table 2 shows that physics and chemistry topics were covered during the MIITEP residential period (as denoted by the "R" unit number) and the study of biology content was a requirement for the self-study period (as denoted by the "S" unit number).

Primary school teachers in Malawi do not specialize in particular subject areas. A teacher at any Standard (grade level) is responsible for all subject areas within that level. When a school has more than one teacher at a particular grade level, it is common for teachers to take responsibility for teaching all students at that level in a set of particular subject areas; that is, the curriculum is often departmentalized. This practice does not meet the stated expectations of the Malawi Ministry of Education (which prefers for individual teachers to teach all subjects to smaller groups of students); however, such departmentalization is regularly practiced across the entire country. Thus, although all primary school science teachers study science education and science topics, not all teachers teach science.

**Table 2: Science and Health Education Topics**

**a) Topics in Handbook I**

| Unit number | Topic |
|---|---|
| 1R | Importance of Science and Health Education |
| 2R | Scientific Skills and Attitudes |
| 3R | Practical work |
| 4R | Science corner and Nature Table |
| 5R | Improvisation in Science and Health Education |
| 6R | Storage and Care of materials |
| 7R | Science Schemes and Records of work |
| 8R | Science and Health lesson planning |
| 9R | Substances found in the Environment |
| 10R | Changes in the States of Matter |

**b) Topics in Handbook 2**

| Unit number | Topic |
|---|---|
| 11R | Mixtures |
| 12R | Separating Mixtures |
| 13R | Factors affecting the rate of dissolving |
| 14R | Soluble and insoluble substances and solutions |
| 15R | Forces |
| 16R | Liquid pressure |
| 17R | Air pressure |
| 18R | Machines |
| 19R | The Inclined plane |
| 20R | Pulleys |
| 21R | The science kit |

### c) Topics in Handbook 3

| Unit number | Topic |
|---|---|
| 22R | Types of energy and their uses |
| 23R | Properties of light |
| 24R | The effects of refraction |
| 25R | Heat transfer |
| 26R | Application of conduction, convection, and radiation |
| 27R | Expansion and contraction of metals |
| 28R | Expansion and contraction of liquids |
| 29R | Expansion and contraction of air |
| 30R | How sounds differ |
| 31R | Transfer of sound in solids and liquids |
| 32R | Transfer of sound in air |
| 33R | Reflection of sound |
| 34R | Simple electrical circuits |
| 35R | Simple electrical repairs |
| 36S | How plants are classified |

### d) Topics in Handbook 4

| Unit number | Topic |
|---|---|
| 37S | Conditions for germination |
| 38S | Animals |
| 39S | Classification of animals |
| 40S | Development of vertebrates |
| 41Z | How to prepare science charts |
| 42Z | Using the environment |
| 43Z | Organizing practical science lessons |

**e) Topics in Handbook 5**

| Unit number | Topic |
|---|---|
| 44S | Invertebrate development |
| 45S | Distribution and environmental protection |
| 46S | Brain and sense organs |
| 47S | Circulatory system |
| 48S | Breathing |
| 49S | Support and movement |
| 50S | Nutrition in people |
| 51S | Common diseases |
| 52S | Disease prevention |
| 53S | AIDS and other Sexually Transmitted Diseases. |
| 54S | Immunization |
| 55S | Common accidents |
| 56Z | First Aid |

**Key: R (Residential topic)**

**S (Self-study topic)**

**Z (Zonal topics)**

## Handbook Coverage of Science Teaching Pedagogy

The introductory segments of Handbook 1 for Primary Science Teachers covers expectations for pedagogy in science education. Because this research project examines the pedagogical practices of primary science teachers in Malawi, it is important to examine precisely those expectations for pedagogy in science education. Here, I summarize the recommendations of Handbook 1 for each of the seven pedagogical topics (2R, 3R, 4R, 5R, 6R, 7R, and 8R).

### *Scientific Skills and Attitudes*

In examining this topic, students learned the scientific process skills such as observing, measuring, inferring, classifying, making models, predicting, interpreting data, investigating, and communicating. They also learned examples of scientific attitudes/dispositions, such as interest in the subject, curiosity, creativity, open mindness, enthusiasm to work, honesty, tolerance and objectivity. Following an explanation of how these scientific skills and attitudes can be acquired, instructors modeled for the students by conducting demonstrations on how to put the information into practice in a primary classroom situation. For example, a teacher educator might organize an activity that would allow students to identify various scientific skills and attitudes. One example of such an activity would be to obtain an insect, describe the appearance of an insect, the length of the insect, the number of legs and wings, the mouth parts of the insect, and discuss knowledge of the length of time this insect might survive (Teacher Development Unit, 1998).

### *Practical Work*

For this topic, the students were involved in activities designed to enlighten them on the meaning and importance of practical work in the teaching of primary science. Types of practical work include modeling and problem solving, visits to the local habitat to study it, and collecting materials for displaying, measuring, drawing and recording information for reporting on objects/animals/plants in their natural habitat. Students were also involved in the study of points to consider when planning for practical work in teaching science. These points included (a) objectives; (b) materials; (c) venue; (d) time; (e) instructions for the activity, and (f) how to gather data.

***Science Corner and Nature Table***

Study of this topic involved learning about the distinction between a science corner and a nature table, the importance of having a science corner and a nature table, and how to construct a nature table. A science corner is a place chosen in the classroom where artificial and natural science materials are to be displayed for student study and manipulation. A nature table is a place within the science corner where only natural artifacts should be displayed (Teacher Development Unit, 1998).

***Improvisation in Science and Health Education***

Here, students learned about the meaning of improvisation, the importance of improvisation, and ways of improvising science and health education materials. The meaning of improvisation in this context is "the art to make something using materials from the immediate environment" (Teacher Development Unit, 1998, p. 54). Teaching and learning materials for science lessons can be improvised using materials such as wood, waste paper, stones, soils, plants, and metals found in the immediate environment. One example would be fixing a piece of wood on the wall using a nail to make an improvised balance beam for measuring weights.

***Storage and Care of Materials***

Students were engaged in activities and discussion relative to how materials and apparatus for science instruction could be stored and cared for. These materials include plant and animal specimens, models, various apparatus such as wooden animal cages and charts. Some methods of caring for science and health education materials included regular dusting, arranging materials in an orderly fashion, labeling science materials so that they could be quickly identified later, keeping proper records, handling records carefully, repairing damaged apparatus, and replacing damaged materials.

***Science Schemes and Records of Work***

Students were taught how to prepare appropriate science and health education schemes and how to complete records of work. In this context, a scheme of work is a document prepared by a teacher that shows the topics or concepts to be covered and the order in which they are to be covered every week throughout a term or semester. In Malawi, the creation of a scheme

of work is a requirement for primary teachers. It is expected that schemes of work will be based on syllabi from the Ministry of Education. Mtunda and Safuli (1986) define a scheme of work as, "the interpretation of the syllabus indicating the amount of ground the teacher is likely to cover during a term" (p. 32). In addition, teachers prepare records of work after teaching their lessons. The teacher records how he or she has actually taught a particular lesson, the successes and failures of the lesson, and what he or she intends to do as a follow-up activity.

### *Science and Health Education Lesson Planning*

A lesson plan is "an outline of the important ideas to be covered during the process of teaching and learning" (Mtunda & Safuli, 1986, p. 28). In their study of this topic, students were taught how to prepare good lesson plans, and they practiced how to use prepared lesson plans during teaching. Some of this practice occurred in the college classes at TTC's and some in the primary schools during the self-study and zonal segments of MIITEP.

## Findings from Science Teacher Educators

While the summary of pedagogical information from Handbook 1 provided foundational information on Malawi's expectations for primary science teachers, these interviews provided foundational information on the actual practices of teacher educators in preparing primary teachers for science instruction in teacher training colleges. This section begins with a brief description of the three science teacher educators who were interviewed, followed by the common features revealed during interviews. The purpose of the interviews was to gain an insight into the perceptions of the three teacher educators with regard to the content and methods they used in preparing students to teach science in primary schools. In MIITEP, students took one science course over the whole (13 week) residential period. Three periods of one hour each were set aside for science. Timetabling of the periods depended on the teacher educator. In some situations, a double period (2 hour block) was scheduled for activities that demanded more time.

Science teacher educators, besides teaching science content and pedagogy in science courses, guide students in analysis of the primary school science curriculum. Other responsibilities of science teacher educators include the following: (a) assisting students in academic advisory work, such as explaining requirements and recommending study skills needed

in preparation for successful passing of examinations; (b) supervising and encouraging students during residential classroom teaching experiences, as well as in both demonstration and regular primary schools; (c) planning and organizing science lessons for upcoming teaching periods; (d) setting, proctoring and marking science exercises and examinations; and (e) utilizing time for personal professional reading.

Jeke was a science teacher educator who had 18 years of teaching experience at the time of the interview. Across those 18 years, Jeke had been teaching science and other subject areas such as agriculture and mathematics. Jeke held a Diploma in Education (three years of college) from the University of Malawi. The interview took place during Jeke's free period in the morning. Only the researcher and Jeke were present for the interview, which took place in a private office.

James was a science teacher educator with 23 years of teaching experience at the time of his interview. Before becoming a faculty member at a TTC in 1989, James had been a teacher in several primary schools in Malawi. James held a Master's Degree in Curriculum and Instruction from Virginia Polytechnic and State University in the United States of America. The interview with James took place in the afternoon in an office next to the science laboratory. The students were given an assignment so that James could take part in the interview.

Jill had been a science teacher educator for 19 years at the time of the interview. Prior to becoming a teacher educator, Jill had 6 years' teaching experience in Biology and Agriculture at the secondary school level and became a teacher educator after obtaining a University Certificate in Primary Education (one year in college) from the University of Malawi. At the time of interview, Jill held a Master's Degree in Education from the University of Bristol in the United Kingdom. The interview with Jill took place on an afternoon in an office at a university.

Analysis of the interviews revealed that all science teacher educators felt that there was not enough time available to cover all of the course material in their methods and content college courses. In addition, Jeke pointed out that those science teacher educators spent a great deal of time fulfilling other responsibilities, such as proctoring required examinations, marking examinations, and attending required workshops. These activities often conflicted with teaching times. The following explanation from Jeke supported this idea**:**

> Sometimes it becomes very difficult to teach because of having too short a period of time to teach. Sometimes these students just come… you are called for marking, then you are at

> marking instead of teaching, now when you come, you will have lost some weeks, then when you start teaching, you may not follow correctly what is supposed to be done; you just want to cover the work, so you will not cover it in the right way because of such kind of disturbances.

Primary teacher education students were in college for only one semester (about three months) when they were supposed to cover all the topics planned for the residential period. The absence of a teacher educator for one or two weeks for other required duties left the students unattended at the time they were supposed to receive maximum interaction with their teacher educators.

James discussed the same issue, observing that because of the short period of time for science teaching, he used strategies that would allow him to cover a lot of material within the limited time, as opposed to making use of more participatory approaches. James said, "But, given the short period of training, we use direct instruction to overtake the circumstances."

While all noted that there was limited time to cover both content and methodology, Jill suggested that time could be saved if the recruitment procedure required that trainees already have knowledge of science. She said, "Candidates with only two years of secondary school education are much less prepared in science content." The current practice in Malawi is that primary teacher candidates with two years of secondary school education and those with four years of secondary education are similarly recruited into the teacher preparation programs.

Observations, measuring, and recording appeared to be the most common process skills that the three teacher educators used in their instruction. When asked why these teacher educators concentrated on the stated process skills, Jeke explained the need to cover what is in the syllabus, as stated in the following: " I concentrate on these because these are very common in the primary schools where they are going to teach. Pupils will be asked to observe parts of a frog… or flower, and record, measure, classify things because they are very common there. That is why I concentrate on. I put much effort on those process skills." In response to the same question, James said that the process skills that he concentrated on are easy to teach, especially observing and measuring, although there can be perceptual variations among students on what has been observed and measured.

When these teacher educators were asked to mention the process skills that they found difficult to teach, each one mentioned a different process skill. James mentioned inferring as difficult. He said,

> The only skill which students find difficult is making inferences because inferences do not just come. They are governed by your understanding of other things. Where you have students who have had low backgrounds in science, they fail to think of what would be a possible thing, and I think if we can arrive at a point where students can start making inferences on things, that would be much better.

On the same issue, Jeke noted that although observation is commonly used, it is difficult to teach, as he explained in the following statement:

> Yes, observing looks simple, but when you teach them and the learners look at observation, they look at it as simple because they think it is just looking at something and they say we have observed. But it involves a lot, it is more than just seeing, so that's why it becomes difficult. If you give pupils or the learner to observe, what they will tell you is what they have been able to see. They will not talk of smelling, what is smell, how, rough, no, they will just look at something and describe and they think they observed. So that shows how this skill becomes very difficult because it looks to be simple, but it is very involving.

Jill mentioned recording as difficult to teach in the following explanation: "The one which is difficult to teach is the recording bit. This is because it requires students to master the language and how you can organize the facts from what you have been doing." Jill further explained that what makes recording difficult for the students may be "failure of the teacher to explain so that the students understand." Therefore, it can be said that the three teacher educators differed in their choice of a process skill that was difficult to teach. While James mentioned inferring, Jeke mentioned observation, and Jill said recording.

All three teacher educators recommended learner-centered approaches to teaching science, where learners would actively be involved in generating their own ideas from the activities given by their teacher. The following statement by Jeke supported this view, "But in science, we need people who can look at a problem and think of what they can do in order to come up with a solution to the problem." Similarly Jill stated the following, "You have to teach

by trying to involve thinking. Something like participatory…the teacher should ask questions so that pupils find answers for themselves before the teacher comments on their responses."

On the use of teaching and learning materials, all three teacher educators agreed that primary teacher candidates should be encouraged to make or improvise their own materials for teaching science. However, James and Jeke felt that some materials were difficult to improvise. On the one hand Jeke said, "Where it is possible, we just improvise, but you still find that there are certain things which you can't improvise, like a microscope. You may not improvise right there." On the other hand, James mentioned cells (batteries) and methylated spirit (methyl alcohol) as difficult to improvise:

> There are times when we don't have teaching and learning materials. Yes, we have locally available resources that we are using, but they have limitations, you only use them up to a certain extent. For example, you can't improvise methylated spirit, you can't improvise cells for doing electricity.

Generally, the three teacher educators agreed on the need for primary teacher candidates to be resourceful in their science teaching. Jeke stated:

> They have to be resourceful, they can get teaching and learning materials from other organizations and some of them e.g. from hospitals, especially those which can be found locally. They can even buy if they find it cheaper.

When these science teachers were asked about their preferences of teaching and learning strategies and reasons for their choices, James and Jeke mentioned the lecture method. They both stated that the lecture method allowed them to cover a lot of material given the short period of time scheduled for the residential courses. In addition to lecturing, James also used the demonstration method. The latter, he stated was used when there were shortages of teaching and learning materials. In spite of this, James recommended the use of strategies that actively involve students. James said, "Because of the situation in which I am, I use the lecture method. In some cases I use demonstrations due to a shortage of materials. But of late, we use think-think and pair-share arrangements. So anything that involves students' sharing ideas seems to be more helpful." In contrast to James and Jeke, Jill said, "I use question and answer and discussion methods. If you give students one or two questions, which can lead them to ask more questions, to me that is the best."

The science teacher educators discussed similarities and differences between what they did in TTC's and what they observed primary teacher candidates doing in teaching science lessons. Primary teacher candidates modeled their college science teachers when teaching as confirmed by Jeke's explanation, "We find that at college, we talk of improvisation, we improvise and we also do experiments. When we go to the field during supervision, we find the teachers doing the same. They also improvise and conduct experiments." Jill also observed this; however, Jill further stated that situations arose when some students learned negative practices from their teacher educators. Jill said, "Students try to model their teachers as much as possible, but if they come across a teacher educator who might have misled them, students do the same." She also discussed one difference between college teaching and that of teaching in primary schools. Jill said, "Most primary schools do not have science laboratories; as such, most of the science teaching is done outside the classroom. Most lessons at college were done in the laboratory." Overall, the three science teacher educators felt that primary teacher candidates did make efforts to model their experiences in science education at TTC's.

Several ideas emerged when these teacher educators were asked for their recommendations for improving science teacher preparation. First, teacher educators felt that there was the need for primary school teachers to specialize in science and recruit those with adequate science content. Jeke said,

> I think specialization would have assisted, because giving skills to people who are not interested in that area, the result is, they don't practice because it is not their area. But if there were specialization, I think those people who are interested in that area, would follow instructions correctly.

Second, Jill felt that selection of candidates for science teacher preparation should change. The following explanation by Jill confirms this, "During selection, you could have a criteria for those ones who are going to teach science. Maybe they should have passed for four years of secondary education. Then you are sure that they have the content because they know that syllabus up to that level." Third, Jill suggested the introduction of seminars and workshops for science teacher educators across teacher training colleges. These seminars would allow science educators to share their ideas. Fourth, James suggested the need to provide extra science reading materials to students so that their scientific knowledge could be widened. James said, "I

would also think that if there were more reading materials in science, there would be more time students would spend on reading scientific ideas, other than depending on teachers all the time."

Fifth, the need for the science courses to be relevant to the needs of the people was suggested by Jill who stated the following: "It could help if we could have a lot of application to everyday life, maybe on each topic. And if possible, we should be doing a lot of how to make use of the environment. That is, how to teach science using the environment around."

In summary, the three teacher educators felt that there was inadequate time to cover all the science content as well as methodology in their courses, which resulted in the use of lecture methods more than they thought these methods should be used. Observation, measuring and recording appeared to be the most common process skills used. But although these process skills were commonly used Jeke found that observation was difficult to teach and James said inferring was also difficult. The three teacher educators agreed upon five recommendations. First, they recommended the use of learner-centered approaches in the teaching of science. Second, these teacher educators felt that teachers need to be encouraged to be resourceful and improvise teaching and learning materials where necessary. Third, there is a need to recruit primary teacher candidates with adequate science content knowledge. Fourth, they recommended the introduction of seminars and workshops across colleges, and finally, they noted that there was a need to teach science by applying it to everyday life.

