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Knowledge Base for Teaching Primary Science in Jamaica

by

Lena Swire-Walton ©

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Abstract

The intent of the study was to understand through stakeholders' perspectives what knowledge base for primary science teaching was offered and/or should be offered to prospective primary teachers in Jamaica. The study explores the views of internal Jamaican stakeholders of the *Science Education Course* and examines the *Science Education Syllabus* to gain insights into suggestions regarding further development of the current *Science Education Course*.

This qualitative study employed a constructivist-interpretivist orientation. Participants for the study included two Joint Board of Teacher Education (JBTE) appointees, one university lecturer, five college lecturers, six primary school teachers, and four prospective teachers from rural and urban schools and colleges. Data were collected through semistructured interviews, field notes and informal conversations, and document analysis of the *Science Education Syllabus*. The interviews focussed on participants' experiences and observations regarding science teaching in primary schools and the *Science Education Course*, which is offered by Jamaican teachers' colleges.

Interview transcripts were analyzed to determine commonly held perspectives and any issues warranting further attention. The syllabus was examined in relation to the findings from the interview analysis. Findings included limitations of the current *Science Education Course*, and suggestions were made for further development.

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CHAPTER 1

INTRODUCTION AND BACKGROUND TO THE STUDY

In 1991 the government of Jamaica proposed a reform of primary education (Task Force on Education [TFE], 1991) to address some major concerns regarding the primary school[1] curriculum and the quality of primary teachers. The document produced by the Task Force on Education (1991), *A Five-Year Development Plan for Education*, identified the quality of teachers as one of the most compelling issues which required attention in Jamaica. Consequently, a review of the curriculum for teacher education was slated to be a part of the reform of primary education (TFE, 1991). In February 1993 the World Bank also issued a report, *Caribbean Region: Access, Quality, and Efficiency in Education*, in which primary education in the Caribbean region was described as nothing short of a fiasco. The report suggested that factors impeding the achievement of desired outcomes of primary schooling included "inadequately trained teachers in mathematics, language and science" (p. 76). To improve primary schooling in Jamaica, five main areas were targeted for intervention (World Bank, 1993). One of these areas was teachers' effectiveness at implementing the intended curriculum. The quality of primary school teachers, which was a major concern of the World Bank (1993), had already been targeted for improvement by the Jamaican government in 1991. The Ministry of Education project that was undertaken to revise the primary school curriculum is now in its final stages; the reviewing of the primary teacher education curriculum should begin shortly. This study is concerned with the primary *Science Education Course*, which is a part of the primary education curriculum for prospective teachers.

An exploration of the literature has shown that teacher education programs are increasingly seeking to offer prospective teachers diverse opportunities to hone the skills

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[1] Primary schools in Jamaica are public schools for children aged 6 to 12 years.

and knowledge that are relevant to the changes that occur in school classrooms (e.g., Darling-Hammond & Cobb, 1996). Jamaica's teacher education program was last reviewed during a major *rationalization period*, 1985 to 1989, when changes in the content and structure of course syllabi were made (Joint Board of Teacher Education [JBTE], 1989). The existing course syllabus for *science education* has not been revised since then. Moreover, perspectives concerning what knowledge might be essential to teaching science in primary school have not been explored from the standpoint of Jamaicans. There is also a paucity of research concerning the influence of Jamaican *Science Education Courses* offered by teachers' colleges on the teaching of science in primary schools. The Jamaican context therefore has remained unexplored in the literature.

My career as a teacher educator started at a teachers' college in rural Jamaica, where I was employed to teach *Science for Living*[2] to Year 2 students[3] and *Human and Social Biology* to precollege students.[4] Although I had attended a Jamaican teachers' college, it was not an easy task to learn the norms associated with being a college lecturer. Upon accepting the position of science lecturer, I was given a syllabus for each of the courses that I was going to teach. It was at this time that I began to discover other aspects of Jamaican teacher education, aspects that, as a student, I did not experience.

During my first year as a lecturer, I reflected on the contributions I had made to the education of those prospective teachers whom I taught in the *Science for Living*

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[2] A science course which introduces prospective teachers to scientific concepts. It is taken by all prospective primary school teachers in the first year of the three-year college program. *Science for Living* is a ninety-hour course covering six units: Measurement, Matter, Basic Materials for Maintaining Life, Energy in the Community, The Physical Environment, and Living Things in the Environment.

[3] Those prospective teachers who are in the second year of the three-year college program.

[4] Sometimes referred to as *preliminary-year* students. Those persons who have applied for entry to teachers' college, but have not matriculated, are invited to spend one year in college working towards matriculation. At the end of the year, students do subjects at the CXC or GCE O'Level. If they are successful, they move into the first year of the Teacher Education Program. The preliminary-year program, which was fully funded by the government, was discontinued in 1996.

course, and I was dissatisfied. I had been keeping a personal journal in which I occasionally entered my reflections regarding experiences and concerns about my new job. I wrote in my journal:

> The second year students seem to be progressing nicely in terms of their coursework grades, except for . . . . I am pretty sure students are on target from what I have seen in the past papers. I am not in the least worried about getting a good pass rate [less than 10% failure in the overall group]. One of my worries is with their [all the students'] attitude towards science. But most importantly, I am concerned that they do not seem to be getting what it takes to be good primary school teachers. I cannot pinpoint what it is that they need to have but I do know from my heart that something is lacking. Then again am I in a position to do anything about it even if I knew what it was? (April, 15, 1993)

I believe that this journal entry was the first time that I recognized how concerned I was about the teaching knowledge that prospective teachers required from a teacher education program as they prepared to become primary school teachers. This study is one phase in my endeavor to contemplate the possibilities of a knowledge base for prospective teachers to help them make sense of the teaching of science in Jamaican primary schools.

The Research

The intent of the study was to understand, through stakeholders' views, what knowledge base for primary science teaching was offered and/or should be offered to prospective primary science teachers. The results of this exploration were used to generate possibilities for a knowledge base for a primary *Science Education Course*. The suitability of a knowledge base that provides appropriate teachers' knowledge for a Jamaican context was a central concern of this study. The perspectives of stakeholders were explored, and documents relevant to teacher education were analyzed to generate possibilities for a knowledge base. The research did not seek to enter into evaluation or altercation with participants' perspectives, but rather to examine and reflect on these perspectives. Throughout the research I have juxtaposed, as far as possible, the various perspectives so that each perspective may be recognized and eventually lead to a new level of understanding, both for my audience and for myself. I entered into the research with several questions, but central among these are the two research questions I have stated here.

Research Questions

The following questions will guide this research:

1. How does the current *Science Education Course* for Jamaican prospective teachers contribute to knowledge for teaching primary science, according to internal stakeholders?

2. What knowledge for teaching primary science should a revised *Science Education Course* provide for prospective Jamaican primary teachers, according to internal stakeholders?

Data collection included interviews and document analysis. All prospective participants who were interviewed were involved in educating primary teachers to teach science or had taken the primary *Science Education Course* which is offered in Jamaican teachers' colleges. Documents analyzed included the existing *Science Education Course Syllabus* for prospective primary teachers, policy documents related to primary science education, and other suitable documents that were suggested or provided by participants. The participants and documents are described in further detail in the methodology.

The data collection for this study was recursive. Because the literature review does not reflect the Jamaican context, a preliminary analysis of the *Science Education Syllabus* provided the context for initiating discussions during the interviews. There was an initial interview which provided an overall picture of the participants' experiences and perspectives relating to the primary *Science Education Course* for prospective primary teachers. Issues raised and not elaborated on by participants in the initial interview were addressed in a follow-up interview and in informal conversations. The follow-up interviews and informal conversations were also used to explore issues that were raised by other stakeholders. This approach to data collection was considered recursive, because each step provided directions for the next step, and each step was used to address and readdress issues of importance. This approach was also important as a means for providing detailed descriptions of the participants' perspectives.

Significance of the Study

This study provided an opportunity to raise questions about a knowledge base for Jamaican primary science teachers. Because this research was done within the context of a developing country and within a specific content area, the findings should be of interest to researchers who have explored theories of a knowledge base for teaching in general teacher education in developed countries.

There is currently a paucity of research literature regarding the preparation of primary science teachers in Jamaica. Brown (1992) observed that little research has been conducted with teacher educators and prospective teachers in Jamaica. Additionally, Newton (1995) suggested that the paucity of research in the Caribbean region is the result of the economic status of countries in the region. Consequently, these developing countries, including Jamaica, rely on research findings and theories generated in developed countries when decisions are made for directions in education (Newton, 1995). This research will add to the pool of research in science teacher education from the standpoint of a developing country.

During meetings of the Board of Studies for Science, research to support and inform decisions regarding teacher education was identified as one area that was in need of urgent attention (minutes of meeting for January 7, 1994, and September 4-6, 1996). A research committee consisting of science teacher educators from the different Jamaican teachers' colleges was formed in 1994. Subsequent support for this committee, however, was minimal; and by 1996 there was still no report of research initiatives or even meetings of the committee. This research provided possibilities which teacher educators may consider when making decisions about teaching and when reviewing *Science Education Courses* for prospective primary teachers. In addition, the findings suggest emphases for planning and facilitating professional development sessions for primary teachers and teacher educators.

Part of the initiative by the JBTE to improve the status of primary teacher education in Jamaica was the creation of the special Canadian International Development Agency (CIDA) project, in which I am a participant. My proposed study provides a means to initiate discussion on issues and concerns about primary science teacher education. These discussions will, in turn, contribute to the impending review of syllabi for primary science teacher education courses which will result from the current revision of the primary school curriculum, mentioned earlier (page 1).

Assumptions

I entered into the research with two groups of assumptions. The first group of assumptions is related to the focus of the study. After several years of learning about teaching by being taught by teachers from primary through high school, prospective teachers enter teachers' colleges with expectations and beliefs formed from the standpoint of a learner (Barnes, 1989; Clarke 1988, as cited in Young, 1992; Lortie, 1975). My assumption is that it is the teacher educator's role to provide the circumstances through which prospective teachers can hone and develop the basic aspects of knowledge required for teaching science. This knowledge for teaching should be representative of standards established by the professional community of science teacher educators and should be congruent with the classroom context in which teachers are expected to function after leaving college. If teacher educators are to assist prospective teachers in developing a basic foundation of knowledge for teaching science, we first have to identify what the types of knowledge are and then clarify how to incorporate them into a science education program. This research was aimed at discerning and describing what stakeholders view this basic foundation of knowledge for teaching science to be.

The second group of assumptions relates to the perspectives of professionals. I believe that there are multiple perspectives within and among the stakeholder groups that I am proposing to study. I also believe that these perspectives are important to consider when designing courses in teacher education.

Bringing Meaning to the Use of the Terms *Stakeholders* and *Perspectives*

Connelly and Clandinin (1988) applied the term *stakeholders* to "persons or groups of persons with a right to comment on, or have input into, the curriculum program" (p. 124). Although the stakes may vary from one group to another, their perceptions and comments are important in the shaping of the curriculum (Connelly & Clandinin, 1988). "Stakes in science education are held by students, teachers, parents, school administrators, the scientific community, industries and many other groups and institutionso (Orpwood, 1985, p. 480).

Orpwood (1985) further divided stakeholders into two groups:

- Internal: those who are accountable by virtue of their affiliation with the ministry of education. Data for this research will be collected from this group of stakeholders.
- External: those who are not politically accountable but have interest in the input and output of the curriculum programs (p. 480).

The perspectives of stakeholders are important to my research because their particular points of view developed as a result of their relationship with primary science education over a period of time. Through their affiliation with science education in Jamaica, participants' perspectives concerning future directions for science education are also important in this research. I had anticipated that, because participants would have had diverse experiences within the Jamaican context of teacher education, they would have formed different viewpoints and would have had different expectations across and within stakeholder groups.

Schutz (1962) developed the premise that the meanings that constitute "common-sense knowledge" of the world are based on experiences within the world. If one agrees with this premise, meanings that result from experiences should be examined within the context in which the experience is formed. Additionally, if knowledge is grounded in social existence (Schutz, 1962), then when factors related to human experiences change, ideologies and perspectives should change.

According to Schutz (1962), individuals orient themselves within the world of everyday life so that they can make sense of situations. To develop orientations, individuals carry out subjective interpretations (p. 25). An individual's orientation is therefore determined by elements of subjective experiences that direct, focus, and enable interpretations of the world.

Part of the common-sense world consists of social interaction with members within and across various groups. The most concrete form of social interaction is through verbal communication (Cox, 1978). In group organizations, the degree to which individuals' perspectives and relevance systems (possibilities of future practical and theoretical activities) overlap determines group membership. Individuals with overlapping perspectives are considered to be members of an "in-group" (Schutz, 1962, p. 348). Members of the in-group accept socially approved knowledge.