## Cases of the Six Science Teachers

### Case 1: Stephen

Stephen was a Standard 5 teacher who taught science as well as all of the other primary subjects. He started teaching as a temporary teacher (unqualified) in 1994 and became qualified as a T2 primary teacher in 1999. Stephen learned science in the first two years of his four years of secondary education.

Stephen had a class of 46 learners, and all but three were dressed in the school uniform. These learners sat in lines on the floor that stretched from wall to wall. A small narrow gap was created in the middle of the room between the students, and this gap served as path for class movement.

Stephen's classroom was built on a strong concrete foundation. At the entrance were four doorsteps. The classroom was brick walled; iron roofed, and had a smooth cement floor. The windows had no panes of glasses and there are no displays on the walls of the classroom. There was a very long blackboard on the front wall. The black paint was so faint that it was very difficult to read anything that had been written on the chalkboard. One wooden table with no chair was placed in front of the classroom for the teacher.

Stephen's self-assessment revealed that while predicting was one of the process skills, which was never done in his classroom instruction, inferring, observations and investigating were sometimes done. He indicated that making models, interpreting and communicating were frequently done.

***Vignette for Stephen's Standard 5 Class***

After greeting the pupils, Stephen introduced the day's lesson topic and wrote it on the chalkboard. He wrote, "Where do we get water from?" He began the lesson by reviewing what was covered in the previous lesson on states of matter. Stephen asked questions of the students on solids and liquids, calling for student responses. He wrote responses on the chalkboard under each of the two headings: "solid things," and "liquid things." After completing the list, Stephen asked the pupils to identify sources of water. Responses such as, "a borehole," "river," "wells," and "dams" were mentioned by students. Stephen explained that availability of water depended on the source.

Next, Stephen switched to a different question about how water could be spoiled. There were no responses from pupils to this question, and they did not seem to be engaged by this topic. Stephen very quickly asked pupils to stand up. While students were standing, he explained how an experiment on boiling water and filtration was going to be carried out. He reminded pupils of their groups and asked them to go outside to the location of the experiment. He told group members to record what was going to happen. Outside the classroom, Stephen asked pupils to sit in a semi circle and listen. First, the teacher explained one way how filtration of water was carried out. He demonstrated how sand particles of different sizes were arranged in a filtering tank. Stephen put sand particles in a small transparent plastic bottle. The bottle was cut open at the top perforated at the bottom. He then deliberately put some plant debris in the water, which was in a cup. The debris was used to show pupils that the water was bad and needed to be

filtered. Two pupils were then asked to show other pupils in class how filtration was done. He asked the two pupils to assist each other pouring water from the cup to the bottle, which was half-filled with sand particles. The other pupils curiously observed the water passing through the bottle and collected in a pot that was placed below the perforated bottle. In trying to summarize this demonstration, Stephen asked pupils why we should drink clean water. One pupil responded "In order to protect us from diseases." He thereafter told pupils that they were going to boil water as he looked around where he had placed the stones and other materials for the next experiment.

As Stephen organized the three stones on the fireplace, he asked one pupil to collect fire from a nearby teacher's house, which was about 20 meters away. The rest of the pupils were asked to go and fetch firewood from within the school surroundings. In less than 5 minutes, the students (who were actively involved) returned with a heap of firewood, which was more than enough. In no time, one pupil volunteered to make the fire, and had it going quickly. Stephen then asked another pupil to put a pot half full of water on to the fire to boil. At this time, all the other pupils surrounded the fireplace, some leaning on their friends' backs in order to see the experiment. He explained facts about boiling water and asked questions in the process; for instance, "Why should drinking water be boiled?" Pupils responded as a group, " To kill germs." Stephen asked pupils to look at the water that had boiled as he held the pot in a slanting position, moving it clockwise. He explained to pupils that in the next phase of the experiment, the water was to be cooled and filtered on a clean cloth. After the experiment, the teacher requested that most of the pupils return to the classroom. A few students remained outside to extinguish the fire while others returned all materials to their correct places. Stephen's experiment ended in suspense. He continued his lesson by asking pupils the following questions: What are we supposed to do after boiling the water? One pupil responded that the water was supposed to be covered to prevent germs. In no time, Stephen went on to explain that water was supposed to be filtered using a clean cloth. The experiment ended there.

Back in class, Stephen summarized the experiment by explaining the danger of drinking unsanitary water and drew a diagram showing filtration. He explained while he drew the diagram. He also drew another apparatus for boiling water as it appeared in the science teachers' guide. He used the latter to consolidate what he had done at this point although it was not necessary to have two diagrams. He reminded all pupils to boil drinking water in their homes in the future. Finally, Stephen asked pupils to copy summary notes in their notebooks as he wrote

them on the chalkboard. Pupils were also told to reproduce the two diagrams about boiling water that had been drawn on the chalkboard by the teacher. Stephen kept moving about the classroom guiding pupils until the time came for the end of the lesson and pupils went for a break.

***Stephen's Perspectives on Science Teaching***

Stephen was taught theory and practical lessons while attending a teacher training college, and he stated that these college experiences played an important role in his current teaching practice. Stephen remembered that while at college, they were taught two types of lesson plans, that is, theory and practical lesson plans and how to use teaching and learning materials. In addition, he remembered that they were asked to wash hands after handling materials used in teaching science. He noted that, among other things, his college lecturers had advised him never to taste items like chemicals or food in his science lessons for safety reasons.

When Stephen was asked how science should be taught in primary schools, he raised the difficulty of teaching in English. Stephen said, "But for students, this is somehow difficult, but for Standards l to 4 most of their lessons are taught in Chichewa, and as you go to Standard 5, you start teaching these lessons in English. So sometimes it becomes very difficult to speak in English all the time. So we sometimes use the vernacular language so that primary pupils easily understand what we are talking about."

Stephen mentioned that group work and question and answer were the common teaching strategies used in his science teaching because he believes that group work tends to help reduce shyness and promote discussion among learners. This perception was in keeping with what was observed in all of his lessons. Stephen used whole class question and answer methodologies primarily during his lesson introductions and conclusions. He involved learners in group work during indoor and outdoor activities. On the use of question & answer as a teaching strategy, Stephen said, "This is commonly used because if you use a question, a person is able to think of whatever relates to that question. From their findings, you can know that at least they are listening as I am teaching."

Stephen identified observation and the making of models as common process skills that were easy to teach, while he found interpretation was more difficult. The difficulty of the latter, as he explained, was due to the fact that learners were being introduced to science for the first time in Standard 5. Stephen said, "When pupils reach Standard 5, they find science very difficult

because it is a new subject to them." At the time of this study, pupils learned some aspects of science in Standards 1 through 4 under the subject, General studies. Stephen did not discuss other science process skills in his interview.

When Stephen was asked about problems that affect his science teaching, he stated that lack of teaching and learning materials negatively affected his teaching, and he suggested that the government provide commercially produced materials for the schools. Emphasis was put on the need for a science kit, which Stephen's school did not have. Stephen stated that the science kit that is available at the District Education Office was shared among teachers of science at several schools. According to Stephen, the sharing of science kits expected to be raised a lot of logistical problems.

In comparison with college teaching, Stephen noted that college lecturers used similar teaching and learning materials and methods to the ones he used in his current teaching in primary schools. Stephen said,

> Similarities are there, especially when using teaching and learning materials. The college teachers were using teaching and learning materials when teaching us. And we also have some similarities; in the way we tackle the lesson. I think we sometimes try to use the methods which lecturers had been giving us, especially one…method (pause) how to conduct these science lessons. The differences are also there. Most science teachers, including myself, sometimes become very lazy about using teaching and learning methods. At times, even if the science materials are there, we easily forget to use them. So at the end of the lesson, we realize and say, ah, I had the materials, but I taught without using them.

For improvement in science preparation, Stephen recommended that, in college, emphasis should be placed on practical work such as actively engaging pupils in class activities. Stephen said, "I think the practical work, not theory, but practical work, this one should somehow be intensive."

He also suggested that student teachers should specialize in science because switching from one subject to another creates problems. Stephen said, "Specialization would help because when the head-teacher says go and teach Creative Arts, or go and teach Music, and yet you are a science teacher, I think this is somehow difficult." Stephen's observation on teaching different subjects indicates his preference for teaching one subject in order to teach effectively.

As for school needs, Stephen suggested that the government provide necessary teaching and learning materials that match the science topics in the syllabus. Such resources would help teachers to teach without wasting time looking for or improvising materials.

***Researcher's Summary on Stephen***

Stephen's lessons, through my four observations, reflected that a lot of effort had been put into planning in preparation for being observed. Stephen indicated that this amount of planning was not necessarily the norm for him or for other teachers. In some situations, there was no planning at all, as Stephen explained, "We are lacking some teachers in other classes, so the time you said, "go and prepare," that's when I went to prepare that lesson." Stephen further stated that, had it not been for the researcher's visit, he was not going to teach science that day. A complicating factor was that Stephen had other administrative duties and responsibilities. It was noted that the lesson in the vignette was incomplete because the pupils did not observe the next phase of the experiment about filtration of the water they had boiled. Stephen was assigned to handle administrative issues in the office and teach all of the 8 classes; he was left alone at a school, which had a capacity of 11 teachers who were either out on official duties or on sick leave.

Stephen also reported that in many cases, when science topics required experiments for which he had no teaching and learning materials available, those lessons were skipped. Stephen said, "If you see that there are no teaching and learning materials, you tend to skip that topic, then we always teach simple topics where there are no experiments." Furthermore, Stephen indicated that although some materials were really scarce, there were times when teachers never used them because of the teachers being busy as stated in the following statement, "Not really laziness, but because of being busy with too much work."

Apparently, Stephen felt that what was in the teachers' guide should never be changed as indicated by asking pupils to draw two diagrams, including the one which was in the teachers' guide. I had observed that there was not enough time for pupils to draw two diagrams at the end. It would have been more effective if Stephen had asked pupils to draw the apparatus that they used in the lesson.

In my opinion, from all the lessons observed, Stephen was eager to teach science, and given time to prepare, he was able to teach effectively. This was also reflected on the day he

taught the vignette lesson. He managed to plan a lesson and collect some required materials in less than 10 minutes. However, the lesson was still lacking in some areas. One comment from Stephen indicated that experiments were not done, as he evaluated his vignette lesson. "First of all, I thought the experiment was not going to be conducted very well because, for the pupils, it was their first experience to conduct an experiment." His shortness of time to prepare for the lesson was reflected in the following statement, "I planned that those pupils should be in their groups and do that experiment, but because of the shortage of teaching and learning materials, that's why I changed the whole organization." The way Stephen conducted his experiment and left it incomplete confirmed his habit of skipping a topic when materials are not available. Perhaps the presence of a researcher forced him to conduct the experiment, which he would not otherwise have done. Stephen stated that involvement as participants in this study was likely to encourage teachers to strengthen their teaching and prepare lessons thoroughly.

**Case 2: Thokozani**

Thokozani was a Standard 5 teacher who had started teaching as a temporary teacher in 1994 and qualified in 1999 with a T2 teacher certificate. She studied science as one of the subjects during her four years of secondary education. She was of medium height and always held either a teacher's guide or a lesson plan in her hands as she taught. Thokozani used a small portable chalkboard that was fixed on wooden legs that supported it upright.

The classroom was iron roofed with a rough concrete floor. The walls were made of brown, smooth bricks that were machine made. These walls came up to shoulder level only. At one corner of the classroom, there was a pile of bricks to be used for the classroom walls that were still under construction. Two small charts were fixed in the classroom, one on the front wall and the other on the back wall. Both charts had science content.

Thokozani had 86 learners in her class. The pupils sat on the rough, concrete floor. To avoid dirtying their clothes, most learners used empty, plastic (50kg) bags as their improvised seats. A few girls used their chitenje (wrapper cloth) to sit on. About four to five girls shared one cloth.

Thokozani's self-assessment revealed that observation and reporting were frequently used in her teaching, and interpretation not used at all. The other process skills such as making

models, classifying, investigating, and predicting were sometimes used. Measuring and inferring were rarely addressed

***Vignette for Thokozani's Standard 5 Class***

The lesson started at 10.20 a.m., after a break. Thokozani started the lesson by asking questions about the external and internal parts of a plant. These questions were based on a previous lesson. Students were successfully able to respond to all of the questions posed.

Next, Thokozani introduced the day's lesson topic by explaining that they were going to learn about animals. She quickly wrote the lesson topic on the chalkboard. The lesson topic was "Looking at Animals." Thokozani told the 82 pupils to go outside to nearby houses to look for animals. The pupils were not organized as groups. The teacher told pupils that the best alternative would have been to go and look for animals at pupils' homes, but this was not possible due to distance. For about 10 minutes, the pupils individually walked around the school and ended up catching grasshoppers. The pupils seemed to have fun as they ran about chasing grasshoppers. The pupils had no catching nets, but used their hands instead. Some pupils caught grasshoppers by beating the ground and grasses with sticks that were collected as they walked around the school environment. The teacher then instructed the pupils to let the grasshoppers go and return to the classroom. There was a lot of noise from the 82 pupils as they ran back to the classroom.

Once the pupils were gathered in the classroom, Thokozani controlled the noise by asking pupils to move their hands up and down at least four times. This strategy caught the attention of the students, and they became quiet quickly.

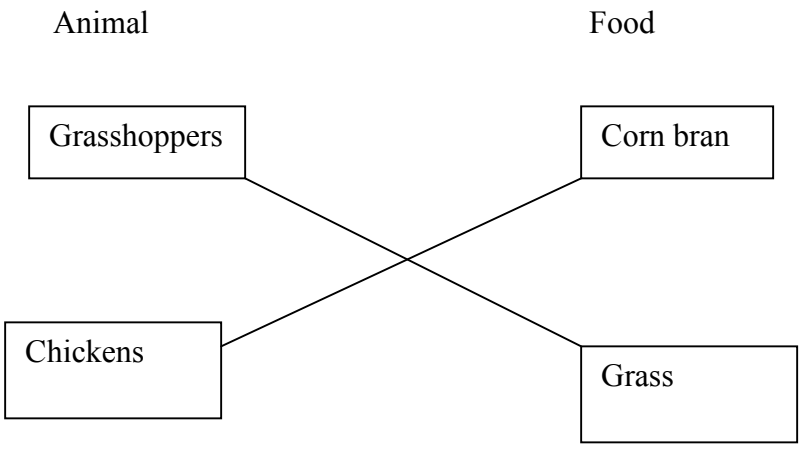
At 10.35 a.m. the class was quiet and the teacher asked pupils to name the animals they had found. "Grasshopper," was the most common answer. The teacher then asked pupils to mention the animals they knew from their homes such as ducks, goats, pigs, dogs, and cows. She listed types of animals on the chalkboard as the responses came from pupils. One pupil wondered whether people are also animals and asked the teacher to explain. She said, "Yes, people are also animals." Thokozani provided no further explanation; however, she added the word "people" to the list on the chalkboard.

At 10.45 a.m., Thokozani asked pupils to choose the animals from the written list and discuss in their groups the foods eaten by these animals. Group leaders were asked to write the

student responses on paper because these responses were to be written on the chalkboard later. Pupils were allowed about five minutes to discuss. Thokozani asked pupils if they had completed the task and provided two extra minutes for groups that had not finished.

During this time, Thokozani drew a table on the chalkboard. The table had three columns headed: (a) plant eaters, (b) animal eaters, and (c) plant and animal eaters. After the group discussions, she asked pupils to return to their original sitting places. Thokozani then called upon each group leader, one at a time, to report the findings of each group in front of the class while she filled in the responses on the table. The pupils clapped hands after each group's report. Thokozani instructed other groups to report only those animals that were not mentioned by the groups that had previously reported.

When the group reports had been completed, Thokozani wrote an exercise on the board in the form of matching items for pupils to write in their notebooks. An example was given based on the pupils' responses, as in the illustration that follows:




After explaining the matching task in English, Thokozani quickly explained in vernacular language (apparently having sensed that the students had not understood the instructions in English). Some pupils did not want to write, as they showed signs of tiredness and asked

questions like, “Are you going to mark this exercise?” She asked the pupils to write and she began moving around the classroom, taking papers from pupils, and marking the exercise.

As the time allotted for the lesson was ending, Thokozani instructed pupils to stop writing. She concluded the lesson by going over the class responses for the exercise on the chalkboard. Pupils who had completed the exercise correctly were asked to go for break. The other pupils were directed to make corrections. When completed, the pupils handed in their notebooks, which were to be marked later when Thokozani had free time.

### *Thokozani’s Perspectives on Science Teaching*

In her interviews, Thokozani highlighted that in Standard 5, English was a problem as a medium of instruction. Because the learners were coming from Standard 4, where vernacular was the medium of instruction, it was very difficult for students to make an immediate transition to understanding lessons and completing their written work in English.

Thokozani described the lack of teaching and learning materials as another problem affecting the teaching of science. This was due, she said, to the lack of money to improvise and, in some cases, due to the lack of a science equipment storeroom. Thokozani suggested that the government should provide printed charts in science, similar to those provided for mathematics in infant classes. She said, “When teachers’ guides and pupils’ books are being developed, like for Standard 1, they have got charts for teaching the alphabet, A, B, C, and A, E, I, O, U. So, we should have charts for science.”

Further, Thokozani said that primary schools should have storage rooms where science materials could be kept. She said, “It is good to have a room for science so that we can keep all materials in the room and it should be a lockable room.”

Thokozani also felt that sometimes what was taught at college was not relevant for her teaching of Standard 5 pupils; rather, she thought that some of the science content presented at the TTC ’s was only there to prepare teachers to pass exams. In keeping with this belief, she recommended that at college, primary teachers should be taught exactly what is to be taught to learners at primary school. She said, “At college, they should teach us exactly what we are going to teach those pupils here (pause): Exactly.”

Finally, Thokozani said that she would prefer to see science classes start as early as Standard 1. She said, “The work is too much. At college, we used to learn a lot of work, but here

there is little work for the pupils. And not all the work that we learned there at college is implemented here. The other content is just for us students to pass examinations. When we come here and start teaching, we find that what we learned there is not applied. One example is that at college, they taught us to make a nature table but here we fail to make it."