There is a connection between Schutz's (1962) argument and this study. Participants within the group of educators and, more specifically, within subgroups of prospective teachers, teachers, lecturers, professors, and policy administrators will have developed their perspectives about the *Science Education Syllabus* through their subjective experiences. Perspectives would also have been developed through interaction within and between subgroups. Participants within and across subgroups may therefore have perspectives that are congruent with their groups (in-group perspectives). On the other hand, through further socialization outside of the context of their groups, persons within an in-group may have developed some differences in perspectives. These multiple perspectives will produce a dialectic situation that requires negotiation before decision making can occur.

Opening up the Idea of a Knowledge Base for Teaching

According to Corrigan and Haberman (1990), a knowledge base is an essential characteristic of any profession. Knowledge is developed and negotiated within the professional community for which the knowledge is intended (Kuhn, 1962). Shulman (1986, 1987) raised issues concerning a knowledge base for teaching. He posited that a balanced blend of content knowledge and pedagogical knowledge is useful for teaching and is used by teachers. He argued that "mere content knowledge is likely to be as useless pedagogically as [are] content free skills" (p. 8). Consequently, Shulman (1987) categorized a minimum knowledge base for teaching to include

- content knowledge
- general pedagogical knowledge: those broad principles and strategies of classroom management and organization that appear to transcend subject matter
- curriculum knowledge: grasp of materials and programs that serve as tools of the trade for teachers
- pedagogical content knowledge: amalgamation of content and pedagogy that is uniquely the province of teachers, their own special form of pedagogical understanding
- knowledge of learner and their characteristics
- knowledge of educational context, ranging from the workings of the group or classroom and the governance and financing of school districts, to the character of communities and cultures

- knowledge of educational ends, purposes, and values, and their philosophical and historical grounds (p. 8).

The knowledge base for teaching proposed by Shulman (1987) was an appropriate starting point for considering a knowledge base for science teacher education in Jamaica. This led to a preliminary analysis of the *Science Education Syllabus,* which indicated that some aspects of Shulman's knowledge base for teaching were represented in the syllabus. Understandably, the aspect not represented was science content knowledge. This aspect of Shulman's knowledge base was covered by another course, *Science for Living*, which is a prerequisite to the *Science Education Course*.

Based on the preliminary finding about the focus of the syllabus, I decided to allow participants' perspectives to provide direction for the remainder of the research. The nature of the research allowed for conceptions of a knowledge base to emerge from the perspectives of participants and the themes and emphases of the documents, which will be analyzed in the research. By taking this approach, I am able to describe possibilities for a knowledge base that is more specific to the Jamaican milieu. The background to the study presented in the next section gives an overview of the Jamaican milieu and provides a basis for locating participants as stakeholders within the system of teacher education.

Background to the Study

The Jamaican Context

Jamaica emerged out of British colonization with many of the British educational traditions still in existence. The structure of the education system, the assessment of achievement, syllabi, textbooks, and teacher training were all derived from our British ancestry (Miller, 1995). Since the 1962 to 1966 reforms, Jamaican teacher education has been one sector of education that has tried to sever its bonds with British traditions and take on a different character from that of its colonial past. The training of primary school teachers in teachers' colleges was later expanded to involve secondary school teachers, and the number of teachers trained and courses offered was increased (Miller, 1995; Whyte, 1985). During this period of reform, the three-year in-college training program was changed to the two-year in-college plus one-year internship program. It was the beginning of a new era for teacher education when in 1962 the University of the West Indies (UWI), in its fifth year of existence, became a new stakeholder in teacher education and was given the responsibility of certifying teachers (Miller, 1995).

The Teacher Training Board, through the Ministry of Education, conducted the certification of teachers prior to 1962 (JBTE, 1993; Miller, 1995). In 1962 the Institute Board of Education attached to the UWI was established as the certifying body for teachers and was later named the Joint Board of Teacher Education (JBTE). The JBTE is currently the body responsible for certifying teachers in Jamaica.

The Joint Board of Teacher Education

The JBTE is a partnership in teacher education. The major partners and their interests (stakes) in teacher education, as suggested in part by the Teacher Certification Regulations (JBTE, 1993) are shown in Table 1.1.

Within its philosophical statement, the JBTE (1993) emphasized its convictions to address, among other areas, (a) teacher competence in skills, content, and pedagogical expertise in their chosen area of study; (b) teacher confidence inside the classroom and in their general public activities; (c) teacher orientation to children, for teachers to show deep concern for the development of children; and (d) professional attributes, including the knowledge of society and its cultural developments.

Additionally, the JBTE (1993) has several functions. Among these are its responsibilities (a) to consider and recommend or approve course syllabi for teacher education, (b) to examine and assess the work of students, and (c) to make recommendations on teacher education to the governments of Jamaica, Bahamas, and Belize (p. 12).

Table 1.1

The Major Partners and Their Interest in Teacher Education (as Suggested by JBTE Regulations of Teacher Certification, 1993)

Major partners	Interests
Ministries of education	Ensuring teachers are trained to cope with and operate in the school systems of each country represented.
Teacher education institutions	Executing the teacher education programs as charged by the Ministry of Education and the government of each country represented.
UWI Faculty of Education	Ensuring that the best available knowledge, critical reflection and creative inputs are brought to bear upon the teacher education exercise.
Teachers' organizations	(Not stated in JBTE document)
Independent community members	Ensuring that teacher education is executed within the interest of the wider society.

The JBTE has tried to ensure that its objectives are achieved by closely monitoring all the courses offered in the teachers' colleges, the assessment of students' achievement, and the professional development of lecturers. One example of this level of supervision by the JBTE is the very structured and common course syllabus for science education that must be used in all colleges offering primary education.

This control that the JBTE exercises over the teacher education program and, consequently, over the course content and the assessment of students' achievement is likely to be a factor that lecturers consider when making decisions related to teacher preparation. Lecturers are careful to prepare students according to course guidelines and suggestions for course work assessment (Lambert, 1998). By so doing, they try to ensure that students will not be at a disadvantage when writing the common examination, which is monitored by the JBTE through appointed external examiners.

The Science Board of Studies

The lecturers and other persons appointed by the JBTE for each subject area that is offered in teacher education form a plenary body called the Board of Studies. All lecturers of science, along with the external examiners who are appointed by the JBTE for each course in science, form the Science Board of Studies, which meets at least twice within each academic year to discuss matters related to science teaching and the assessment of students. Professional development exercises are also undertaken at these meetings. Under the Teacher Certification Regulations of the JBTE, the Boards of Studies are expected to develop and recommend new syllabi or consider amendments to existing syllabi and then submit their recommendations to the JBTE for consideration and approval.

The existing course syllabus for primary science education has been in use since 1990 without amendments. In view of the responsibilities of the Science Board of Studies that are documented in the Teacher Certification Regulations (JBTE, 1993), it is curious that there have been no amendments to a 10-year-old *Science Education Course Syllabus*. How the existing course syllabus contributes to a knowledge base for primary science teachers is therefore of immediate concern.

Overview of Jamaica's Teachers' College Primary Science Education

Children between the ages of 6 and 12 attend primary schools in Jamaica. The development of an organized, well-defined primary science education in the Caribbean followed the period of intense reform in the United States and the United Kingdom from the late 1950s to the 1960s. Before this period, science was viewed as nature study, with walks in nearby fields being the main strategy for science lessons (King, 1995). With the assistance of international agencies such as the World Bank, primary science was reconceptualized, and a more organized science for primary schools was included in the primary curriculum in 1975 and further revised in 1980 (General Education Unit, 1980). The entire primary school curriculum is currently under review.

Teachers' colleges in Jamaica offer three-year teaching diplomas in both secondary and primary education. For the primary education program, all students must take courses in science totaling 135 hours. This primary science program is divided into two courses: *Science for Living*, a 90-hour science content course that was fashioned from the primary school curriculum; and *Science Education*, a 45-hour methods course (JBTE, 1993). The course syllabus for *Primary Science Education* will be a major focus of this research.

Students (prospective teachers) are examined in science education and all other courses through an external examiner who is appointed by the JBTE. Although lecturers of the course are asked to submit possible questions for the examination, the external examiner decides on the content of the exam. The external examiner also provides a marking scheme for each item on the exam (see Appendix A). Lecturers are expected to mark students' (prospective teachers') examination scripts within the framework of the suggested mark scheme. For each course, the external examiner for the course decides the final grades for students.

Teachers' college lecturers in Jamaica are employed with a minimum qualification of a first degree in education or another relevant discipline. For example, a lecturer who has a Bachelor of Science degree in chemistry could be employed by a teachers' college to teach science. This particular lecturer might not be employed to teach *Science Education Courses*, but science content courses. Lecturers of *Science Education Courses* are usually certified teachers with a first degree. Teachers may become certified after completing a college Diploma in Teaching or by completing a Diploma in Education, which is a one-year after-degree program. Each teachers' college employs lecturers as required and on the approval of the Ministry of Education.

The teacher education program in Jamaica is centrally monitored and administered; therefore, decisions made by the JBTE about the characteristics of teacher knowledge to be provided for prospective teachers are guided by the course syllabi. If lecturers adhere to these syllabi, are they satisfied with the knowledge base? What makes them satisfied or unsatisfied? Are other internal stakeholders satisfied with the knowledge base that is purported by this and other supplementary documents? These are some specific questions that will be addressed through research questions 1 and 2 (page 4).

Organization of the Study

Chapter 2 presents a discussion of some theoretical positions regarding teacher knowledge and science education. In this chapter I also discuss my own position regarding science teaching and learning to teach in relation to the theories presented. Chapter 3 provides a description of the theoretical framework for the research. I have also described the methodology employed in collecting and analyzing the data. A list of documents that were used in the study is also presented in Chapter 3. Chapters 4, 5, and 6 present the results of the study. Overall, these three chapters represent a process through which my understanding regarding a knowledge base for primary science teacher education evolved. During this process concerns and questions emerged, and understandings of these initiated further concerns and questions. In Chapter 7 a discussion of the findings is presented, followed by implications. Finally, in Chapter 7 I present my final reflection of the study.

CHAPTER 2

LITERATURE REVIEW

Introduction

In this chapter I will develop and discuss two themes considered to be related to the proposed research. First, some evolving trends in studies on teachers' knowledge will be reviewed, followed by a discussion of issues that I feel influence the development of a knowledge base for science teacher education. Trends in science teacher education are also presented here. Finally in the chapter, I present a summary of the issues explored, as well as my biases regarding science teaching and science teacher education. As a science teacher and a teacher educator in Jamaica, I have developed pre-understandings about science and science teaching which I am bringing to this research. Although most of the literature that has supported the discussion of these issues is not from Jamaica, the research is situated in an international perspective because of my background as a scholar in this Canadian university.

Evolving Perspectives on Teachers' Knowledge

The burgeoning amount of research on teachers' knowledge within the last two decades is an indication of the interest that researchers have in how teachers understand and process the knowledge of teaching (Carter, 1990). Shavelson (1983) reviewed a collection of studies conducted between 1975 and 1980. These showed that the study of cognition in teacher education had increased during this period. The evolving and increased research concerning cognition and teachers' knowledge are based on the assumption that although there is wide variation within teachers' classrooms and among teachers' knowledge about teaching, it is possible to codify in general terms what teachers know that enables them to navigate their classroom territories.

As a result of this increased research on teachers' knowledge, several approaches to knowledge that represent different assumptions, emphases, theoretical frameworks, and methodological commitments have emerged (Carter, 1990). Three approaches to knowledge that have been employed to study teachers have emerged out of a review of earlier research (Carter, 1990). The three approaches, information processing, teachers' practical knowledge, and pedagogical content knowledge, will be outlined below.

Information processing studies are those which focus largely on decision-making processes in the classroom. Studies of teacher information processing that were reviewed by Shavelson (1983) were primarily descriptive and focussed mainly on teacher's judgement, planning, and decision making. Shavelson concluded that although these studies have contributed to the expanding knowledge about how teachers process information in the classroom, further research is needed to relate these findings to teacher education.

Information processing studies have also been reviewed by Clarke and Peterson (1986). The review indicates that these studies provide contrasts between decision-making practices of expert and novice teachers. Shulman (1986) noted that studies emphasizing the search for predictors of teaching effectiveness can be classified as being process-product. As well, in these researches, learning to teach is likely to be viewed as the acquisition of methodological principles and may lead to learning to teach being reduced to the learning of effective techniques for teaching. Moreover, if a model of effective teaching is applied to contrast novice and expert teachers (as in Housner & Geffrey 1985; Peterson & Comeaux, 1987), results lead to broad generalizations about the quality of the existing differences (Carter, 1990) and about principles of effective teaching. According to Carter, these studies add very little to theory concerning how teachers' knowledge develops or how novice teachers can be assisted in their construction of teaching knowledge. Additionally, process-product studies that observe teaching from a standpoint of methodological principles may be promoting teaching as a technical enterprise. Overgaard (1994) argued that the idea of teaching as a technical enterprise is a distortion of the nature of teaching and neglects to consider its moral and social dimensions.