When asked about science process skills, Thokozani felt that observation and measuring were easy skills to teach, but that interpretation was more difficult. She said, "Observation is easy because pupils observe what you teach; for example, when you are teaching a topic like sense organs, they observe what you teach, like when you are teaching about the ear, the pupils observe the ear, and once they have observed, they can draw on their own what they have observed." Commenting on why interpretation was difficult to teach, Thokozani said that it was due to problems of communication. She said, "In Standard 5, to interpret things in English is difficult because of language."

When questioned about teaching strategies that were commonly used, Thokozani said that she often used question and answer because she felt that this method allowed her to assess pupils' understanding of topics. Thokozani explained, "Most of the time I use question and answer method (pause). When the pupils answer the questions, we know that they have understood the lesson, but when we explain to them using lecture method, we assume they have understood, but [it may be that they] did not learn anything. That is why I use question and answer."

***Researcher's Summary on Thokozani***

Thokozani's interviews revealed that she was a teacher who felt that her science teaching could be more effective if she used more teaching and learning materials. However, her concern was that these materials should be readily available to her. This was reflected by her concern that pupils should be provided with textbooks, and that schools should also be provided with printed charts on science topics. Thokozani also emphasized the need for schools to have science storerooms where available materials could be stored. Her comments indicated that she knew the value of using teaching and learning materials, but she did not put much effort in gathering and using them in her teaching. The following comment confirms this: "At college, we used a science room and teaching materials were available there, but here we do not have materials and we teachers are poor, as you know. To find sugar, for example, and make a solution so that

pupils see is difficult, when at home you failed to have a cup of tea." This comment indicated that Thokozani was not in a position to use some of her money to buy materials like sugar that could be utilized to make her teaching more effective.

Thokozani also noted that the nature table, which was emphasized at college, was not utilized in her school. She indicated that she had a lack of items to put on a nature table. This statement demonstrated a lack of resourcefulness on the part of this teacher because materials to put on the nature table were available almost everywhere around the school. Thokozani was teaching in a classroom, which had two science charts. These charts did not have adequate information for the pupils to utilize. For example, one of the charts showed a human arm, but it had no heading and no labels.

Observations of lessons taught by Thokozani indicated that she was a very steady teacher with very clear voice; however, most of her lessons did not contain enough activities for pupils to last for the amount of time allotted for science lessons. For instance, in one lesson, she prepared and taught a lesson on two different topics that had no relationship to each other based on what she taught. These topics were, "Germs," and "Things We Use." During the post-observation interview with the researcher after this lesson, Thokozani explained, "The lesson was not good because I thought that "Germs," as a topic, cannot be taught in two periods, so I combined with the other topic." Thokozani's idea to utilize the lesson time by combining the two topics was acceptable; however, she failed to link the two topics, creating a disjointed science experience for the pupils. Another possible approach would have been to plan a lot of activities on the first topic and involve pupils in those activities as much as possible.

In conclusion, it can be said that observation skills and question and answer methods of teaching were commonly used in Thokozani's lessons. However, she felt that lack of teaching materials and use of English as medium of communication created problems in her science teaching. She, therefore, suggested the need for the Malawi Government to provide storerooms and printed charts in primary schools. The idea of teaching science beginning in Standard 1 (equivalent to grade 1 in United States) was also suggested by Thokozani.

## Case 3: Chidecha

Chidecha started teaching as a temporary teacher in 1994 and qualified in 1999 with a T2 Teacher certificate. At the time of this study, Chidecha had been teaching Standard 6 for the past three years. He also studied science during his four years of secondary education.

Chidecha's classroom was brick walled; iron roofed, and had a smooth, cement floor and lockable doors. The classroom windows were located on only one side of the room. All windows contained glass windowpanes. A big, green chalkboard was fixed in front of the classroom and it was divided into two equal portions by a wooden plank. On the back wall, opposite the chalkboard, there was a large display board. Different charts had been placed on it, and most of them were for science and social studies.

Chidecha had 66 learners in his class and all except one or two wore school uniforms. The learners were provided with steel made tables and chairs. At least three learners used one table, although they had been designed for only two pupils to use. The chairs and tables made a lot of noise when moved and, at times, it was obvious that this noise disturbed the learning process for some pupils. In the front of the classroom, there was a metal teacher's table and chair.

Chidecha's self-assessment revealed that the most frequently used science process skills in his classroom included making models, interpreting, and reporting. Chidecha reported that inferring and predicting were not used in his teaching of science, whereas observation, measuring, and classifying were sometimes used in science lessons.

### *Vignette for Chidecha's Standard 6 Class*

The lesson started at 8.40 a.m. After greeting the pupils, Chidecha asked the students about common diseases in Malawi. He wrote the names of diseases on the chalkboard based on pupils' responses. Student responses included malaria, scabies, tuberculosis, and diarrhea. After writing these responses, Chidecha wrote HIV on the chalkboard and asked pupils to identify the causes of HIV. The teacher distributed alphabet letters "A," "I," "D," and "S" to four pupils. Chidecha asked the pupils holding these letters to go in front of the classroom each holding a different letter. The arrangement of the pupils was not in the order "AIDS," presumably because Chidecha wanted the students to be thinking about the letters, how they should be ordered, and

what they might represent. Chidecha called on one pupil to go and rearrange the four pupils holding the letters so that they would read "AIDS."

After this ordering had been accomplished, Chidecha distributed word cards with "Acquired," "Immune," "Deficiency," and "Syndrome," to four groups of pupils. These groups were asked to go behind the first group of pupils (the letter holders). Each group held one of the letters. With instructions from the teacher, one of the pupils holding a letter was asked to lift the letter up in front of the entire class. Chidecha asked a pupil concerned to lift up the word card upon mentioning it. The rest of the pupils were asked to repeat the word, which was held up by one pupil. The activity was repeated three times with another set of pupils. Using another set of cards, he explained the meanings of the four words, "acquired," **"**immune," "deficiency," and "syndrome." teacher provided the following meanings:

Acquired – got from

Immune – protected

Deficiency – lack of

Syndrome – different signs and symptoms of diseases

At 9.05 a.m., Chidecha explained the meaning of "acquired" in vernacular language in order to assure pupils' understanding. Chidecha also metaphorically explained the action of white blood cells by relating them to pigs in a kraal (pen). He then drew a sketch diagram of a pigs' kraal to relate students' understandings of the white blood cells to pigs in a kraal (as foreign germs). Based on the faces of the pupils, it seemed that the teacher did not clearly explain the connection. The pupils looked rather confused, but studied the sketch diagram with curiosity. The teacher concluded the lesson by explaining again the meaning of the acronym "AIDS," and he briefly explained the difference between HIV and AIDS. The lesson ended at 9.15 am.

***Chidecha's Perspectives on Science Teaching***

In response to the question concerning college science teaching experiences, Chidecha remembered experiments and visits to the local habitat, as confirmed in the following statement: "At college we were visiting our laboratory doing experiments and we were visiting again some environment around our college for collection of some plants and some valid animals like the insects."

Commenting about common strategies used in his own teaching, Chidecha stated, " In my teaching, I prefer the participatory method like group work because from those group works, pupils are able to express themselves; and after their discussions, they come up with the points and I always ask those groups to come up with those points and write on the chalkboard. And then I explain to them. The explanation method is the last one I choose." When asked about process skills, Chidecha stated that he concentrated on observing and reporting skills. He explained his choice of those skills:

> Because, when pupils are observing, they are able to record on their own and grasp the point, and in so doing, they cannot forget it after observing on their own. I recommend also the reporting skill, because whatever you have reported on your own, it's difficult to forget it…If a long time passes, you will be able to remember that one day I reported this myself. That is why I mostly use these, the reporting and observing skill.

Chidecha mentioned that he found inferring and predicting difficult to teach because pupils expected their teacher to explain everything. He confirmed this in the following statement:

> Especially inferring and predicting (pause). If you ask our learners a provoking question; they mostly switch off and wait for the teacher to clarify. And this one, inferring (pause), you can ask them and still more they will just look at you without thinking on their own so that they can come up with correct solutions.

Lack of textbooks was mentioned as one of the problems faced when teaching science in the primary school. In addition, Chidecha noted that his pupils lacked curiosity and interest. He stated, "Curiosity in our learners is not there, and some of them are not serious; that is why, when we are teaching, maybe we say, 'Go to groups, and do this.' Others withdraw and do not participate in those groups; that is another problem I anticipate in my science lessons."

Chidecha made several suggestions as to how science teaching could be improved. First, he emphasized that science teachers should use a variety of teaching and learning materials; therefore, Chidecha recommended that the government provide teaching and learning materials to schools. He gave one example, saying that the government should provide flip charts to the primary schools to support science instruction.

Second, Chidecha thought that improvisation of teaching and learning materials should be emphasized during teacher preparation. He felt that it was particularly important that science teacher educators teach primary teachers how to make and use science materials in the

classroom. For instance, Chidecha indicated that students should be told how to improvise and operate pulleys: "We may not know how a pulley works, and how we can improvise a pulley? So at college we had pulleys in the laboratories, we had single and double pulleys, we just used them (pause). At college, they are supposed to put much concentration on improvisation so that those students qualify with skills of improvisation." It was clear that Chidecha felt he had not been prepared well enough to use improvisation for his own science teaching.

In addition, Chidecha recommended that college students be told exactly what the primary school science kit contained so as to be able to use it effectively whenever it was available. He also insisted that college lecturers should try to use many teaching and learning materials so that they act as models for their learners.

***Researcher's Summary on Chidecha***

Observation of Chidecha's class reflected strong organizational skills in lesson planning and adequate knowledge of the subject. He appeared confident when teaching. Chidecha's pupils showed their desire to learn by being alert in class at all times. Chidecha also encouraged his pupils to communicate in English, which they did throughout the session. He was a teacher who gave feedback to the pupils, such as correcting spelling mistakes. For example, he corrected a pupil who had written the word, "meet" on the chalkboard, rather than "meat," and another pupil who wrote "heat" rather than " heart."

Chidecha's use of metaphors (for instance, the metaphor of the pigs in a kraal as compared to white blood cells attacking germs, as in the vignette), was an interesting technique. In order to use this teaching method effectively, there is a need to choose a metaphor that will enhance pupils' understanding. Relating immunity to protection for pigs in a corral confused the pupils. A better connection could have been made.

Data from Chidecha's interview revealed that in times of scarcity of science teaching materials, he at times, skipped the topic. If he decided to teach a topic for which he did not have science-teaching materials, Chidecha taught theoretically by using the lecture method instead of conducting experiments. His explanations indicated that science topics that demanded unavailable materials were not effectively taught to the pupils.

## Case 4: Jim

Jim started teaching as a temporary teacher (unqualified teacher) in 1994. He later qualified with a T2 teacher certificate in 1999. Jim taught all subjects in Standard 6, including science. At the time of this study, he had been assigned as a Standard 6 teacher for two years.

Jim had only 11 learners in his class, a very small class size, which is very uncommon in Primary Schools in Malawi. Many of the students who originally attended this school had transferred to a nearby school (where a mid-morning porridge meal was provided for students each day by the United Nations International Children's Educational Fund [UNICEF]). Jim's classroom was a very large, brick-walled, iron-roofed building with good ventilation through the windows, which were circular concrete slabs with a filigree design. The front wall had an unpainted, grey-looking concrete chalkboard. Generally, the pupils sat on the mud floor that was smeared every Friday by the same pupils. The purpose of this smearing process is to create a hard, smooth surface from the dusty disintegration of the mud floor from the use of the past week. The job entails gathering more soil into containers and adding water, making a semi-liquid paste. This clay paste is then applied by hand to the floor. Some pupils sat on one or two bricks piled on top of each other. These bricks were brought from outside the classroom. The teacher had neither a table nor a chair.

Jim's self-assessment revealed that apart from observation skills, which were frequently used in his science lessons, classifying and reporting were also sometimes used. All other skills, according to his assessment, were rarely used. The four observed lessons revealed that, although Jim stated that reporting was used only sometimes, it was used in all of the four lessons observed.

### *Vignette for Jim's Standard 6 Class*

Jim greeted the pupils and started the lesson by reminding pupils about the previously taught lesson topic on the skeleton. Jim said, "We are still studying parts of our bodies. Last time we learned about the skeleton." He asked questions in relation to the skeleton such as, "What are uses of the skeleton?" Pupils provided with responses such as, "Protecting the brain and spinal cord," and "Gives shape" [to the body].

Jim reviewed the function of the skeleton by explaining once again in Chitumbuka (one of the vernacular languages spoken in Malawi). He introduced the new topic while writing on the

chalkboard, “How to keep the skeleton strong and healthy.” He then explained the meaning of “strong and healthy” in local language.

Jim asked pupils to discuss ways of keeping the skeleton strong and healthy. Two groups of five and six pupils were made. He went around guiding pupils, in most cases using the local language. After about 5 minutes, he asked pupils to go back to their original sitting positions. At this time, the group leaders were asked to report on what was discussed. Both groups reported in English without problems and were praised by their teacher for a well-done activity. Jim summarized ways of keeping the skeleton strong and healthy such as doing physical exercises and having enough sleep.

Continuing from there, Jim explained that walking with one shoulder high was an example of bad posture. Using his body, Jim demonstrated what he meant by, “one shoulder high.” After this demonstration, he showed pupils a chart he had drawn showing good and bad postures. Pupils looked at the chart with curiosity and were later told to demonstrate good and bad posture when sitting on a chair, when walking, and when lifting a big stone. Jim collected a chair and a big stone and placed them in a corner of the classroom. After a demonstration by 2 boys and 2 girls, he reminded pupils to apply this knowledge to their everyday life, that is, to walk and sit using good posture at all times.

Next, Jim explained how physical exercises help make the skeleton healthy. Three minutes later, he asked pupils to go outside, where they were engaged in the exercises of running and frog jumping. Jim provided instructions for each activity in Chitumbuka. The students were all actively involved in the activity.

Towards the end of the lesson, the students were brought back into the classroom, where Jim asked pupils to stand up and respond to questions. Only those giving correct responses were allowed to sit down. One after another, all the 11 pupils responded correctly and sat down. He summarized pupils’ responses by writing on the chalkboard in a table form. Pupils were told to copy the summary notes. The lesson ended with Jim asking the pupils to demonstrate good posture in the future when walking, sitting on a chair and lifting a big stone. The lesson was followed by a 10-minute break.

***Jim's Perspectives on Science Teaching***

When Jim was asked about his science preparation at college, he said, "At college, we learnt scheming, how to write a lesson plan, and how to make science teaching and learning materials using locally available materials that we can use in our teaching." He went on to say that students in the TTC's were also taught to be very resourceful and to involve pupils in learning experiences. Jim said, "We were also told to be very resourceful because pupils learn more when doing, than when just listening to what the teacher has said. So, you must involve pupils in science lessons."

When Jim was asked about the commonly used teaching strategies, he identified discussion and observation because he felt that those strategies involved pupils and allowed them to learn by doing.

Commenting on the use of process skills, Jim said that he found making models difficult to teach because of lack of knowledge. He said, "Maybe it happens that I myself do not have knowledge of making models."

Lack of books was mentioned as one of the problems faced when teaching science. Jim explained that their school did not have the science teachers' guidebooks, stating, "I have one that I borrowed from somewhere, and they need it back."

Comparing college teaching and his current teaching of science, Jim explained that there were many similarities, although the depth of content differed. Jim said, "What we learned at college I think is the same, only that it was deeper than what we do here."

When asked to comment on science teaching in general, Jim mentioned that there were communication problems related to language use. He said, "I just want to comment that science is a good subject and pupils like it, but they have problems in discussions, but they like it. If you tell them what to do, they do it, only that they have a problem of language. If you ask them in English, they respond in Chitumbuka [local language]."

Jim's observed lesson demonstrated that he regularly repeated what he said in English by translating it to the vernacular. It was clear that the 11 pupils in Jim's classroom were able to follow his lessons well. He encouraged them to discuss group tasks and respond to questions in English. Jim's small class size made it possible for him to provide assistance to his pupils whenever there was need. For instance, in the vignette lesson, Jim asked topic-related questions

and called upon every standing pupil, assuring that every one had the opportunity to provide a correct response. Allowing a pupil to sit down after correctly answering a question was a reward given to all of the pupils.

When making recommendations, Jim commented that the idea of involving teachers in research was good, as it encouraged the teachers to work hard. He said, "I just want to thank you for organizing such research. I think if there was research all over, the teaching would somehow be changed. Because in some areas we are awakened."

Since science at primary school is called "Science and Health Education," Jim suggested that these two be split and be taught as separate subjects to avoid confusing learners. He also pointed out that during his teaching, learners struggled to discuss science topics in English. In order to have meaningful discussions of the science topics, the students switched to their vernacular language, in this case, Chitumbuka.

***Researcher's Summary on Jim***

Jim's small class size made it possible for him to assist almost all of the students when there was need. This was also observed in the lesson presented in the vignette, as well as the other lessons. All students were called up during the lesson and Jim made it possible for all to demonstrate success in responding to his questions.

Jim demonstrated that he was able to evaluate his lessons well, based upon comments during post-observation interviews. One example of his lesson evaluation was, "The lesson was good, although there were weaknesses here and there. In the introduction, I was not good at rephrasing the questions so that I drive at what pupils should say. Under development, I forgot to tell pupils the time when I sent them into groups; I also noticed that there were silences here and there, especially when I was writing on the chalkboard. The class was silent for a minute or so (pause). I can say that the lesson was good."

Jim taught his lessons by presenting information in English, then translating to the local language. Learners were very actively involved when using their vernacular language during group discussions; however, Jim encouraged them to report in English, which they did without shyness. Jim reported that he enjoyed teaching science more than other subjects, and his enthusiasm for teaching science was obvious during his observed lessons.

## Case 5: Bob

Bob started teaching as a temporary teacher in 1994 and qualified in 2001 with a T2 Teacher certificate. Besides teaching in his Standard 7 class, he was a patron for the science club at his school.