Studies about *teachers' practical knowledge* indicate what teachers know about the actual practice within the classroom context (Doyle, 1983, 1986; Doyle & Carter, 1984; Elbaz, 1987); therefore, the classroom became the context for researching teachers' knowledge. Teachers' practical knowledge refers to the complex, practically oriented knowledge teachers that use to overcome classroom dilemmas that they face (Carter, 1990). This kind of knowledge is used by teachers to shape and direct their activities and helps teachers to take purposeful actions in the classroom setting. Elbaz suggested that there are five aspects of teacher practical knowledge: self, milieu, subject matter, curriculum development, and instruction. Elbaz also posited that teachers operate by using general orienting frameworks that provide images of how teaching should proceed. These images are generated through the teacher's own feelings, beliefs, needs, and values.

Other studies that have presented a basis for advancing information about teachers' practical knowledge include Clandinin (1985) and Clandinin and Connelly (1986), who examined specific teaching episodes to interpret how teachers come to know their classroom situation. These studies present an image of the effects of experience and of the conditions under which teachers use their knowledge. Likewise, Lampert (1985) suggested that teacher knowledge of self and cf students provides a basis for teachers' practical knowledge.

Studies concerning teachers' practical knowledge have provided multiple perspectives and a greater understanding about teachers' classroom activities and experiences. Teachers' voices have become important for substantiating knowledge of how teachers learn by teaching and how teachers utilize knowledge within their classrooms. However, Carter (1990) opined that these studies may not provide a generalized conception of what teachers know or how teachers learn a defined set of knowledge about practice. Additionally, studies about teachers' personal-practical knowledge as pursued by Clandinin (1985) and Clandinin and Connelly (1986) were void of the place of common understandings (norms) and justification of action, which are constitutive of and by the practice of teaching (Overgaard, 1994). Overgaard concluded that although studies about teachers' personal-practical knowledge have recognized the extent to which teaching involves making judgement and the need to consider the specific context in which teachers practice, they have neglected to pursue the idea that knowledge of teaching is constructed within broader historical and social contexts.

In an attempt to determine what teachers know about their subject matter and how they translate that knowledge into classroom curricula events, studies of *pedagogical content knowledge* were initiated (Carter, 1990). The concern raised by Buchmann (1984) about the disciplinary knowledge that beginning and more experienced teachers possessed seems to have been the start of research into teachers' pedagogical content knowledge. According to Carter, what has been learned about the limited pedagogical content knowledge of new teachers has given new life to concerns about teacher education programs. By delineating the categories of knowledge that inform teachers' classroom practices, Shulman (1986, 1987) has initiated greater interest and concern among teacher educators about the types of knowledge that beginning teachers have and require (Carter, 1990). Consequently, many studies into the knowledge base for teachers in different subject matter areas have been launched (e.g., mathematics, Ball, 1990; teacher education, Ball & Feiman-Nemser, 1988; science, Hashweh, 1987). However, when these researches are applied to teacher education, there is the risk of again reducing teaching to a technical enterprise because recommendations resulting form these studies may be easily misconstrued to be recipes to guide action as prospective teachers prepare to enter the practice of teaching.

Feiman-Nemser (1990) and Zeichner and Liston (1990), through historical analyses of trends in teacher education, provided a synopsis of structure/orientations of teacher education which were evident in American teacher education programs up to the 1990s. Historically, five conceptual orientations have been explored in teacher education: critical/social, personal, academic, technological, and practical. Each orientation highlights different issues that must be considered when thinking about teacher education programs. However, Feiman-Nemser suggested that each orientation in itself is insufficient to offer a fully developed framework for teacher education, and therefore teacher education programs have been developed by considering different aspects of each of the orientation.

Notwithstanding the variety of ideas that go into developing teacher education programs, issues regarding the social context of schools, educational equity, and the capability of teachers to deal with the cultural diversity in classrooms have initiated a number of research findings and concerns. The preparation of teachers to teach in culturally diverse classrooms is one that has received a great deal of attention (Gomez 1996; Kennedy, 1991; Liston & Zeichner, 1991; Zeichner, 1996; Zeichner & Melnick, 1996). Arguments raised and findings generated by these educators and researchers have suggested that teacher education programs are having little success in addressing the problems associated with teaching for cultural compatibility because of the effects associated with labeling students according to cultural groups and the nature of teachers' professional development.

The social context of schools has also influenced concerns in teacher education regarding learning. During the 1990s constructivism in teacher education became a central thought among education reformers and educators. The main interest in constructivist teacher education emerged out of its use in pedagogical activities for shifting from teaching as transfer of knowledge to teaching as facilitating human construction of knowledge (Richardson, 1999). Research in teacher education has shown that as a result of the constructivist focus, a variety of instructional strategies are being used to assist students to actively construct knowledge of teaching (Feiman-Nemser & Beasley, 1997; Mayer-Smith & Mitchell, 1997; Richardson, 1999). Some of these strategies include case analysis, constructing and interpreting concept maps, and modeling of teaching. A main consideration within these constructivist-oriented instructional strategies is that the learner be guided into deep engagement with the learning task in order to develop understanding from it. Teacher education students are therefore given the opportunity to test, discuss, and compare various perspectives and approaches to teaching as they learn to teach.

Another focus in teacher education, which is also interwoven into constructivist teacher education, is reflective practice. The concept of reflective practice was advanced by Schon (as cited in Zeichner, 1996) and seems to acknowledge the wealth of information that is a part of the practice of teachers. Therefore, instructional strategies are structured so that the teacher-education students are encouraged to reflect on teaching before, during, and after a lesson. According to Loughran (1997), this engaged reflection on teaching extends the teachers' views about teaching and learning, facilitates risk taking, and helps develop professional identity.

Although considerations of cultural diversity, reflective practice, and constructivism seem to have been the focus of teacher education throughout the past decade, the concern about knowledge for teaching which is required by prospective teachers remains. The question of the kind of knowledge that is provided for and required for primary science teaching is pertinent at this time when Jamaica is about to review its *Science Education Syllabus*. The evolving perspectives on teachers' knowledge that have been discussed in this section indicate that substantial knowledge has been developed in this area. These studies are mainly North American, and therefore these finding may not be directly applicable to the Jamaican context of teacher education. At the same time, the findings from these studies are of significant merit to be considered in this research.

Factors Influencing the Knowledge Base for Science Teacher Education

Schwab (1962) described four commonplaces—the milieu, subject matter, learner, and teacher—which serve as starting points for curriculum planning and evaluation. These commonplaces cannot be discussed separately from one another because each commonplace is interpreted within the context of the other (Connelly & Clandinin, 1988). In this section I will discuss factors that I feel are influential in deciding on a knowledge base for science teacher education. For the discussion I will employ Schwab's four commonplaces as the focal points.

The Milieu

Science education is dependent on goals set by the state and other concerned organizations within and outside of the scientific community (Bybee, 1993). These goals change over time, depending on the priorities and the defined needs of the society. Deboer's (1991) documentation of the debates surrounding the purposes of science in America's public schools shows that some advocates of science have diverse views of what science should provide for students. These changing views have initiated alterations to the purpose of science education and ultimately the knowledge that teachers require to teach science (Brickhouse, 1991).

Societal Influences and Science Education

The Jamaican milieu bears striking similarities to that of the North American context of which Deboer (1991) and Brickhouse (1991) wrote. Similar to North America and the rest of the world, Jamaica has come to place great emphasis on the power of science and modern technology to achieve economic development. The most recent "summary of development issues" that was presented in the Jamaica *Development Plan for Education* document (Task Force on Education, 1991) included a proposal to emphasize several areas for development in education. Among the areas proposed for development were *Science and Technology Education* to "develop action plan for science and technology education to ensure that the education system keeps pace with local and international development in science and technology" and *Environmental Education* to "incorporate environmental issues into the curriculum as appropriate" (p.45).

Although no clear direction for achieving national development was provided in this document, the expectations of science to promote national development has been well articulated. In the document *Science and Technology: A National Policy* produced by the Ministry of Development, Planning, and Production (1990), science and technology were envisioned to be the major contributors to future development of Jamaica. Jamaica is supposed to "harness science and technology" to enhance national development and to secure status within the international context (Ministry paper No. 16, Office of the Prime Minister, 1994). From this document it appears that science is viewed as being able to control the environment and the people and that science is intimately related to technological and societal issues. According to Roberts (1988), when a society adapts such a view of science, it has identified the need to keep from destroying itself. In essence such a society would look to science and technology to provide answers and solve problems. Jamaica is not alone in this search for international status through science and technology. Canada's *Science for Every Student* (Science Council of Canada, 1984) proposed science education that would be appropriate to the future needs of Canadians within the context of worldwide scientific and technological advancements.

The new wave of reform in the United States with its focus on achieving scientific literacy is one prime example of how the science education community reacts to changing goals, philosophies, and priorities of groups (external stakeholders) outside of the immediate circles of education (Collins, 1995; Kirst, Anhalt, & Marine, 1997). Project 2061 by the American Association for the Advancement of Science (AAAS) and the National Science Teachers Association's (NSTA) Scope Sequence and Coordination (SS&C), both advocating major reforms of science education, have surfaced in the United States within the last decade. These main reform efforts are seeking not only to improve performance of students, but also to reshape the image of science education in the United States.

Philosophical Influences and Science Education

There are important questions that educators might want to ask themselves in this context of change in science education: (a) What view of science and discovery will best support the kind of science we wish to foster in science education? (b) What kind of science education will provide the opportunity for students to determine "what is this thing called science?" and (c) "Why is it so important?" Chalmers (1982) used these latter two questions as a basis to discuss, from a historical perspective, the changing and diverse philosophies of science. His discussion brings into focus the epistemology of science as seen through the work of Popper, Toulmin, Kuhn, and Feyerabend among others. These philosophers have provided an avenue for another understanding of the process of scientific discovery and the epistemology of scientific knowledge. Knowledge, according to Chalmers' discussion, is constructed within communities of like-minded people rather than discovered or guaranteed by an objective experimental method.

Although there are many issues that have emerged out of the discussion on the philosophy of science, two have received considerable attention in science education debates. The first is the scientific method, and the second is the nature of scientific observations (Blanco & Niaz, 1997). Making observations and devising methods for experimenting are now understood to be dependent on rather than independent of existing theories and personal biases.

School science can contribute to erroneous views of science when students come to perceive learning of science as memorization, when school science does not relate to everyday life, and when school science is one of individual pursuit (Bardules, 1991). Clemenson (1990) and Blanco and Niaz (1997) have suggested that science educators scrutinize the philosophical underpinnings of their own perspectives of science. Science educators are also encouraged to consider school science as an opportunity for children to construct, reorganize, and negotiate knowledge to arrive at scientists' concepts and theories. Additionally, science educators are also reminded to extend a keener interest in the philosophical and epistemological issues of science because these influence the teaching and learning of science (Clemenson, 1991).

Companion Meaning: Emphases of Science

The milieu provides a basis on which the emphases of science develop and are represented in science teaching. The seven curricula emphases discussed by Roberts (1982, 1998) raise important questions about the implications of societal and philosophical influences on a knowledge base for science teaching. These emphases—everyday coping, structure of science, science technology and decisions, scientific skill development, correct explanation, self as explainer, and solid foundation (p. 246)—were developed inductively from the study of policy statements and textbooks over an 18-year period. According to Roberts (1998), curriculum emphases in science education are messages about science which, along with other companion meanings, serve as a means of socializing students in particular directions. Companion meanings may be implicit or explicit in the curriculum, but however they are stated, they have strong implications for what science means to individuals and how science is both taught in schools and employed in society.

Ostman (1998) expanded on Roberts' theses regarding curricula emphases and suggested that not only views of science are learned in science classrooms, but views of nature are also learned. Science education discourse therefore communicates

- epistemological values: Science is attributed to the character of saying, This *is* the way things are;
- practical-technical values: Science is directly useful in controlling and understanding our interaction with the environment; and
- moral values: Science has a role in deciding how human being should treat the environment.

Teachers are the bearers of scientific discourse in primary school classrooms. They are essentially intermediaries between science and students, and as such they have the job of persuading students about the relevance of science (Osborne, 2000). Osborne explain that the teacher acting as a rhetor persuades students by providing the basic entities necessary for students to develop a scientific worldview. Consequently, there is a widening of the gap between teacher and students, which in turn creates grounds for argumentation in science classrooms. Whereas there may be grounds for argumentation, deliberative interaction that is essential for argumentation is suppressed, consequently dismissing any initiative on the part of students to challenge teachers' claims (Osborne, 2000). The result of this type of science teaching is a view that science says, This *is* the way things are.

Newton (1988) opined that science education should allow students to see the direct relevance of science to their lives. The existence of a connection between science education and a student's needs, aspirations, and expectations imply relevance. How do teachers and curriculum developers determine the connection that exists between science education and future relevance for primary school students? Teacher education programs are faced with providing prospective teachers with a starting point from which to negotiate the pedagogical issues that arise in the primary classroom with regard to what emphases are relevant and appropriate for children.