Bob taught in a classroom that was brick walled and had iron roofed with a smooth concrete floor. The windows were without windowpanes. A long chalkboard that needed repainting was attached to one of the front walls of the classroom. On the opposite of this chalkboard, two display boards were fixed. The display boards were filled with charts. Some of the charts had samples of cereal and legume seeds glued to them, so they appeared to be related to science and health education. Bob had 46 learners in his class. The learners sat on the floor in lines. The teacher had the girls arranged in lines separated from the boys. The teacher had neither a table nor a chair.

Bob's self-assessment revealed that the frequently used process skills in his classroom were observing, classifying, investigating, and reporting. The self-assessment showed that inferring was never used; however, Bob indicated that he sometimes used measuring, making models, predicting, and interpreting data.

### *Vignette for Bob's Standard 5 Class*

After greeting the 42 pupils that were present, Bob informed them of the lesson topic for the day, writing "Poisonous Substances" on the chalkboard. He introduced the lesson by asking pupils to mention some examples of poisonous substances found in their homes. Pupils came up with responses such as, "aspirin'" and "paraffin" (kerosene).

After this, Bob grouped pupils by having them count around the room the numbers 1 through 4. Students were to be in the group corresponding with the number they called out. He wrote three questions on the chalkboard for group discussion. These were, "What would happen if a person had eaten rotten food?" "List down substances that can cause poisoning," and, "State the dangers of poisonous substances." The student groups got to work discussing responses to these questions. Bob circulated around the groups, checking their understandings, and guiding them where necessary.

After about 10 minutes of group discussion, time for reporting was called. Bob called one representative from each group to go to the front of the class and report what had been discussed.

Each reporter started by reading each of the questions from the chalkboard before giving their responses. The lesson ended with the teacher reviewing all of the questions and their answers through a whole class discussion. Then the pupils went out for a 15-minute break.

***Bob's Perspectives on Science Teaching***

When Bob was asked about his college experiences, he stated that he learned many things, as in the following: "At college, we learned many things, how important science is, and how to prepare a science lesson that effectively teaches. So, that is planning in science. Then, we also learned different skills on how to handle science lessons."

When asked the question about teaching and learning strategies that were commonly used in teaching primary science lessons, Bob stated that he used several strategies that allowed pupils to participate. He said, "In my lessons, I always use first, demonstration, and second, group work, plus practice." Bob gave the following reason for his choice. "I like these because pupils are much involved. Everyone participates."

Observation was a process skill that Bob said he concentrated on. He stated that observation allows pupils to observe "a real thing in a real life situation." On the other hand, Bob felt interpretation was the most difficult process skill. He said, "Mainly, it is interpreting data. That is because some pupils fail to explain more on what they have discussed because of the language problem." Predicting was also mentioned as a difficult skill because of the problem of using English as the medium of communication. Bob said, "Yes, language problem, a lot of the pupils fail to predict in English."

When commenting on similarities and differences between his college classroom instruction and his current teaching in schools, Bob explained that the same teaching strategies were used. However, a difference was noticed in the use of teaching and learning materials. Bob noted that a lot of teaching and learning materials were used at college when compared to the limited possible teaching materials used in his current teaching.

Commenting on one of his observed lessons, Bob said, "In fact, my lessons, I believe that I will do much better than what I did today, just because I was engaged a bit by my boss. Had it been that I did not have such a type of test, I would prepare furthermore than what I have taught today." (It should be noted here that at the time the science lesson was to start that day, the

researcher found Bob writing some administrative reports in an office. The head teacher had told the researcher to wait for some time before Bob came to start teaching his science lesson.)

Bob provided several recommendations for improving science teacher education. First, he suggested that teacher educators should prepare their lessons thoroughly and carefully teach their students how to make use of teaching and learning materials. Second, he recommended that effort was needed for teacher educators to provide numerous examples that relate to real life situations. Finally, Bob suggested that both teacher educators and primary school science teachers should be resourceful. He further stated that for effective teaching, emphasis should be on the use of teaching and learning materials.

When asked to comment on problems that he faced as a science teacher, Bob said that the lack of teaching and learning materials was a significant problem. For instance, Bob pointed out the shortage of cells (batteries), wires and bulbs for teaching a topic like electricity.

***Researcher's Summary on Bob***

Bob was a teacher who always prepared for his lessons, although some lessons lacked enough content for the time allocated for the teaching of science lessons. In some cases, a lot of time was given for a group task that should have lasted only a few minutes. In some situations, his lesson ended earlier than the expected time. On one of his post-observation interviews, Bob admitted this weakness by stating the following: "In fact, somewhere the lesson was bad just because, at the end of the conclusion, pupils answered those questions, but I remained with some minutes to end my lesson." On another occasion, he indicated that he was engaged in other required administrative work that involved assisting the zonal coordinator at a Teacher Development Center (TDC).

The researcher had the perception that Bob's lessons may have been written in a hurry, which could explain the fact that the lessons lacked enough content for the time allotted. On the other hand, it is possible that the lessons were well prepared, but not thoroughly taught due to the fact that Bob's time was being divided between teaching and assigned administrative responsibilities.

It was also observed that on one occasion, Bob had prepared two lesson plans for a double period lesson, an indication that he was not very sure of expectations for double period science lessons. In one case, Bob was observed teaching science in the first period. At the end of

the first period, Bob went to the researcher and asked, “Should I continue?” As it turned out, Bob had a second lesson plan for science that was to be followed after the first lesson.

Generally, Bob was a teacher who spoke his mind. He demonstrated the ability to speak openly about his teaching and issues connected with school life. Bob showed that he knew how to self-evaluate his teaching. On one occasion, Bob was very open to comment about his lesson and problems that he faced. He said, “In fact, the next lesson will be better just because I will be forced to prepare accordingly, only that in my classroom over there, I tried to stick in some posters and tried to put in teaching and learning aids on the nature table, but people, including pupils, picked them up. This is the main problem that I am facing here.” In response to Bob’s problem, I recommended to the head teacher that he consult the surrounding community and attempt to stop people from removing items from Bob’s classroom.

In conclusion, Bob showed enthusiasm to teach and prepared his science lessons all the time. Although he was ever prepared, he was very much engaged in other administrative activities. When teaching science he mostly used group discussion method. Bob knew how to evaluate his lessons well.

### Case 6: Marvin

Marvin was a male teacher who started teaching as a Temporary Teacher (TT) in 1994 and qualified in 1999 with a T2 Teacher certificate. He taught in Standard 7 at one of the primary schools in the Central Eastern Education Division of Malawi. He learned science during his four years of secondary education.

Marvin’s classroom was brick walled with a cement floor and an iron roof. The windows were built of concrete slabs with a filigree design, allowing some ventilation. A very long blackboard was fixed in the front of the classroom. At the back of the classroom, there was a display board improvised from a brown cardboard box. Two papers showing highly marked exercises in English composition were posted on the display board.

Marvin had 66 learners in his class. The learners had long wooden desks that were attached to wooden seats of the same length. These seats were designed for two learners, but they each held three to four learners who were squeezed tightly together. Marvin explained that the students who did well on class exercises were given the chance to sit on these seats. The students who did poorly on class exercises sat on forms, which had no desks.

Marvin's self-assessment on science process skills revealed that interpretation and making models were sometimes used in his teaching. Observation, measuring, investigating, recording, reporting were frequently used in science lessons. Inferring was rarely used in Marvin's class.

***Vignette for Marvin's Standard 7 Class***

The lesson started at 10 a.m. with Marvin greeting pupils as they stood up. This was a double period of seventy minutes (two thirty-five minute sessions combined). Marvin asked the students to sit down; then he began asking questions based on the previous lesson. These questions were about the internal and external parts of a bean seed. For instance, Marvin asked, "Name any three external parts of a bean seed." Pupils raised their hands to respond to the questions. He called upon pupils to respond to the questions by pointing at both some who had raised their hands and some who had not. Next, Marvin quickly drew a bean seed on the chalkboard. The drawing included the internal parts of the seed and Marvin labeled them as he received responses from pupils.

After this review activity, Marvin introduced the new topic for the lesson. He wrote, "Seed Germination," on the chalkboard and started explaining roles of radicle (the part of the seed from which the root grows) and plumule (the part of the seed from which the shoot comes up in the ground) in the process of germination.

Marvin wrote short notes on the chalkboard for the students as the lesson progressed. He wrote three incorrect spellings on the chalkboard within a short period of 5 minutes. These included, "obsorb" for "absorb," "cotyled" for "cotyledon," and "plume" for "plumule."

Marvin brought potted bean seedlings, which he had grown at his home, into the classroom. He picked one potted bean seedling that had just germinated and showed it to the whole class by holding it up. He moved back and forth in the front of the class in order for all 66 pupils to see.

At 10.15 a.m., Marvin told pupils to get into their five groups, which had been previously organized. As pupils went around positioning themselves according to groups, the teacher distributed one soaked and one un-soaked bean seed to each of the five groups. He then asked each group to observe the beans and identify similarities and differences between them. He also

wrote three questions on the chalkboard to guide pupils in their discussions. These were: a) What are the similarities? b) What are the differences? c) What do these differences suggest?

Marvin supervised each group by circulating around the room explaining and asking more questions as the children engaged in their discussions. Group secretaries were told to record in their notebooks the main ideas discussed. At 10.35a.m, the teacher called for group secretaries, one at a time, to go to the front of the class and report. Each secretary read what was written. There was no further discussion concerning the reports. Marvin asked the learners to clap hands after each group had reported.

At 10:45 a.m., Marvin wrote the questions on the chalkboard for pupils to answer orally. These questions included: a) What part of the bean seed gives rise to roots? Leaves? and b) What is the function of the cotyledon in a bean seed? Before the learners could answer, Marvin read through the questions to clarify. After this discussion, the teacher modified the same questions by writing statements with blank spaces so that pupils could fill in the blanks. The modified questions were: a) Bean seeds have _____ that grow into leaves, b) _____of the bean seeds grow into roots, c) The part of the bean seed that stores food for the germinating seed is called _____, and d) The outer covering of the bean seed is called _____. Marvin then asked the pupils to copy the exercise and fill in the gaps. At the ending bell at 11.10 a.m., the teacher had not yet finished marking the exercise. Thus, Marvin decided to collect all unmarked notebooks. He did this by asking learners with unmarked exercises to raise their hands. The teacher went round collecting the notebooks. At this time, some learners were asked to collect bean samples and put them on the teacher's table as they waited for the mathematics teacher to enter.

***Marvin's Perspectives on Science Teaching***

Commenting on teaching strategies, Marvin said that group work was seen to be the most useful strategy in the teaching of science in primary schools. Marvin explained that he involved learners in group work as much as possible so that they could share ideas. This was in keeping with what was observed in all of his observed lessons.

Commenting on process skills, Marvin said that observation, measuring and investigating were the process skills that he concentrated on. No reasons were given as to why he concentrated on these particular process skills. Marvin highlighted interpretation as one of the most difficult

process skills to teach as reflected in the following response: “I think interpreting is difficult because the pupils are not good at speaking English.”

Lack of teaching and learning materials was mentioned by Marvin as one of the main problems faced during science teaching in both primary schools and teacher colleges. Marvin said that in primary schools, teaching and learning materials were lacking, compared to what was available in college.

On the question of whether there were similarities between his college science experience and his current teaching in schools, Marvin said, “In both there are not enough teaching and learning materials to use. Also, we use a participatory approach in schools while at college the lecture method was mainly used. This may have been because the students in college are regarded as adults.” Marvin pointed out that the technique of questioning and organization of group work was the same for the teacher training colleges and the primary schools.

When Marvin was asked how science teacher preparation should be improved, he suggested the utilization of institutions, organizations, or any resource center from the community in the teaching and learning of science. For example, he said that helpful activities might include an educational visit by students to a nearby hospital to discuss diseases such as HIV and AIDS, or a visit from a District Health Officer as a resource person to talk to students. In addition, Marvin suggested that some teaching materials such as a model of a human skeleton could be borrowed from a hospital.

Marvin also felt that there was a need for schools to be provided with teaching and learning materials. Marvin stated that, “The Government should fight hard to send materials to school, for example, thermometers for science teaching.

One other suggestion made by Marvin was that meetings should be organized regularly so that science teachers could assist each other. Marvin felt that it would be helpful for science teachers to share ideas for lessons and materials, and that there was much that science teachers could learn from one another.

***Researcher’s Summary on Marvin***

Generally, Marvin was a teacher with a lot of confidence. He was always prepared for his lessons. He regularly made use of question and answer techniques during his teaching. In all of his lesson introductions, Marvin asked questions based on previous lessons. These questions

primarily required that pupils recall information, and the responses required only about two to three word answers. The questions asked regarding the previous lesson linked with the lesson topic for that day; thus, Marvin was activating pupils' prior knowledge before introducing new information. One example was the question, "How do amphibians breathe?" with the correct response being "Using gills when young, and using lungs when adults." This was a revision of a question from the previous lesson on amphibians, but he linked it to the topic of the day, which was "How do vertebrates eat?"

In the lessons observed, Marvin conducted his lessons by asking revision questions on what had been taught in the previous lesson. These questions were normally chosen directly from the Teachers' Guide and Marvin normally wrote these questions on the chalkboard. It was interesting to note that Marvin asked learners to respond to these questions while answers were on the chalkboard in the form of brief notes. The teacher wrote notes on the chalkboard as each lesson progressed. In some lessons, the learners were asked to copy the notes and in other situations, there was no copying of notes from the board. Learners answered revision questions either orally, or in the form of a written exercise.

One process skill that was regularly used in Marvin's observed lessons was observation. In most cases, he asked learners to observe samples brought in class. There were also lessons in which he asked the learners to go outside and make observations in the school environment. Marvin always provided guiding questions for group tasks. These questions were always written on the chalkboard for either the group leader or group secretary to copy before the group engaged in completion of the task. For instance, on the topic, "Plants and the Environment," Marvin wrote the following guiding questions on the chalkboard before learners started the group task:

1. What types of plants are in the environment?
2. Were the plants planted or not?
3. Why are the animals found on plants?
4. Are there any signs of erosion?
5. How would you reduce soil erosion?

Using these questions, the learners were able to carry out their activity without problems.

The pupils in Marvin's class were actively involved almost all of the time, and it was common for the pupils to go outside to carry out class activities. While question and answer

method of teaching was commonly used during introductions, group discussions dominated most of his lesson time. Giving guiding questions was the norm for his lessons. Furthermore, Marvin highlighted lack of teaching and learning materials as major problem in science teaching. He, therefore, suggested the need to utilize the other institutions nearby as sources of teaching and learning materials. In addition, Marvin suggested regular meetings and seminars across colleges in order to share ideas.

## Cross Case Analysis

Major findings from the cases of science teacher participants in the study were that: (1) Stephen was notable in that he was very enthusiastic and eager to teach, but had many other responsibilities that interfered with his teaching. (2) Thokozani was very steady and showed confidence when teaching; however she failed to include enough content and activities to cover the whole time allowed for the science period. At all times, she held either a lesson plan or a teacher's guide in her hands. (3) Clarifying ideas clearly through chalkboard illustrations was a highlight of Chidecha's teaching style. In addition, he always encouraged his pupils to discuss group tasks in English, which they did. (4) Jim had the ability to actively involve all his pupils through his class sessions. He was able to explain ideas clearly, but was fond of translating them from English to the vernacular. (5) Bob always prepared his lessons, but his plans lacked sufficient content and activities to fill the available time. His prepared science lessons could not be taught because other activities engaged him since he was Patron of the School Science Club. (6) Marvin was memorable in that he actively involved all of his pupils to utilize the school environment in the teaching and learning of science.

Furthermore, five similar themes were identified based on analysis across the data collected from the six participants in this study. These themes included: (a) the use of teaching and learning materials, (b) perceptions about the need for science teacher educators to serve as models, (c) the use of group discussion in science instruction, (d) ineffective use of class time during primary science instruction, and (e) interest and background in science. Here, each of these themes has been discussed.

### *Use of Teaching and Learning Materials*

All of the participants indicated that they felt it was important to make use of teaching and learning materials during primary science teaching in order to engage students in science, get

them excited about science, and learn science concepts clearly. Further, they all indicated that useful teaching and learning materials were not available in their schools.

Some participants indicated the need to improvise by using TALULAR (Teaching Using Locally Available Materials), which has been widely recommended and promoted by the Malawi Institute of Education and the Malawi Ministry of Education. Although these participants considered TALULAR an important strategy, they indicated that there were problems with TALULAR. Chidecha, a Standard 6 science teacher explained, "At college, at least they could have added more time teaching students how to improvise." He went on to say that there should be a much greater emphasis in Teacher Training Colleges on assuring that teachers are well prepared in making and utilizing improvised materials, as explained in the following statement: "Pulleys simplify the work, but how? Even the teacher himself does not know how to put it or arrange it."

According to these participants, the lack of adequate teacher preparation in the Teacher Training Colleges has an impact on the extent to which teaching and learning materials are used during teaching in the primary schools. Observations of classroom lessons confirmed that some of the participants were not particularly creative or resourceful in their use of teaching and learning materials. For example, in one case, a teacher was observed teaching a lesson on types of roots in which some examples were provided for group examination. This teacher provided one small tap root and one small fibrous root to each of the five groups. It was difficult for students to recall examples of plants with these differing root types. It would have been possible for the teacher to take a more active, hands–on approach to teaching this lesson if the students had been asked to go outside and identify different plants with those two types of roots. Near the classroom were growing crops such as sweet potatoes, peanuts, corn, and beans. In addition to these, there were different types of planted as well as natural trees and grasses. This collection of locally available plants could have been utilized in studying this topic on types of roots. Perhaps the teacher did not think of these materials, which were abundantly and locally available. Based on the perceptions of these participants, improved use of teaching and learning materials might result if there was a greater focus on this within teacher training programs.