The Subject Matter

Shulman (1986) suggested that content knowledge refer to the "amount and organization of the knowledge [that is] in the mind of the teacher" (p. 9). To further explain this construct of knowledge, he wrote:

> Teachers must not only be capable of defining for students the accepted truths in a domain. They should also be able to explain why a proposition is deemed warranted, why it is worth knowing, and how it relates to other propositions, both within the discipline and without, both in theory and in practice. (p. 9)

Pedagogical content knowledge, as defined by Shulman (1986), goes beyond the knowledge of content to the dimensions of translating the subject matter content to make it comprehensible to others. He suggested that this is a form of content knowledge that "embodies that aspect of content most germane to its teachability" (p. 9). Pedagogical content knowledge includes knowing the most "powerful" means of representing the subject matter and understanding what makes learning difficult or easy for a student.

Content Knowledge and Science Teaching

Teaching science, especially within the vastly overcrowded classrooms in Jamaica, requires great expertise in knowledge of content, knowledge of managing and translating this content (pedagogical content knowledge) for learning, and knowledge of curriculum materials that relate to this content. Studies have shown that primary school teachers have always been apprehensive (Gabel & Rubba, 1979; Shrigley, 1974) about science teaching. Teachers lack confidence (Yates & Goodrum, 1990) and admit that they avoid teaching science, especially sections related to physics because of their lack of knowledge (Smith & Neale, 1989) and understanding (Kruger, Palacio, & Summers, 1992) in these areas.

Studies such as that of Smith and Neale (1989) have shown that science content knowledge as well as pedagogical content knowledge are important for teacher effectiveness in elementary science teaching, whereas Gustafson and Rowell (1995) reported that lack of knowledge restricted teaching activity and teacher confidence. Appleton (1995) also found that prospective teachers have shown significant gain in perception of knowledge and ability to teach science following a science education unit that provided only a small amount of disciplinary knowledge. The study described by Appleton did not specify the criteria employed in determining whether or how effective these student teachers were in translating this subject matter content during teaching or whether prospective teachers had acquired the kind of subject matter content knowledge that Shulman (1986) advocated. Appleton's research was also not specific about other science content-related courses that could have been a part of the teacher education program.

Researchers (e.g., Duschl, 1983; McDiarmid, 1990) have questioned the implications of providing prospective teachers with subject matter courses before teaching methods courses in teacher education. Questions have also been raised about the effectiveness of these subject matter courses in providing the materials that prospective teachers require in order to meaningfully translate the subject matter knowledge in such a way that children will understand. According to Duschl (1983), prospective teachers who have been exposed to this design of teacher education develop an "antagonistic dilemma," which is a condition characterized by confusion, insecurity, and apprehension when teaching science. Duschl suggested that the difference in the nature of science with which both courses are taught promotes this condition in prospective teachers.

According to Smith (1997), college science may not be well aligned with school science; therefore, a greater knowledge in college science may not always become useful to science teaching when beginning teachers enter the school classroom (McDiarmid, 1990). An alternative that should provide more useful background for science teaching would be a "closer alignment of subject study with curriculum topics and emphasis on linking those to extend their expertise in pedagogical content knowledge" (Smith, 1997, p. 151).

Structure of Subject Matter Knowledge

Using Schwab's conception of the structure of knowledge, Grossman, Wilson and Shulman (1989) suggested that content knowledge within a discipline "emerges through a critical analysis that is guided by both the substantive and syntactic structures of the discipline" (p. 29). According to this framework, the substantive structure of the discipline includes the supporting explanations of how knowledge is arrived at for the discipline. Understanding of the substantive structure of a discipline should help prospective teachers to make pedagogical decisions about how to teach content. This underlying structure of science, how the knowledge of the discipline is achieved, is indicated in Kuhn's (1962) discussion of the nature of scientific revolution. Additionally, the means by which new knowledge is introduced into the field (syntactic knowledge) is also important. This knowledge helps to alleviate the prevailing belief that inquiry in science is more than confined laboratory exercises (Grossman, Wilson, & Shulman, 1989). It helps to define the central role of scientific method in scientific inquiry.

Although teacher education programs might include these knowledge structures in their overall program, each subject area discipline should provide an avenue for presenting these to prospective teachers. According to Driver, Asoka, Leach, Mortimer, and Scott (1994), "The role of the science educator is to mediate scientific knowledge for learners, to help them to make personal sense of the ways in which knowledge claims are generated and validated" (p. 6). The role of the science teacher educator would further involve mediating the knowledge of teaching in terms of the knowledge of science, helping prospective teachers to understand how knowledge claims develop.

In a positivist frame, where knowledge is understood to exist in the world, the curriculum is viewed as a body of knowledge or a collection of skills to be transmitted (Benson, 1989). This view of science as a body of knowledge is considered to be naive when knowledge is considered to be socially constructed. From a social constructivist perspective, the way an individual interprets and makes sense of the world is dependent upon the situation, experience, purpose attached to the process of understanding, and the actual process of coming to understand (Driver & Oldham, 1986). This means that no two individuals have identical methods of devising scientific knowledge or teaching knowledge, but they might have similar interpretations of the knowledge.

The view that learners construct knowledge has implications for curriculum development and curriculum experiences in teacher education. The first is that science knowledge should be partially negotiated among students so that the meaning of multiple ways of coming to know is established. This in turn would have a further implication for the framework of common and core curricula content. According to Darling-Hammond and Cobb (1996), the kind of teaching and teachers that are required to meet demands for thoughtful learning cannot be produced through teacher-proof materials and regulated curriculum. The Jamaican teacher education program currently has a curriculum that is closely monitored by the JBTE. This regulates the certification of teachers and ensures that the teacher who is certified to practice will be competent in knowledge of content, skills, pedagogical expertise and personal qualities (JBTE, 1993).

The Learner

The conventional view that knowledge can be transferred from teacher to learner has been challenged by cognitive psychologists and educators who think that the learner is at the center of an active transaction between teacher, learner, and context (Barnes, 1989). Of the three traditions for explaining learning in educational psychology, the developmentalist, behaviorist and constructivist approaches (Driver, Guesne, & Tiberghien, 1985), the latter has dominated developments in science education within the last decade.

A Perspective of Learning

Jamaica's science education for primary children and prospective primary teachers has attempted to move away from the traditional orientations of teaching science by memorization (JBTE, 1993). In Jamaica the theory of learning shown in the *Science Education Course* is based on Piaget's developmentalist theory (JBTE, 1990; Young, 1979), whereas the approach to teaching science which is shown in the same *Science Education Course* utilizes a process approach (JBTE, 1990; Young, 1979). The process approach is a behaviorist approach to teaching science (Appleton, 1997). This behaviorist approach to teaching science developed as a result of attempts made in the 1960s to provide systematic ways to teach skills that scientists supposedly used in their work. Smith and Neale (1989) provided a profile of the *orientations to science teaching and* *learning*. From this profile, the process orientation of learning science is learning and practicing the steps in the scientific method and the processes of science.