In addition, three of the participants felt that the Government of Malawi should provide teaching and learning materials to support science instruction. The participants had different ideas about how this should be accomplished. For instance, Stephen thought that the Malawian

Government should provide commercially produced items in general, such as science kits for the schools. Thokozani thought that it would be very helpful for printed charts on science topics to be provided, and Chidecha believed it would be helpful if flip charts were made available. These teachers seemed to be more interested in having the government provide materials for them than in taking their own time to collect and create instructional TALULAR materials from the environment on their own.

In summary, all of the participants in this study stated that they felt there was a need for more teaching and learning materials to support science teaching in the primary schools. They felt that better training in the use of TALULAR was needed as a part of teacher education at the TTC's, and that the government should provide additional materials to the primary schools to support science teaching and learning.

### *Need for Modeling in Science Teacher Education*

Almost all participants noted that, in the Teacher Training Colleges, science teacher educators should teach using the same kinds of instructional methods that they would like their students to use in the primary schools. Modeling of this kind would make it possible for teacher education students to see exactly how these methods could be practiced in primary school classrooms in the teaching of science. A representative case was that of Chidecha, who said, "At college, at least they would have added more time teaching students how to improvise . . . In addition to that, our lecturers needed to teach us how to operate those machines; because during teaching, maybe a teacher can fail to operate that pulley." Bob said, "At college, our tutors demonstrated to us different skills of teaching science and I also try to do the same when I teach my pupils." In addition to this, Jim said, "May be it happens that I myself does not have knowledge of making models because the lecturers did not clarify to us."
These comments reflect a common perception among the participants regarding the need for teacher educators to model ways in which primary teachers should teach science lessons.

### *Use of Group Discussion*

Group discussion was a common strategy used by all the participants in their teaching; however there were some variations in the ways in which groups were organized and utilized during lessons. Most teachers used permanent groups, which they had formed at the beginning of

the semester. These groups were commonly identified by names of animals familiar to children for instance, “Zebra,” “Lion,” “Cow,” and “Goat.” In some cases, names of mountains found in Malawi were used as the names of groups. For instance, one participant had groups named “Vipsya,” “Mulanje,” and “Nyika.” In some classes, new groups were formed during the course of the lessons. When this occurred, the most common method of establishing groups was by having the pupils count, and then those with the same number formed a group identified by the number.

The reporting of the ideas discussed in group meetings also varied. A common reporting strategy was to ask group leaders and secretaries to read their notes on what the group had discussed to the whole class. The students either read their notes while standing in their positions with their groups, or the group leaders/secretaries went to the front of the classroom and read out their reports. Some teachers asked group representatives to go in front of the classroom and write their findings on the chalkboard. One other method of reporting, used by only one of the study participants, was that of collecting written reports from the groups and reading each report to the whole class. The use of group discussion and different approaches to the reporting of group findings demonstrated that the teachers were making use of several grouping and reporting skills that are often taught during teacher preparation programs.

### *Ineffective Use of Class Time*

The findings demonstrated that time allocated for science was not fully utilized by the participants. The interviews indicated that it was fairly common for some science lessons to be eliminated and never taught at all. During the observations, it was noted that several of the science lessons ended earlier than the time frame allotted for science lessons. There were two main reasons for the early stopping times on science lessons. First, some teachers were assigned to attend to other official duties. For example, some were required to attend workshops that interfered with teaching complete science lessons. There were days when the teachers left very little work for students to do during the time that the teachers were going to be engaged in other official duties. As a result, science lessons were not taught or time allocated for science lessons was not fully utilized.

Some of the study participants were given administrative duties for supervising the whole school because other teachers were absent. Because of this, time allotted for teaching was not

used for that purpose. This happened to Stephen on a day when he was to be observed. He had been told by the head teacher to take charge of the school while the head teacher was attending a meeting elsewhere. According to Stephen when given responsibility for the whole school, it was not possible to fully teach lessons for any group. He said, "Because we are more involved in other classes, for example in Standard 3, there is no teacher, and in Standard 2, there is no teacher, so we were going to other classes. So I planned for only some few lessons of other subjects apart from science itself." In this circumstance, Stephen planned some work for his students to do, but this did not include science. Stephen indicated that no science lesson was taught, even though it was timetabled, hence science teaching time for his students was not utilized for that purpose.

The second reason given by the study participants for the lack of allotted time being spent on teaching science lessons was more nebulous. Most of the teachers taught using English as well as the vernacular (local) language. English is expected to be medium of instruction from Standards 5 through 8; however, these teachers spoke in English and then translated what was said in English to the local language. The teachers assumed that the students would understand the content better if it were presented in the vernacular. For example, Stephen said, "But according to Standard 5, this is somehow difficult but for Standards 1 to 4 most of the lessons are taught in Chichewa and as you go to Standard 5, you start learning these lessons in English." This is a reasonable assumption in this context in which vernacular languages are spoken almost exclusively at home and in the community, and where English instruction is provided to students for about thirty minutes per day in Standards 1 through 4. The repeated use of English to vernacular translations during science lessons was very time consuming, and it meant that perhaps twice as much time was spent on teacher talk; hence engaged learning time for primary students was wasted. Much more instructional time could have been focused on student learning in science lessons if less time had been spent on translations from English to the vernacular.

### *Interest and Background in Science*

During the lesson observations and teacher interviews, in different ways, each of the participants expressed their interest in teaching science. Enthusiasm for science as a content area was demonstrated by the manner in which lessons were taught. The voices of the teachers were animated and through their voices, smiles, and attitudes, it was clear that they had an interest in

science and wanted their students to share their enthusiasm for this subject matter. In a statement that is representative of this group of participants, Jim said, “Science is a good subject and pupils like it: they have problems in discussions, but they like it. If you tell them what to do, they do it; only that they have a problem of language.”

Although there was an absence of teaching and learning materials, participants used teaching methods that actively involved students. If they had not genuinely cared about teaching this subject matter, it would seem to be less likely that the teachers would have taken the time to design their science lessons so carefully. For example, on the topic of how to keep the skeleton strong and healthy, one teacher demonstrated good and bad postures; then he asked the students to participate in walking and running using good and bad postures. He also involved the students in lifting a big stone using good and bad postures.

It was noted that the level of science content knowledge varied among the participants. Three of the six participants indicated that they studied science through four years of their secondary education. This is a choice for secondary students in Malawi, so it can be considered to be a reflection of interest in science. One of the primary science teachers studied science only in the first two years of a secondary education. The interview questions did not inquire about the number of years of secondary science preparation for the primary teachers, and in two interviews, this information did not come up. Thus, no assumptions can be made based on this study about the relationship between levels of science preparation and enthusiasm for teaching science. Further research might be useful to explore this topic.

There were indications that many of the pupils were interested in science as a subject, as indicated by their active participation within group activities both in and outside the classroom. For instance, in one lesson where students were observing what happened when things are heated, all of the pupils were noted as having smiling faces and demonstrating eagerness to participate. Most pupils wanted to heat wood, paper, and candle wax themselves. More excitement came when one student was asked to breathe onto a mirror in order to see the water vapor. The curiosity among students indicated that they had developed interests in and positive attitudes about science, despite inadequate materials for the experiments. The students seemed to be shy about asking questions during lessons that were observed, but this could have been because of the presence of the researcher in the classroom. Nonetheless, based on the

observations, it seemed likely that the enthusiasm for science shown by the teachers had influenced the students to also appreciate science.

## Summary

This chapter has discussed the science teacher preparation program in Malawi. Science teacher education in Malawi expects primary teacher candidates to be equipped with adequate and appropriate science content and pedagogy in order to teach effectively. The views of three science teacher educators concerning their methods of training primary science teachers showed that: (a) there was limited time training primary teacher candidates on science content and pedagogy; (b) participatory teaching approaches, such as group discussions, should be encouraged during teacher preparation; (c) improvisation of the teaching/learning materials should be encouraged; (d) the need for regular seminars/workshops across teacher training colleges; and (e) the need for science content courses to be relevant to the needs of the people.

Analysis across the six cases revealed that there were five major themes including: (a) the use of teaching and learning materials, (b) perceptions about the need for science teacher educators to serve as models, (c) the use of group discussion in science instruction, (d) ineffective use of class time during primary science instruction, and (e) interest and background of science.

# CHAPTER FIVE
# DISCUSSION

The purpose of this study was to observe the teaching practices of six primary school science teachers in Standards 5-7, to interview these science teachers to learn about their perceptions of teaching science, and to examine whether or not their teaching practices were in keeping with what they were taught during teacher preparation, as well as Malawi educational expectations for primary school science based upon the MIITEP Handbooks. The study involved six primary school teachers, all located in the central region of Malawi. All of the primary teacher participants had completed the MIITEP program in the past three to five years. The primary data sources for the science teachers included a self-assessment form, pre-observation interviews, post-observation interviews, and lesson observations. Data were also gathered from the MIITEP Handbooks, and three science teacher educators. The data were analyzed using descriptive analysis. The chapter includes a discussion of the findings based upon the three research questions, which were:

1) What is the science teacher preparation program for primary teachers in Malawi?
    c) What is the curriculum of science teacher preparation program?
    d) What were the perceptions of selected science teacher educators in the teacher training colleges about the science preparation program?
2) What were the instructional practices of six beginning primary science teachers who were prepared in Teacher Training College programs?
3) What connections were evident between what beginning primary science teachers were expected to learn and what they demonstrated in the classroom?

The chapter concludes with reflections on the study's implications for teacher preparation and recommendations for further research.

## Discussion of the Findings

The first research question examined in this study was: What is the science teacher preparation program for primary teachers in Malawi? In order to answer this research question, two sub questions were posed: (a) What is the curriculum for the science teacher education

program? and, (b) What were the perceptions of selected science teacher educators in the teacher training colleges about the science preparation program?

The first sub question for Research Question 1 dealt with the curriculum of science preparation program. The science curriculum in Malawi required students in the TTC's to learn science content as well as pedagogical content from both theoretical and practical perspectives.

*Science Content*. The science content to be covered consisted of Biology, Chemistry and Physics topics. Other aspects of science such as earth science and astronomy were covered in Social studies, which was one of the twelve subjects in the Malawi Primary School curriculum at the time of this study.

The MIITEP Student's Handbooks 1 – 5 were developed using the two-year teacher education science syllabi. These syllabi had been the basis for teacher preparation in science in Malawi prior to the time in which MIITEP was designed and implemented. The Malawi primary school syllabus for science identified the content of what was to be taught in primary science classrooms. The student handbooks covered basically the information in the syllabus, but at a slightly deeper level. For example in TTC's on the topic "Photosynthesis" primary teacher candidates discuss the chemical processes involved in photosynthesis, the raw materials required and the products of the process by using chemical symbols such as "C" for carbon and "O" for oxygen, and balancing up the equation. Sometimes students are involved in balancing up photosynthesis equation. However, when the new primary school teachers teach photosynthesis process, it is discussed without considering the chemical equation and symbols. Similarly, the science content covered in the MIITEP Handbooks is the science content that is to be taught in the primary schools. Thus, science teachers are expected to know science content only at a slightly deeper level than the level at which they are expected to instruct students. This level of content knowledge does not appear to be adequate to influence the new teachers' pedagogy in a positive manner.

*Pedagogical Content*. The pedagogy topics were discussed primarily in Handbook One. The pedagogy expectations set out for primary science teachers in the handbooks included:

(a) The use of specific scientific skills and the development of particular attitudes about science and science teaching,

(b) The development of knowledge about practical work in teaching science,

(c) The need for the science corner and nature table in science classrooms and the constructions of them in primary classrooms,
(d) Improvisation in obtaining and creating materials for science and health education,
(e) The storage and care of materials for science and health education,
(f) The preparation of science schemes of work and the completion of records of work, and
(g) Science and health education lesson planning

In addition to covering these pedagogical topics, students in the TTC's were required to have a variety of experiences in which they practiced teaching; first, within the context of their college classrooms, second, in the demonstration primary schools located at each of the six TTC's, and third, in selected primary schools. The inclusion of pedagogical topics for effective teaching within the science teacher preparation program is in keeping with findings of a study by Halium and Meerah (2002), who demonstrated that a good understanding of content alone was insufficient for effective teaching of physics for science trainee teachers in Malaysia. Labaree (2000) also supported this idea. He said, "Like doctors, lawyers, accountants, and architects, teachers have to master their disciplines to be effective in their profession, but knowing their subject matter is not sufficient" (p. 232).

The second sub question for Research Questions 1 was: What were the perceptions of selected science teacher educators in the TTC's about the science preparation program?
The science teacher educators in this study indicated that scientific skills and attitudes were being applied in their teaching; however, some scientific skills were more commonly used than others, for instance, observation skill. They felt that although they attempted to engage primary teacher candidates in all the process skills, some of these process skills were definitely more difficult to teach. Perceptions about the difficulty of specific scientific process skills varied among the science teacher educators. For example, James found inferring skill to be difficult to teach, Jeke found observation skill to be more difficult, and Jill found reporting to be difficult to teach.

The science teacher educators stated that students should be taught how to improvise teaching materials, although it was noted that some teaching materials were difficult, if not impossible to improvise, for instance, methylated spirits and thermometers. During interviews all three of the science teacher educators felt that the Malawi government should provide some

teaching materials, especially those that are difficult to find locally. The science teacher educators in this study did not discuss storage and care of science teaching materials. However, they stated that students were engaged in preparation of science schemes of work and lesson plans as a part of the MIITEP program. Further, the students in the TTC's practiced filling out records of work after teaching.

There were other issues that were raised by these science teacher educators in this study. First, all of the teacher educators said that learner-centered teaching approaches such as group discussion, role-play, field trips and projects should be encouraged. They provided examples of how they used these kinds of teaching approaches in their own classrooms, indicating that all of these teaching methods were modeled for students in the TTC's. Similarly, Levitt (2002), in his analysis of elementary teachers' beliefs with regard to the teaching and learning of science, found that there was great need for student-centered approaches to science teaching and suggested that student-centered approaches allowed for higher levels of learning. He said, "Traditionally, learning of answers, memorization of bits and pieces of information, recitation and reading are emphasized in the science classroom at the expense of exploration of questions, critical thought, understanding in context, argument and doing science" (p. 2). He went on to recommend that teaching of science should be student centered in such a way as to assure that the role of the teacher be a flexible one that made it possible for teachers to focus on the needs of the student. Similar findings were also reported by Appleton and Kindt (2000) in their study of influences upon beginning teachers' practices. They observed that lecturing, reading books, and writing reports dominated teaching practices among Australian science teachers as opposed to the use of methods of creating student-centered learning opportunities.

These three science teacher educators felt that engagement in other official duties such as proctoring and marking examinations took a great deal of their time that should have been devoted to teaching. It was common for science teacher educators to be called away from their "normal" teaching duties and spend several weeks involved in activities such as reading and scoring examinations. During the time in which they were assigned to mark examinations, their classes simply did not meet and students received no instruction. As a result of this lost time, the science teacher educators usually resorted to teaching using the lecture method after they returned to their teaching duties. Science teacher educators indicated that this method made it possible to cover science material that had been skipped and "catch up" in coverage of the

required content. Turning to lecture as a method of content coverage meant that best practices were not used in science teacher preparation. The science teacher educators realized that lecture was not "best practice"; however, they felt that there were few choices available to them after getting behind in their teaching schedules. In other words when it was necessary to teach a great deal of science content very quickly, science teacher educators perceived lecture to be the most expedient teaching tool (because "doing science" takes much more than "telling science"). In their study of science teachers' practices in Egyptian classrooms, Johnson, Monk, and Swain (2000) reported that most teachers knew a variety of learner-centered teaching strategies, although they did not use them. Failure to use these teaching methods was the result of external factors, according to this report. Like the Malawian teacher educators, the Egyptian teachers experienced pressures from external forces that led to not using "best practice."

The science teacher educators all recommended that more rigorous criteria be used in the recruitment of primary school teacher candidates for the TTC's be employed for better science teacher preparation. Specifically, the science teacher educators felt that candidates for the TTC's should be drawn from those who had completed Form 4 (Grade 12) and had passed the MSCE. A requirement of this kind would assure that primary teaching students in the TTC's would have a stronger basic knowledge of science content before beginning the teacher preparation program. This type of recruitment of primary teaching candidates was used in the implementation of a new teacher education curriculum at the University of Durban-Westville in South Africa. Entry requirements were raised from the level of Junior Certificate (2 years of secondary education) to the level of 4 Cambridge School Certificate Credits (Stuart, 1999). As a result of this recruitment change, the University of Durban-Westville expected that science teacher preparation could be made much more meaningful to the students. More instructional time could be focused on pedagogy and teaching practice, and less time would be used on the development of content knowledge. Presumably, with enhanced opportunities for making pedagogical gains, the university would be able to prepare stronger primary science teachers for the schools. In industrialized countries, it is common for primary teachers to be required to not only complete secondary school (Form 4), but to have attended college and completed at least a Bachelor's degree program. It is reasonable that the science teacher educators would expect that requirements for content knowledge in primary teacher candidates to become more rigorous over time.

Another recommendation made by the science teacher educators was that seminars and workshops be encouraged across all of the TTC's. The purpose of this suggestion was to allow science teacher educators to share ideas in order to improve teacher preparation. The participating science teacher educators recognized the fact that there was much that they could learn from and share with their peers, and that all could develop higher levels of expertise through collaboration. One of the National Science Education Standards (NSES) in the United States emphasizes true collaboration among schools, colleges, local industry and other science-rich centers. In this way, people can work together with each other and with teachers as they integrate their knowledge and experiences (NSES, 2003).

In summary, the first research question dealt with the science teacher preparation program in terms of the science curriculum and the perceptions of science teacher educators. The science curriculum involves the teaching of science content and pedagogical content, which are taught from both theoretical and practical perspectives. Science teacher educators encouraged students to use learner-centered teaching approaches and apply all the process skills where appropriate in order to create effective science teaching and learning opportunities in primary school classrooms although their schedules frequently resulted in using lecture in their own classrooms.

The science teacher educators also felt that greater availability of teaching and learning materials was needed. They thought that there was a great need for primary teachers to work hard to improvise science materials and also that the Malawi government should provide materials that were difficult or impossible to improvise for science instruction. Changes in the recruitment of primary teacher candidates, and the introduction of seminars and workshops for science teacher educators were also suggested.

The second research question investigated in this study was: What were the instructional practices of six beginning primary science teachers who were prepared in Teacher Training College programs? Observations of science lessons and interviews with primary science teachers demonstrated that the teachers made many efforts to meet the expectations for them that had been set out in the MIITEP Handbooks and in their science teacher preparation programs.

All of the participating science teachers attempted to use teaching and learning materials in their lessons, although in most cases, the materials were not adequate for the whole class. That is, the teachers made efforts to have teaching materials that were appropriate for the lesson topic,

but in most of the lessons, there were not enough materials for the number of pupils.
The science teachers made efforts to utilize materials from the local environment by either taking students out of the classroom (as was commonly the case with Marvin) or by collecting materials for the students to use in the classroom (as was consistently the case with Stephen and Chidecha). When teaching and learning materials were not available, some participants skipped the lesson on specific topics completely, and planned for these topics to be taught in the near future. In other instances in which teaching and learning materials were not available, participants stated that they decided to teach science using the lecture method, as opposed to involving pupils in hands-on practical activities such as investigations and observations. This practice had been modeled for the primary science teachers in the TTC's when the science teacher educators found that they were behind and had to cover content quickly. It is not surprising that the primary teachers turned to lecturing when teaching and learning materials were unavailable or difficult to improvise. Although the participants were not observed teaching any lessons in which lectures were used, it is clear based upon the interviews that the primary science teachers all used lectures for some lessons. It is reasonable to assume that science lessons taught using the lecture method for primary students could be made stronger with some time and effort on the part of the teachers. This could be in many different ways for example, teachers could engage pupils in thinking about the questions they have about the topic, then meet in groups to share and seek answers to their questions.

Several of the teachers indicated that they had busy schedules due to an overload of other subject areas to be taught and additional assigned duties in their schools. However, for some of the teachers, it appeared from their interviews that they had the time, but did not put forth the effort to collect supplies for their lessons. For instance Stephen said, " The differences are also there; most science teachers including I myself, we sometimes become very lazy using teaching and learning materials."

In addition to the fact that there were minimal teaching and learning materials for most of the observed lessons, there were no nature tables in any of the classrooms where science lessons were observed. The nature table is an expected learning resource for every Malawian primary classroom in Standards 5-8, and these tables are supposed to be used to enhance science learning. Nature tables are relatively easy to construct with locally available resources, and teachers are supposed to place natural items from the local habitat on these tables for student manipulation.

When lessons related to the items on the nature table are taught in class, teachers should use these items and encourage students to study these items. Nature tables are expected to remain in the classroom as a means of keeping students interested in science artifacts. With no nature tables appearing in any of the science teachers' classrooms, there are fewer opportunities for expected science learning in these primary classrooms.

Another expectation for primary classrooms in Standards 5-8 is the science corner, a spot in the room where science materials such as charts are displayed. Five of the six teachers had science corner areas in the classroom on which teachers typically displayed a few science charts containing information on previously taught science topics. These science displays were never mentioned or used during science lessons. For most of the science topics that were studied in the observed lessons, it would have been relatively easy for the teachers to display either a teacher-made chart about the lesson content or student work that had been completed related to recently taught science lessons. Again, the science corner provides an opportunity to enhance student learning relative to the science topics presently under study, but none of the participating teachers included materials in the science corner that corresponded to the current topics.

The science teachers in this study very commonly used question and answer and discussion methods in their science lessons. Most of the questions asked for the pupils by the teachers were low level, i.e. basic recall questions rather than high level comprehension questions that called upon the students to use critical thinking or problem solving skills. For example, when teaching the topic "Uses of Substances," Stephen asked the following introductory questions: "What are the three states of matter?" and "What are the properties of liquids?" These introductory questions were based on material taught in the previous lesson and could be classified as basic recall types of questions. In the development of this lesson, Stephen asked one higher order question: "What might happen if dissolved salt is allowed to evaporate?" The science lessons that were observed could have been strengthened if the teachers had used a variety of kinds of introductory activities that called upon students to not only recall basic prior knowledge from the previous lesson, but that also required critical thinking and the construction of connections across content recently covered. The teacher could provide a drawing showing a list of different types of solids, liquids and gases. Students could be asked to group them according to their similarities and differences based on the drawings. They could be asked to give reasons for these groupings. Such an activity would engage pupils to think and relate to the

three states of matter and their properties. There are many possible explanations for the prevalence of the use of basic recall questions in introducing science lessons. One explanation could be that this practice was modeled in teacher training. Another explanation could be that, in their own experiences as students, these teachers experienced many lessons that were introduced in this way. Lortie (1975) referred to this phenomenon as the "apprenticeship of observation"(p. 61). Many scholars have reported on the fact that previous life history and experience as a student has the power to impact teacher behaviors and beliefs in strong and enduring ways (Waller, 1932; Lortie, 1975; Zeichner, 1980; National Center for Research on Teacher Education, 1988; Florio-Ruane & Lensmire, 1990; Calderhead & Robson, 1991; Richardson, 1996). It clearly appeared that the use of basic recall questions was an easy way for primary teachers to begin their science lessons, as indicated in their evaluations in the post-observation interviews. None of the teachers evaluated themselves negatively relative to their question and answer introductions to lessons.

Lesson introductions need to be motivating so as to draw the attention of pupils, arouse their curiosity, and get them thinking deeply about what they have learned in the past and how it might relate to what they are to learn in the current lesson. This study has shown that only one method of introducing science lessons was common, and this was to briefly review the previous lesson by asking recall questions and calling for student responses. In a previous study the Multi-Site Teacher Education Research Project, Stuart (1999) found that the use of closed, recall types of questions was common in lessons in Malawi and Lesotho. She found that Malawi and Lesotho had many similar problems, although Lesotho had developed a new curriculum that had been designed to address many of these problems.

The teachers encouraged pupil involvement in small group discussions as a foundational teaching method in their teaching of science. All of the teachers were observed arranging their students in groups and giving the students tasks to complete or questions to answer. The teachers circulated around their classrooms and spent time with each group, sometimes just observing, and at other times participating in the discussions briefly or answering student questions. After the group discussion had been completed, the teachers called upon group leaders representatives report to the class on what the groups had discussed or discovered.

Observation and reporting skills were the most common process skills used both inside and outside the classroom. In these lessons pupils were asked to observe science phenomenon such

as: (a) water filtration through sand, (b) animals in the local area (grasshoppers), (c) the presence of soil erosion, (d) the feeding habits of goats, and (e) parts of flowers. After pupils completed their observations, the teachers typically brought them together as a group, asked for reports on what they had observed, and summarized what pupils should learn and remember related to the observations. Of the six participants, only two engaged pupils in any analysis of the group reports with regard to differences noted among the different groups. When students reported on their observations, the common practice was that a teacher would ask students to clap hands for the group that had reported.

In the observed lessons, there was almost no emphasis on process skills other than observation. No teachers were observed engaging their students in the process skills of making inferences. Only one teacher engaged students in interpretation of data, and two involved students in predicting. This finding was very much in keeping with the self-assessments completed by the teachers at the onset of the study, in which they all reported upon using observation frequently in their teaching.

Most teachers did not make use of all the time for the science lessons. Only two planned enough for the entire time allotted. Some of the teachers planned very little work for a single 35-minute lesson and in some situations, there was actually even less work for a double 70-minute lesson. In addition to this, some of the allotted time for teaching science was not utilized for science instruction at all due to assignments to other official duties. There were instances in which the science teachers stepped in and provided assistance in other classrooms when there was a shortage of staff as a result of illnesses, deaths, and other teachers attending meetings or workshops – meaning that they "stepped out" of teaching their science lessons.

Furthermore, large amounts of science lesson time were consumed with the repetition of information presented to the students first in English, and then in the vernacular. Mbano (2003) examined the performance in science of secondary school students in Malawi and found that among other factors, science was perceived as difficult because it was taught in English, which is their second language. In this study, when the teachers felt that students had not understood what had been stated in English, they switched languages and repeated the same information in the vernacular. In many cases, this happened with frequency, meaning that a great deal of science teaching time was devoted to repeating information that had already been provided in English.

In summary, Research Question 2 dealt with the teaching practices of the six science teachers. This study revealed that the science teachers attempted to model their science teacher educators by using teaching strategies that had been used in the TTC's such as the question and answer method and group discussion. They engaged pupils in observation and reporting skills more than any other process skills. Inferring was not used at all. The teachers made efforts to use teaching and learning materials, although there were not enough materials for the number of pupils in class. Five of the teachers had science corners that consisted of few science charts, but none of the participants had a nature table for classroom use. Little time was spent on science instruction due to preparation of sketchy lesson plans, engagement in other administrative duties that took science teachers out of their classrooms, and teaching using both English and the vernacular.

Research Question 3 was: What connections were evident between what beginning science teachers were expected to learn and what they demonstrated in the classroom? To answer this question, a table was created representing the pedagogical goals from the MIITEP Handbooks for primary science teachers and the expectations of the science teacher educators compared with the six primary science teachers and what they were observed doing (O) or stated that they did in the interviews (I). If a given pedagogical goal was observed or mentioned one time, it was marked with an O or I; if the goal was never observed or mentioned in an interview, it was marked with an X. The teachers are organized on the figure according to Standards they taught (S5= Standard 5, S6= Standard 6, and S7= Standard 7). (See Appendix I.)

To create a method of comparison among these data, they were examined with regard to cases in which the observations and interviews of the science teachers matched the pedagogical goals, cases in which there was a partial match between the observations and interviews and the pedagogical goals, and cases in which there was a mismatch.

***Matches***

When comparing the Malawian educational expectations for primary school science based upon the MIITEP Handbooks and the expectations of science teacher educators with what was observed in the primary school classroom, there is evidence that there were some matches. First, there was evidence of preparation of schemes of work for all of the primary science teachers. It is expected by the Malawi Ministry of Education that teachers prepare a scheme of

work document that outlines topics and content to be covered every week throughout the semester or term. Science teacher educators emphasize the preparation of schemes of work with their students in the TTC's. In this study, it was observed that primary teachers were able to prepare these schemes of work, hence matching with expectations. The researcher was able to look at these schemes, and all of the science teachers had prepared them. The expertise with which the schemes of work had been written was not scrutinized because it was not the focus of this study. Related to schemes of work, there was evidence that records of work were being completed by primary teachers after teaching their lessons. Again, this was in keeping with the expectations of the Malawi educational expectations based upon the MIITEP Handbooks.
In the interviews, the primary school teachers were able to comment on how well their lessons were taught, and these kinds of comments were included in the records of work, including discussions of successes and failures that they experienced in science lessons. The Malawian activity of writing records of work is similar to expectations for elementary and middle school teachers in United States. For instance, pre-service teachers are often required to write reflections about their lessons taught and these reflections are presented to their supervisors.

Third, there was evidence that science lesson plans were being prepared by primary school teachers. These lesson plans were being written following the lesson plan format as stipulated in the MIITEP Handbooks. It should be noted here that the amount of detail included in each lesson plan varied among the participants, and from topic to topic. However, each participant was able to prepare and utilize the lesson plan.

Fourth, there was evidence that group discussion as a teaching strategy dominated in all of the classrooms. The science teacher educators stated that they expected their students to utilize a variety of teaching and learning strategies; however, group discussion was the only strategy used by the primary teachers that matched these expectations and those noted in the MIITEP Handbooks. Deboer (2002) found that many strategies, especially problem solving, project-based teaching, discovery learning, and guided discovery, have proved to be problematic due to the fact that they require inquiry-based teaching and hence require that pupils be scientific inquirers in the classroom who are able to generate meaning more or less independently of the teacher. He went on to say that after encountering inquiry-based teaching strategies, students often complained that they were not learning the material they would be tested on. This reasoning could also apply to Malawi where, in most cases, teaching is examination oriented. Although

they did not state this during the interviews, it could be that the primary science teachers did not use other recommended strategies because of their focus on assuring that pupils learned the content that would be covered later when they took the Malawi Primary Leaving Certificate Examination. Research is needed to explore the influence of examinations on teaching practices.

Finally, the primary school science teachers engaged their pupils in observation skills and recording and reporting skills. Almost all of the teachers who were observed involved pupils in an activity requiring that they observe objects or events inside and outside the classroom. Pupils were also involved in recording what they had observed or discovered. Reporting on pupil observations occurred towards the end of the lessons.

In summary, it can be concluded that there was some evidence that ways in which the primary science teachers demonstrated in the classroom what they were expected to learn during teacher preparation. They prepared schemes and records of work, and prepared lesson plans for every lesson. The teachers' lesson plans and their actual lessons reflected the use of group discussion methods and engagement of pupils in the scientific process skills of observation, recording, and reporting.

### *Partial Matches*

There were a number of instances in which there were partial matches between the expectations for primary science teachers and what they demonstrated in the classroom. The partial matches included the presence of the science corner, the use of teaching and learning materials, and specific teaching and learning strategies and process skills.

In Malawi, the science corner is expected to be a place in the classroom where artificial and natural materials related to current science instruction are to be displayed. As stipulated in the MIITEP Handbooks, a science corner does not necessarily have to be at a corner. In this study, five out of six of the participants had a science corner. The science corners in the observed classrooms contained charts representing science ideas taught in the previous lessons. There were no displayed items that appeared to be displayed for the purpose of motivating pupils to utilizing the science corner. Rather, the charts contained information previously studied, perhaps displayed for the purpose of review. The presence of science corners in these classrooms provided evidence that the primary school teachers were aware of their use in teaching and learning. The science corners could have been used more effectively to support science learning

if they had included locally available materials for pupils to manipulate. Further, it would have been helpful if teachers had placed charts and materials in the science corner that were related to the lessons currently being taught, and if they had utilized or made reference to these charts and materials during lessons. Andersen (2000) argued that scientific literacy is the result of doing science, and not reading about science. He emphasized that science can be "done" anywhere, with or without expensive equipment.

While there was evidence from the prepared lesson plans and lessons observed that the primary science teachers used some teaching and learning materials, it was notable that, consistently, there were not enough materials for the number of pupils in these classrooms. An example can be drawn from the vignette lesson of Chidecha on the lesson topic "types of roots." Chidecha provided real samples of the roots of peanuts, sweet potatoes and lawn grass. One root type was given to each of the groups that Chidecha organized. Each group had 11 pupils; thus, it was very difficult for individual pupils within a group to carefully observe the one root that was provided to the group. The groups had been asked to observe the roots, identify their characteristics, and consider them in relation to the information Chidecha had presented at the onset of the lesson; however this was not realistic with one root for each group of eleven students. While it is not realistic to dig up plants that have been purposefully planted to provide family food, for the purpose of providing one to each and every student, plants with similar characteristics could have been uprooted in the area immediately surrounding this school. After all, this lesson was taught in the month of February, which is growing season for most of the agricultural crops in Malawi. As for grasses, these were available close to the school. Chidecha could have allowed pupils to go round and uproot some grasses from the school grounds. Each pupil easily could have collected grass plant with roots. This activity would have enhanced pupils class observation of grass roots. Also, if the groups had been half as large (5-6 students in each) and there had been twice as many roots provided by the teacher, it would have been possible for all of the students to observe and manipulate different types of roots. Slightly more effort on the part of the teacher would have led to a science lesson that would have been more meaningful in terms of "doing" science for Chidecha's pupils.

Marvin's use of bean seeds in his lesson on the topic "seed germination" provides another example. In this lesson, again, not enough seeds for the number of students were provided. One unsoaked bean and one soaked seedling was supplied to each of five groups of children.

Marvin's groups consisted of thirteen to fourteen pupils in his class of 66 pupils. It would have been easy for Marvin to provide more seeds and seedlings. It is common in Malawi for each household to have beans. Beans prepared in different ways, often serve as a relish for a main meal at lunch or supper. Marvin could have asked pupils (in their groups or individually) to gather some beans from their homes and plant them a few days prior to this lesson, then bring them to school for the lesson. Soaked beans could be prepared a day before the lesson. This would have allowed the class to have enough bean seedlings and soaked bean seeds for all students to observe closely during the lesson.

Primary science teachers are expected to improvise in obtaining and creating teaching and learning materials, depending on availability. Based on the observed lessons, it can be concluded that these teachers improvised in some ways. One example is that of Jim, who improvised a charcoal refrigerator made of locally available materials. The materials used in this lesson included wood charcoal, hard carton paper, hessian sacks (made of porous plant fibers) and tin. Pieces of charcoal were placed in between two hessian sacks, which was covered on the outside with tin. The latter was wide enough to accommodate two one-liter bottles of water. Using this charcoal refrigerator, Jim was able to teach his class by demonstrating how it works. It should also be noted that Jim had only 11 pupils in his class, which was a good small number for effective viewing of the charcoal refrigerator. Jim would probably have had problems using one refrigerator if he had a large class of, say 66, as was the case in the classrooms of Chidecha and Marvin. In such a situation, asking pupils to bring these local materials to class and allowing them to construct the charcoal refrigerator would have been meaningful.

Regarding the care and storage of teaching and learning materials, while two participants showed evidence that they stored their teaching and learning materials, four indicated that they did not. The care and storage of science teaching materials is a goal of the MIITEP program and is a topic discussed by science teacher educators in the TTC's; thus, most of the teachers in this study were not meeting this particular expectation.

In examining teacher use of teaching and learning strategies intended to enhance science learning for pupils, it was noted that a couple of teaching strategies were used by the science teachers, but others were not. As previously discussed, all participants commonly used group discussion; however, there was very little use of other teaching and learning strategies. Science teacher educators expect primary teachers to use a variety of appropriate teaching and learning

strategies in science teaching. Recommended teaching and learning strategies include role-play, case method, projects, field trips, and visiting resource persons. The MIITEP Handbooks suggest the use of these participatory approaches, particularly those that allow pupils to be actively involved in the learning process through use of their senses.

Similarly, the primary teachers used some scientific process skills, and others were not used at all. It is expected that primary science teachers will engage pupils in all of the process skills that can be applied within the study of a specific science topic. While it is not usually possible to engage pupils in using all of the process skills in any one lesson, it is possible that several process skills can be integrated within the same lesson, and over a series of lessons on a topic, it should generally be possible to use all of the process skills. Lee (1997) argued that students should be engaged in scientific inquiry by, "manipulating materials, describing objects and events, making explanations, verifying evidence, and constructing and organizing ideas"(p. 220). However, this scientific inquiry was not observed in the science classrooms in this study. Observation, recording, and reporting skills were observed in the lessons and discussed in the interviews with the teachers. The teachers were not engaging the students in measuring, predicting, classifying, interpreting data, or inferring, despite the fact that these skills could have been integrated in many of the observed lessons. Therefore it can be said that there was partial match between expectations for science teachers and what was observed and discussed with these teachers; they used some process skills, and did not use others.

In summary, it can be said that science corners, although available in five out of six classrooms, did not have items that could enhance teaching. Few charts were displayed on them. Generally, teaching and learning materials were not sufficient for the numbers of pupils in class. However, in some situations these materials were improvised. Regarding storage and care of materials, most of the teachers did not meet the expectations. In addition, it was observed that a couple of teaching and learning strategies and process skills were being used, but additional possibilities that could have enriched the presentations were absent.

### *Mismatches*

There were three areas in which there was a mismatch between expectations for primary science teaching and what was observed or discussed by the primary science teachers. First, time for teaching science did not match with the expectations from the MIITEP Handbooks and the

statements of the science teacher educators. In the section of the handbook on lesson planning, the MIITEP Handbook sets out the expectation that science will be taught for five periods of 35 minutes each week. The Handbook suggests that science teachers plan some single periods of 35 minutes and some double periods of 70 minutes for longer, inquiry-based lessons. Science teacher educators attend to this expectation carefully in the TTC's and the science teacher educators in the interviews mentioned it. The lessons observed in this study ended prior to the allotted time in almost every case. Thirty-five minute lessons were completed in 25-30 minutes. Seventy-minute lessons were taught sometimes as two separate science lessons (rather than one integrated, inquiry-based lesson), and these lessons lasted for 45-60 minutes.

Based on observations and interviews, there were three factors that affected science lesson time. First, there were several teachers who were assigned to other official duties such as workshops, meetings, and school administration. These responsibilities limited time for science lessons. In one case, the teacher being observed was actually the only teacher on the school grounds; all of the other teachers were away due to the fact that they were attending workshops and meetings or because of maternity leave or illness. This science teacher was unable to continue with his lesson because he needed to attend to the students in the other classrooms. In other cases, teachers had responsibilities such as funerals and they were unable to teach their science lessons because of these related absences. For example, in Malawi (with the average life span being age 37), funerals are very frequent and family members must take responsibility for organizing these. It is quite common for teachers to be called upon to organize funerals for their family members and members of the staff or community. When this occurs, teachers are excused from school and other teachers watch their students.

In addition, some of the teacher participants prepared lesson plans that were inappropriate in relation to allotted science-teaching time. Lesson plans did not have enough details of content and activities. For example, in one seventy-minute double lesson, one participant wrote a lesson plan that had few details and in which the suggested lesson activities were not elaborated. Her lesson topic was very general, "The Skin," and yet she taught about care of the skin. Also, in one of her activities, she blindfolded one pupil to feel warm and cold water from two different tins. No explanation was written in the lesson plan regarding washing hands and legs using water and soap; however, this was a part of the lesson. In addition, body lotion was applied to the washed hands and legs. The lesson plan did not indicate whether there was to be a discussion

about care of the skin, although a brief one was conducted in the classroom. In addition, this teacher concluded the lesson by explaining uses of the skin, using a chart showing the human arm. The pupils wrote summary notes and drew the human arm. The lesson ended ten minutes earlier than it should have based on Malawi's expectations for science lessons. When comparing the events that took place during the lesson to the lesson plan, it was clear that the plan did not include some significant details. One possible use of time would have been to involve some or all the pupils in washing their hands and legs. In addition, some time would have been used to discuss the importance of and reasons for using clean water, soap and a body lotion when caring for the skin. Allowing Standard 5 pupils to take part in such an activity in a better location outside the classroom would have allowed for greater student participation.

Third, as previously discussed, it was noted the all of the participants taught using English (as expected of MIITEP) and later repeated what had been already stated in the vernacular. This resulted in less time for actual science teaching.

Another mismatch involved the presence of nature tables in the classrooms. Although it is expected that nature tables will be available in all Standards 5-8 classrooms, there were no nature tables in the observed classrooms. A nature table is a place where only natural items should be displayed for student observation and manipulation. Nature tables are discussed in the MIITEP Handbooks and the science teacher educators indicated that this topic was discussed at the TTC's and that students in the TTC's would construct these tables and obtain natural items for them as a part of the student teaching experience. The availability of nature tables is expected to enhance science teaching and kept pupils interested and motivated in science**.** The absence of nature tables is a clear mismatch and therefore it raises the question of their effective use. Perhaps the construction of nature tables is not a reasonable expectation for primary science teachers in Malawi.

In summary, science teaching time did not match with Malawi's expectations due to many factors which interfered including teachers being engaged in other duties and lesson plans that were not appropriately designed for the expected lesson period. Further, teachers mixed English and the vernacular when teaching and this did not match with using English only as mandated. Also, by repeating information presented in English in the vernacular, much time was wasted. In addition, nature tables, although they help in enhancing teaching, were not available in the classrooms, hence the mismatch.

## Conclusions

Based on the three research questions in this study, several issues have emerged. The Science Teacher Preparation Curriculum in Malawi required primary school science teachers to acquire science content and pedagogical science content. Science teacher preparation programs in Malawi emphasize that their primary school teachers (a) use scientific skills and develop particular scientific attitudes about science teaching, (b) develop knowledge about practical work in teaching science, (c) use improvisation to obtain materials for teaching science lessons, and (d) store and care for teaching and learning materials for teaching science. In addition, primary school science teachers are expected to (e) prepare appropriate schemes of work, (f) prepare and deliver lessons, and (g) complete records of work after teaching. When comparing the perceptions of science teacher educators obtained through their interviews and the views and teaching practices of primary school teachers, indications are that there appears to be matches, partial matches, and mismatches, based upon Malawi teacher education expectations.

While some expectations were being fulfilled by the primary science teachers (such as preparation of schemes of work, completing records of work, and lesson preparation), teacher preparation programs should emphasize areas that need improvement. This study revealed that primary school science teachers did not fully engage pupils in all the scientific process skills, nor did they utilize a variety of appropriate teaching and learning strategies for science. When teachers used materials to support their teaching, there were not enough materials for the numbers of students. Nature tables, which enhance teaching, were nonexistent. The use of improvisation and the storage, care and use of teaching and learning materials left a lot to be desired. In addition, allotted time for science lessons was not fully utilized due to many factors, including poorly designed lesson plans and time conflicts with other official and community welfare duties. Further, time was lost as a result of the science teachers using a mixture of English and vernacular, which is contrary to the expectations of the Malawi Ministry of Education, which recommends English as a medium of instruction when teaching science in Standards 5 through 8.

The science teacher educators made a variety of recommendations that are in keeping with the findings from the primary science teachers. First, there was the suggestion that a change is needed in the recruitment of primary teacher candidates. If the primary science teachers had

possessed a stronger knowledge of science content, their lessons for students might have been stronger. The science teacher educators also felt that it was important to use learner-centered methods at the TTC's, thereby modeling this approach regularly for primary teaching candidates. Also, the science teacher educators felt that they could improve their own practices and gain additional knowledge through the sharing of ideas among one another. They recommended the introduction of workshops and seminars for science teacher educators across the colleges.

## Implications for Practice

For this study to be of value, there must be a move from research findings to practical applications. After interviewing primary science teachers, observing their lessons, and engaging in post-instructional reflections, several implications for practice in the teaching of science in Malawi can be established.

To begin, there is a need for science teacher educators to be more effective models for their primary school teacher candidates. Primary school teacher candidates need to see from their science teacher educators how to use longer time allotments for science lessons effectively, how to teach using appropriate teaching and learning strategies and materials, and how to apply various process skills when teaching science. It is hoped that through modeling, students can be in a position to understand how to create effective science lessons in the field. This calls for well-qualified science teacher educators who are dedicated to their work, skilled in communicating, and willing to share their time and knowledge with student teachers.

In addition to modeling for students, there is need for teacher education programs to provide primary school science teacher candidates with more teaching practice (practica) that includes frequent supervision and meaningful feedback on methods of improvement. This should happen with peers in the college classrooms, in demonstration primary schools, and then in the field.

Primary science instruction could become more meaningful for pupils if there were hands-on lessons for all topics, and if sufficient materials were provided for all pupils. Teachers believe that the Malawi Ministry of Education should provide adequate teaching resources to all schools. At a minimum, these would include books for pupils, syllabi, charts, paper, chalkboards, chalk, primary school teaching guides and science equipment such as thermometers, magnifying

glasses, weighing scales and insect catching nets. While both science teacher educators and schoolteachers are encouraged by the government to be resourceful, a basic level of supplies should be readily available to all so that time is available for lesson planning rather than searching for supplies and equipment. In particular, science teacher educators and primary science teachers need materials that are not available in the local environment, for instance, cells (batteries). This calls for proper planning in the distribution of financial resources at all levels including divisional, district, college and local school levels.

In this study, all of the participants were T2 teachers, meaning that they had completed secondary school. At least three mentioned their study of science in secondary school. Given the nature of the observations of science lessons observed by these T2 teachers and the problems noted in their science lessons, it is reasonable to assume that the science lessons might have been weaker had the participants been T3 teachers. There may be a need to reconsider the required qualifications for primary science teachers. There is evidence that the majority of primary school science teachers are not competent in using English as the medium of instruction for science lessons (Mchazime, 200l). Therefore, recruiting those primary school science candidates with adequate English and Science content might address this problem. It may be that if all primary school teachers complete four years of secondary education, primary science teaching could improve in Malawi; however, further research is needed in order to examine this assumption.

If the lessons taught by the primary science teachers in this study were actually a reflection of what they learned during teacher preparation for the teaching of science, it would appear that there are significant weaknesses in teacher preparation program in science. The majority of the teacher educators in Malawi hold a diploma, which reflects the completion of three years of college training in education. If teacher educators were required to earn a bachelor's degree in education, they could have a stronger knowledge base for supporting the learning of primary teachers. With much higher levels of content and pedagogical knowledge that could be gained through a baccalaureate program in education, presumably, teacher educators could be much more highly prepared to provide higher quality teacher education. It would be helpful if plans could be put in place by the government of Malawi to have all teacher educators upgrade by earning the bachelor's degree. The knowledge gained during the process of upgrading could provide science teacher educators with up-to-date information on the preparation of primary school teachers for science.

The four-year Bachelor of Education program currently operating at Domasi College of Education in the southern part of Malawi is one approach to solving this problem. This program was started in January 2004 and has so far recruited three cohorts of 30 students each. It is essential that bachelors of education students gain strong communication skills in English so that these teacher educators will be better prepared to provide instruction to primary teachers in using English to teach content area subjects. Other efforts are being made to upgrade the educational levels of some teachers. The Virginia Polytechnic Institute and State University's Partnership for Institutional Capacity-Building (UPIC), Lakeland University, and Fulbright Scholarships all are key partners in this endeavor.

There is need for primary science teachers to improve their teaching practices in teaching science. Given the fact that thousands of trained primary teachers are already in the field, efforts could be made to organize professional meetings in order for these teachers to advance in their everyday practices. One example of such an initiative would be development of a plan for primary science teachers from neighboring schools to organize meetings to support collaboration, possibly once a month or once a semester to discuss the teaching of science. By taking part in a discussion of issues such as challenges in their teaching and classroom management, science teachers could share their knowledge, experience, and materials. A collaboration of this kind holds the promise of leading to improvements in primary science instruction; however research is needed in order to examine this possibility.

Furthermore, there is need to strengthen science instruction in primary school. One possible long-term plan could be to allocate subject specialists responsible for a specific number of schools. For example, one science specialist could be responsible for at least two or three nearby schools. This specialist would assist science teachers within his area on issues concerning teaching and learning science.

There is need for the PEA's to interact with college tutors for effective supervision of primary school teacher candidates. One possible way could be my inviting both PEA's and college tutors to a workshop where they could share ideas about how best they can supervise their primary school teachers. Arrangements could also be put in place for these PEA's and college tutors to meet, perhaps once a month to discuss matters of supervision. It is hoped that through these kinds of interaction, teacher preparation and science teaching could reach a higher Standard.

Additionally, it would be helpful for the Malawi Ministry of Education to organize professional workshops and seminars where science teacher educators across all colleges can share their knowledge. Since this has financial implications, it would be necessary to consider convenient places where such workshops could be carried out at minimal cost**.**

In summary, it can be said that several implications for the improvement of science preparation and teaching emerged from the study. These were: (a) the need to see effective teaching and learning of science, (b) the need for intensive and supervised teaching practice, (c) the need to model for students in science teaching, (d) the need to provide adequate teaching resources in all schools, (e) the need to upgrade the education of science teacher educators, (f) the need for PEA's and college tutor interaction, and (g) the need to improve primary science teachers professionally through the use of science specialist and teacher collaboration.

## Implications for Further Research

This study has revealed possibilities for the future of science education at all levels in Malawi. First, there is a need for an extensive study of what science teacher educators do during teacher preparation. This kind of research would assist in getting an in-depth understanding of teaching practices of science teacher educators and what actually happens at the teacher training college. In this study, there was an examination of the perceptions of three science teacher educators; however, this study provided no information on what actually happens in courses in science teacher education. For instance, it would be useful to conduct a study in which researchers "shadow" science teacher educators across a whole semester. By looking at several science teacher educators in an in depth study, researchers could create a clear picture of how primary science teachers are prepared, and this information could form a data base that could establish specific research-based needs for improvements in science teacher education.

Second, data from the current study revealed that most teachers did not fully utilize the available teaching and learning materials from the immediate environment. The researcher, therefore, recommends further research to investigate to a greater depth the use of teaching and learning materials in science. For example, an in-depth study on the types of relevant teaching and learning materials available within the local environment, the degree to which they are

utilized in primary science lessons, and how they are stored and cared for, could provide useful information needed for the improvement of science teaching in primary schools.

Third, research could also be conducted to investigate the use of teaching and learning strategies and process skills in greater detail. This study has revealed that teachers were not utilizing some teaching and learning strategies and some process skills. It would be helpful to conduct action research with primary science teachers and/or science teacher educators related to the application of a variety of appropriate teaching and learning strategies in primary classrooms. In addition, a useful study could involve investigating science teacher educators and the process of engaging students in using a variety of process skills as they teach their science lessons. The findings of research on the practices of science teacher educators could be compared with what the science teacher educators in this study revealed during their interviews.

Fourth, the fact that nature tables are not available in classrooms despite the fact that these tables are expected to be present in every science classroom by the Ministry of Education (Sharma, 1980) is of interest. Because there were no nature tables, most pupils in these science classes lacked hands-on, eyes-on and minds-on experiences in the utilization of natural artifacts that could have been available within the classroom. It would be useful to learn the following in connection to nature tables: Should nature tables be emphasized during teacher preparation? Are there other alternatives besides nature tables that could achieve the same purposes? Why are nature tables not found in science classrooms? The researcher, therefore, recommends further research on availability and utilization of nature tables, and natural artifacts in general, in the teaching of science in Malawian primary schools.

Fifth, future research could be carried out to determine the most effective means of communicating science to primary school pupils in Malawi. The science teachers in this study combined English and vernacular in their teaching. The researcher observed that in at least one case, the teacher assumed that the pupils did not understand science when they are taught in English and repeated information in the vernacular. However, in this particular case, it was clear that most of the students understood what had been presented in English. Research is needed that will examine the degree to which pupils do understand science instruction in English. Research in this area would assist in determining whether the pupils should be taught in the vernacular or in English, or in some of both languages. Pupils may possibly require a stronger English background at an earlier age in order to understand science lesson in English in

Standards 5-8. Another part of this difficulty may involve the teacher's personal skills in communication, especially with science vocabulary, whether in English or in the vernacular. Further research is needed to study this phenomenon.

Sixth, this study was done over one semester, which is three months in Malawi. Although this time period met the needs of this study as conceptualized, the researcher recommends more extended studies in the future. A thorough study could look at teachers from the point of entry into teaching, through teacher preparation, and into the beginning years of teaching. This could be accomplished as a longitudinal study over a period of approximately six years. A specific cohort of student teachers could be studied over the time period. Data could be collected beginning with the pre-service stage of teaching; then these teachers could be followed into their teaching practice in the field. After completing teacher education programs, these teachers could be tracked for at least two years into their teaching practice. The overall purpose would be to examine the match between what these teachers were taught, what was expected of them, the successes and dilemmas they faced in attempting to put what they had learned into practice in the primary schools, and how they actually teach after several years of practice.

Seventh, research is needed to explore science knowledge acquisition in primary school science teachers. Through a study involving pre- and post-test assessment, it would be possible to discover the levels of scientific knowledge held by teacher candidates before entering teacher training colleges. Later, these teacher candidates could be tested to determine the level of science knowledge acquired during the teacher preparation program. This would address the question of what scientific knowledge is actually acquired by students in the TTC's. It would also provide a database for understanding the scientific knowledge that is lacking in primary school teachers. Such information could be used to improve science teacher preparation in the TTC's.

Finally, the findings of the current study could be used as the basis for the development of a survey on science teaching that could be administered to a larger number of science teachers. The purpose would be to establish an overall database on methods used in primary science teaching in Malawi. This study was conducted in one education division in the central region of Malawi, and it would be useful if this study could be replicated in other regions of the country. A larger proportion of the population could be studied in the Southern Region. This region is the most densely populated area of the country.

In summary, the most important research questions that now need to be asked to further this research agenda on science teaching in the primary schools of Malawi include:

(a) What are the teaching practices of science teacher educators during teacher preparation programs?

(b) What factors influence a primary school science teacher's decision to utilize available teaching and learning materials in primary school science classrooms?

(c) Why do primary school science teachers in Malawi use specific teaching and learning strategies and process skills in their classrooms?

(d) Which medium of instruction should be most appropriate for teaching primary school science in Malawi?

(e) What are the perceptions of primary school science teachers on the utilization of nature tables in primary school classrooms? Are nature tables actually useful in promoting learning and motivation in science for primary school students?

(f) What connection is evident between what primary school science teachers are expected to learn, what they are taught, and how they actually teach in their classrooms over the span from pre-service teaching, to beginning teaching, to teacher education, and into the practice of teaching?

(g) What science knowledge do primary school teacher candidates possess before and after teacher preparation programs?

(h) What are the most common instructional methods of science teaching in Malawian primary schools, and why?

## Background of Teacher Preparation Programs and Malawi's Vision for the Future

The Malawian government has tried to reduce the shortage of trained primary school teachers by: (a) construction of more teacher training colleges, and (b) the development and implementation of a variety of teacher training programs. This section highlights some of the innovative Malawian teacher training programs in the past 20 years (since 1987). Current plans for the future will also be discussed briefly. It should be noted that before Malawi attained independence in 1964, TTC's were run by missionary groups such as: (a) Catholic missionaries, (b) Dutch Reformed missionaries, (c) Established Church of Scotland missionaries, and (d) the Free Church of Scotland. Although each group of missionaries had its own school curriculum to

suit its needs, all of their education systems emphasized reading, writing and arithmetic, commonly referred to as "the 3 R's." After independence, the missionaries started working hand in hand with the government to develop one common curriculum in all TTC's so that teacher candidates could work in any part of the country regardless of religious affiliation.

The missionary approach to teacher preparation was the two-year "normal" teacher education program. This program existed prior to independence and continued until approximately 1993. In this program, student teachers attended residential courses full time in the teacher training colleges that were available at the time. Besides course work, teacher candidates had placements in local schools for six weeks of teaching practice in the first year, as well as in the second year before writing examinations.

Between 1987 and 1993, two programs existed simultaneously, the two-year Normal school teacher preparation program and a "Special One-year Program." The one-year program was introduced at Domasi Teacher Training College, one of the TTC's in the southern part of Malawi. The objective of this program was to train all untrained teachers already teaching in the field. These untrained teachers only had one year of teacher preparation, and this was a new approach in Malawi. Their curriculum consisted of one-third content and two-thirds pedagogy. Toward the end of this one-year program, teacher candidates had six weeks teaching practice before writing final exams.

Next, the Malawi Special Teacher Education Program (MASTEP) was introduced (1990-1993). This was a three-year education program. Teacher candidates attended residential courses during school breaks (holidays) and through self-study of content materials while teaching in the field. Students wrote final exams at the end of the MASTEP program.

When MASTEP ended, a modified version of the "normal" teacher training program was put in place. In this program, teacher candidates entered a TTC after teaching for at least one year in schools. These students studied at college for only one year before writing final examinations.

In 1994, the Malawi Integrated Teacher Education Program (MIITEP) was implemented. Its aim was to train 22,000 untrained teachers within three years. MIITEP was launched to solve the problem of the shortage of teachers as a result of the introduction of free primary education, which raised primary school enrolment from l.9 million in 1993/94 to 3.2 million in 1994/95. Although MIITEP was designed to handle six cohorts of 3,000 students, in reality, 12 cohorts

went through this program. All of the participants in this study had been through MIITEP training. The design of this program consisted of residential courses, zonal courses, self- study courses and teaching practice as discussed earlier in Chapter 4.

As MIITEP was phased out, the Initial Teacher Education Program (ITEP) began. In September 2005, ITEP was put in place, and it was a modification of the MIITEP program. In this program, teacher candidates are trained in the teacher training colleges for one year, after which they write examinations before going for teaching practice in the second year. To intensify supervision of teacher candidates in the field, plans are underway to identify and train mentor teachers who will work together with the PEA's. Several researchers have noted that mentor teachers are believed to influence teacher candidates' (a) work socialization, (b) feelings of career satisfaction, (c) philosophies of teaching, and (d) instructional practices (Achinstein & Barrett, 2004; Britzman, 2003; Kelchtermans & Ballet, 2002; Seperson & Joyce, 1973). Thus, it is expected that using trained mentors with teacher candidates in the field will enhance teaching development for the ITEP students. The syllabi have been developed and the program is in place, and instructional materials such as student teacher's handbooks are being prepared and distributed while students are in the program. The syllabi and student teachers' handbooks are being developed at the Malawi Institute of Education, a curriculum development center in Malawi.

It is my expectation that the ITEP program will take into consideration the strengths and weaknesses of the previous teacher preparation programs. In addition, the new program should implement the expectations for the primary curriculum reform recommended by the PCAR project. PCAR requires a systematic, in-depth evaluation of teacher education programs such as the former MIITEP.

There will be a continuing need for well-trained primary teachers in Malawi, and it is essential that program evaluation and research be conducted over the years to provide a database for improving teacher preparation. In the past, program evaluation and research has not been extensive, systematic, and longitudinal across the teacher training colleges and a great number of the primary schools. In order to serve the needs of the children of Malawi, more systematic and in depth assessment of the training of teachers is necessary.

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## APPENDIX A

Kasungu TTC,
P/Bag 23,
Kasungu.
31st October, 2003.

The Secretary for Education,
Ministry of Education, Science and Technology,
P/Bag 328,
Capital City,
Lilongwe 3.

Cc: The Chief Methods Advisor, Min. of Education Science &Technology,
P/Bag 328,Capital City, Lilongwe 3.
: The Acting Director, Dept of Teacher Education, Box 215, Lilongwe.
: The Divisional Manager, Central Eastern Division, Box 233, Kasungu.
: The Divisional Manager, Central Western Division, Box 98, Lilongwe.
: The Divisional Manager, South Eastern Division, P/Bag 48, Zomba..
: The Principal, Lilongwe Teachers College, Box 40064, Kanengo, Lilongwe 4.
: The Principal, St Joseph Teachers College, Box 11, Bembeke, Dedza.

Dear Sir,

PERMISSION TO CONDUCT RESEARCH IN SOME TEACHER COLLEGES AND PRIMARY SCHOOLS

I would like to get permission to collect data from science teacher educators in Central Western Division and some beginning primary school teachers in Central Eastern Division and/or South Eastern Division.

I am a doctoral student majoring in Science education at Virginia Polytechnic and State University in USA. My dissertation topic is "The influence of science teacher preparation

programs on instructional practices of beginning primary school teachers in Malawi. I have all the hope that the findings of this research will help improve pre-service and in-service teacher preparation in Malawi.

I would appreciate if this letter is considered.

Yours faithfully,

Wotchiwe M. Kalande.

## APPENDIX B

27th January 2004

FROM: : The District Education Manager,
P.O. Box 38,
Kasungu.

TO: : All Head teachers Concerned

**LETTER OF INTRODUCTION**

The bearer, Wotchiwe M. Kalande, is conducting research on Science Teaching in Primary Schools.
You are therefore requested to cooperate and assist her, as per her requirements.

Christopher M. Kumikundi
District Education Manager

## APPENDIX C

VIRGINIA POLYTECHNIC AND STATE UNIVERSITY

**Informed Consent for Participants in Research Projects Involving Human Subjects**

**Title of project:** The influence of Science Teacher Preparation Programs on Instructional Practices of Beginning Primary School Teachers

**Investigators**: Wotchiwe M. Kalande
Josiah Tlou

**I The Purpose of the Project:**

This study examines the degree to which instructional practices of three-year beginning primary school teachers are aligned with the preparation they received in teacher education

**II Procedures:**

Participants for the study will be six beginning primary school teachers with three years of teaching experience recruited from primary schools in both rural and urban settings, and three science teacher educators recruited from teacher colleges. Beginning teachers will be asked to complete a self assessment form before being interviewed for one hour and observed four times. A brief post-observation interview will follow.

Science teacher educators will only have one-hour face- to- face interviews

**III. Risks:**

There are no risks to the participants as a result of their participation in the study.

**IV. Benefits of this Project**

There are no specific benefits for participants as a result of participating in this study. However, this study will contribute to the understanding of similarities and differences that exist in the current teaching of science in Malawian primary schools in relation to how teachers are prepared in teacher colleges.

**V. Anonymity and Confidentiality:**

Neither your name or any other personal identifier will be associated with any information you will supply. Pseudonyms will be used at all times. Curriculum developers, science teacher educators, as well as primary school teachers are expected to use the results of this study.

**VI. Compensation:**

There will be no compensation for participation in the study.

**VII. Freedom to Withdraw:**

Participants are free to withdraw from this study at anytime. Participants are free not to respond to any questions that they choose without penalty.

**VIII. Approval of Research:**

This research has been approved as is required by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University, by the Department of Teaching and Learning.

---------- ----------

**IRB Approval Date** **IRB Approval Expiration Date**

IX**. Participant's Responsibilities:**

I voluntarily agree to participate in this study.

X. **Participant's Permission:(**sign one copy and keep the other for your records)

I have read and understood the informed consent and conditions of this project. Any questions that I had about the study have been answered. I hereby acknowledge the above and give my voluntary consent for participation in this study. If I participate, I may withdraw at anytime without penalty. I agree to abide by the rules of this project.

Subject signature----------Date----------

Witness----------Date----------

Researcher----------Date----------

Should I have questions about this research project, I may contact the following:

Wotchiwe M. Kalande, Telephone 08340518 wkalande@vt.edu

Duncan Nyirenda Telephone 01536300 MIE@vt.edu

Mary Alice Barksdale 01-540-231-3166 mab@vt.edu

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Departmental reviewer/Departmental Head/ 01-540-231-3166 mab@vt.edu

Daisy Stewart, Telephone 01540231-5347 daisys@vt.edu

Office of Research Compliance

Research and Graduate Studies

Virginia Tech, Blacksburg, V.A.29061, USA.

## APPENDIX D

### Self assessment form

Name of teacher (*use pseudonym)*…….

Teaching school……

Teaching class……..

Date……..

Time…….

Over the past term (semester) how often did you present to students the following process (scientific) skills in science lessons? ***Please tick the column that applies to you.***

| Process skills for students' engagement. | Not Done | Rarely Done | Sometimes Done | Frequently Done |
|---|---|---|---|---|
| Observation | | | | |
| Measuring | | | | |
| Inferring | | | | |
| Making models | | | | |
| Classifying | | | | |
| Investigating | | | | |
| Predicting | | | | |
| Interpreting | | | | |
| Communicating. | | | | |

## APPENDIX E

### Interview protocol questions for primary school science teachers.

Time of interview:

Date:

Place:

Interviewee:

Questions:

1. What experiences did you have in your science teacher preparation program that you recall as particularly meaningful, useful or applicable to your teaching?
2. How should science be taught in primary schools?
3. Which teaching strategies do you commonly use in your lessons? Why?
4. Describe a typical science lesson
5. Which process skills do you concentrate on and why?
6. Which process skills are most difficult to teach and why?
7. What are other things that make it difficult to teach science in this school context?
8. What similarities / differences are there between college science teaching practices that you experienced and your current teaching?
9. What would you wish should improve in science teacher preparation program?
10. What other comments would you like to share?

.

## APPENDIX F

### Interview protocol questions for science teacher educators

Time of interview:----------

Date:----------

Place:----------

Interviewee:----------

Questions:

1. What experiences do you provide in your science teacher preparation program that you recall as particularly meaningful, useful or applicable to your teaching?
2. How should science be taught in primary schools?
3. Describe a typical science lesson.
4. Which teaching strategies do you commonly use in your lessons? Why?
5. What are other things that make it difficult to teach science in this college context?
6. Which process skills do you concentrate on and why?
7. Which process skills are most difficult to teach and why?
8. What similarities/ differences are there between college science teaching practices and current teaching practices you observe in schools?
9. What would you wish should improve in Science teacher preparation program?
10. What other comments would you like to share?

**APPENDIX G**

Class observation checklist

Name of teacher……..School……

Title of lesson……

Date……Time…….

| **Process skills for students' engagement.** | **Tick the skill applied during the lesson** | **Comments** |
|---|---|---|
| Observing | | * |
| Measuring | | |
| Inferring | | |
| Making models | | |
| Classifying | | |
| Investigating | | |
| Predicting | | |
| Interpreting data | | |
| Communicating/reporting | | |

**space for comments was increased during actual data collection*

## APPENDIX H

### Post-classroom observation interview

1. How do you think the lesson went? (How was the lesson?)
2. What did you like best about the lesson?
3. Were there any ways in which the lesson was different from what you had planned? (Explain.)
4. What is the next step for this lesson?

## APPENDIX I

MIITEP pedagogical goals for primary science teachers that were either directly observed (O), or that the teachers stated they used during the interviews (I), or not observed or mentioned at all (X).

| **MIITEP Pedagogy goals for Primary Science Teachers** | **Stephen S5** | **Thokozani S5** | **Chidecha S6** | **Jim S6** | **Bob S7** | **Marvin S7** |
|---|---|---|---|---|---|---|
| ***Scientific Skills and Attitudes*** | | | | | | |
| **The teaching of The scientific skills of:** | | | | | | |
| Observing | O, I | O, I | O, I | O, I | O, I | O, I |
| Measuring | I | I | I | I | I | I |
| Inferring | X | X | X | X | X | X |
| Predicting | X | O, I | O | O | O | O |
| Classifying | O | O, I | O | O, I | O | O, I |
| Interpreting data | O | I | O, I | O | X | O |
| Recording | O, I | O, I | O, I | O, I | O, I | O, I |
| Communicating/reporting | O, I | O, I | O, I | O, I | O, I | O, I |
| **Demonstration of scientific attitudes of:** | | | | | | |
| Interest in science | O, I | O, I | O, I | O, I | O | O |
| Enthusiasm about teaching science | O, I | O, I | O, I | O, I | O, I | O, I |

| | | | | | | |
|---|---|---|---|---|---|---|
| Creativity in teaching science | O | X | O | O | O, I | O, I |
| *Practical Work* | | | | | | |
| Modeling for pupils | O, I | O, I | O, I | O, I | O, I | O, I |
| Engaging pupils for problem solving | O, I | O | O | O, I | O | O, I |
| Taking pupils into the local habitat for science study and observation | O, I | O | O | I | I | O, I |
| Collecting science materials for display | O, I | O | O | O | O, I | O, I |
| Engaging pupils in recording scientific information for reporting | O, I | O | O, I | O, I | O | O, I |
| *Science corner and Nature table* | | | | | | |
| Science corner present in the classroom | O | O | O | X | O | O |
| Nature table present in the classroom | X | X | X | X | X | X |
| *Improvisation in Science and Health Education* | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| The use of improvised materials from the environment in science lessons | O | O, I | O, I | O | O | O |
| *Storage and Care of materials* | | | | | | |
| Evidence that the teacher stores and cares for science instruction materials | X | X | X | X | O | O |
| *Science schemes and records of work* | | | | | | |
| Evidence of teacher preparation of schemes of work for science instruction | O, I | O, I | O, I | O, I | O, I | O, I |
| Evidence of teacher preparation of records of work following instruction | O, I | O | O, I | O, I | O | O |
| *Science and Health Education lesson planning* | | | | | | |
| **Planning for Instruction that includes:** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Objectives | O | O | O | O | O | O |
| Materials | O, I | O, I | O, I | O, I | O, I | O, I |
| The instructional time and venue | O | O | O | O | O | O |
| Instructions for the activity | O, I | O, I | O, I | O, I | O, I | O, I |
| Information on how students will gather data | O, I | O | O | O, I | O | O, I |
| Provides lesson conclusion | O, I | O, I | O, I | O, I | O, I | O, I |

**APPENDIX J**
**Curriculum Vita**

**A) Personal details**

**Surname name**: Kalande

**First name**: Wotchiwe **Sex:** Female

**Maiden name**: Mtonga **Number of children:** 1 plus 4 Orphans

**Marital status:** Single

**Date of birth**: 31st May 1959

**Place of birth:** Mzimba **District**: Mzimba

**Nationality:** Malawian

**Religious Denomination**: Presbyterian (CCAP)

**Village**: Ehlambeni **TA**: Chindi **District**: Mzimba

Malawi

| **Contact address**: | **Home address:** |
|---|---|
| Domasi College of Education,<br>Box 49,<br>Domasi.<br>Malawi | Vwirani Rest House,<br>Box 51,<br>Mzimba<br>Malawi |
| Tel: 01536255 (office)<br>01536509 (Home) | Tel 01342325 |
| Email: wkalande@vt.edu | |

**B) Educational and professional qualifications**

| **Level** | **Place** | **Year** |
|---|---|---|
| PhD in Curriculum and Instruction (Science Education) | Virginia Polytechnic Institute and State University (USA) | 2006 |
| Masters degree in Education | University of Bristol (UK) | 1997 |
| University Certificate in Primary Education (UCE) | University of Malawi (Chancellor College) | 1986 |
| Diploma in Agriculture | University of Malawi (Bunda College) | 1979 |

**C) Work experience**:

| Job Title | Place of work | Period | Number of years |
|---|---|---|---|
| Lecturer | Domasi College of Education (Malawi) | 2004-2006 | 2 |
| Lecturer | Kasungu Teachers' College (Malawi) | 1997-2004 | 7 |
| Lecturer | Mzuzu Teachers' College (Malawi) | 1987-1997 | 10 |
| Teacher | Mzuzu Government Secondary School (Malawi) | 1986-1987 | 1 |
| Teacher | Mzimba Secondary School (Malawi) | 1980-1986 | 6 |
| Accounts clerk | Agricultural Development and Marketing Corporation (Malawi) | 1979-1980 | 1 |

**D) Other contributions**

- Head of Science Department (1981-1983)
- Assistant examiner for Malawi National Examinations Board (1982-2000)
- Writer of the Primary School Teaching Syllabi and Teachers' guides for Agriculture (1987-1991)
- Member of Agriculture Syllabus Committee (1988-1990)
- Core Trainer of Primary School Science under Malawi Teacher Training Association (2005-2006)
- Member of the College Appeals Committee (2005-2006)