Although Piaget was not considered initially to be a constructivist, one of his major viewpoints was that the learner constructs knowledge. He postulated the existence of cognitive schemes that are formed and developed through co-ordination and internalization by persons in the world (Bruner, 1985). Although Piaget is the theorist who is presented as a part of the *Science Education Syllabus*, the constructivist theory of learning is not included in the Jamaican *Science Education Course* for prospective primary teachers.

The importance of existing conceptions of learners is a common theme of constructivist research programs (Driver, Guesne, & Tiberghien, 1985). Learning is then viewed as conceptual development. Learners are allowed to articulate their ideas and existing views about science, make sense of discrepant events, contrast evidence, predict outcomes, and solve problems as a means of learning. This view of learning and the learner has also been considered within teacher education where the prospective teacher is the learner (e.g., Hoban, 1997; Marrion, Hewson, Tabachnick, & Blomker, 1999; Mundy & Russell, 1995; Summer & Kruger, 1994).

Barnes (1989) opined that when prospective teachers' learning is viewed from a constructivist perspective, there are two significant implications for teacher education. The first is the need for prospective teachers to be involved in planning and instruction and to be given opportunity to learn about pupils' conceptions. The second is that learning to teach must be acknowledged as occurring in the same way as any other learning. Another important aspect of practice that must be included in teacher education is providing prospective teachers with ample opportunities to reflect on their learning to teach and on teaching science (Hewson, Tabachnick, Zeichner, & Lemberger, 1999).

Hewson et al. (1999) found that although a *Science Education Course* was structured around constructivist views to help prospective teachers conceive of teaching and learning from a conceptual change point of view, some prospective teachers still had difficulty creating new conceptual change lessons in their own elementary school classrooms. These in turn suggest the approaches and strategies that should be used with the prospective teacher in the college classroom.

Learner Characteristics

Understanding that a number of factors may influence college learning and learner characteristics is another aspect of Shulman's (1987) knowledge base for teaching. Although prospective teachers need to be aware of the importance of this kind of knowledge, college lecturers must also recognize its importance in their practice. What prospective teachers bring with them to the college classroom will influence how and what they learn. When science teacher educators are aware of students' physical impairments, their cultural background, language, religion, gender, and socioeconomic influences as factors affecting students' learning, they are better able to organize their classroom for academic and social interaction (Barnes, 1989). If teacher educators acknowledge and act on these factors, strong motivational values are promoted. This holds promise for enhanced learning (Newton, 1988).

Cultural influences on students' learning would be one area to concern Jamaican science educators. Hodson (1993) and Stanley and Brickhouse (1994), among others, have raised the issue of the influence of sociocultural factors on the history and development of Western science and use these to question the relevance of Western science to other societies that are rooted in different ideologies. Jamaica is one of these societies that is now grappling with the issues surrounding the teaching of "Western science" and the effects that cultural differences have on children's learning. Jamaica has a rich heritage that reflects the cultural practices and beliefs of British, African, East Indian, Chinese, and Lebanese (George & Glasgow, 1988). The diversity in cultural practices that is found in Jamaica is the result of colonization, the slave trade, and importation of indentured labor to tend the production of sugar. The cultural practices and beliefs of these different groups have been preserved by the people, but until recently were largely ignored by the Jamaican school curriculum. One example of this lack of concern for differences that exist among the Jamaican people stands out in the *Religious Education* curriculum, which emphasizes only Christian principles in public schools.

George and Glasgow (1988) acknowledged the effects of these cultural beliefs and practices on science teaching and learning. This study revealed that cultural beliefs (associated with nutrition, medicine, agricultural practices, reproduction, and childcare) were accepted by secondary school children studied and that there was no questioning attitude toward the findings and explanation of the "truth" about these beliefs (p. 115). The researchers suggested that this accepting nature portrayed by students seemed to deter any questioning of principles learned in school science. Children waited for the teacher to advance the conclusion from any activity that was pursued in class. The research findings suggest that to a large extent children within this cultural context relied on the powers of chosen objects or phenomena for medicinal and agricultural decision making. The study concluded that these cultural practices are likely to make it difficult for children to conceptualize the notion of manipulating variables or to accept the characteristic tentativeness of knowledge involved in learning school science. Children may expect that scientific knowledge should not be questioned, and they are not willing to accept tentativeness of knowledge because this compromises the power of scientific knowledge.

Teaching is a learning profession (Barnes, 1989); prospective and beginning teachers are at the initial stage of the learning process and should be treated as learners. Learners have a host of learning strategies at their command. Teacher educators would do well to "equip learners [prospective teachers] with a menu of possibilities . . . to arm them with procedures and sensibilities that would make it possible for them to use the menu wisely" (Bruner, 1985, p. 8).

The Teacher

"Teaching begins with teachers' understanding of what is to be learnt and how it is to be taught" (Shulman, 1987 p. 7). The Jamaican teachers' college *Science Education Course Syllabus* (1990) does not emphasize the subject matter content. Pedagogical content is the major emphasis, and a portion of the document is dedicated to various approaches and strategies to teaching science (pp. 17-20). These aspects of the syllabus should contribute to teachers' knowledge about how to teach science. The document also identifies the role of the teacher, the contextual constraints to teaching, and the way that children learn as factors that are all essential for prospective teachers to know. These areas are included in the "broad principles and strategies of classroom management and organization" that lie within the realm of Shulman's (1987, p. 8) general pedagogical knowledge. This research is attempting to understand how stakeholders interpret this knowledge of teaching that is suggested in the *Science Education Syllabus* and to what extent this knowledge forms a part of the knowledge base that they consider to be important to prospective teachers.

A View of Teaching

The action of teaching occurs within a social context in which the teacher makes decisions about what and how to teach. Teachers develop their own styles of teaching and will choose particular approaches to teaching different areas of the science curriculum. According to Appleton (1997), there are several approaches to teaching science, and teachers choose the approach most comfortable to them and most suitable for the science topic. Unfortunately, researchers such as Smith and Neale (1989) have suggested that teachers are not willing to use some teaching approaches because of the demands these place on them and because of the extent of their content knowledge.

Scott, Asoko, and Driver (1991) suggested that constructivist oriented teachers make pedagogical decisions at three levels: about the learning environment, about the selection of teaching strategies, and about the selection of learning tasks. Further decision making which is required for selecting appropriate teaching strategies includes the learner, the nature of the intended learning outcomes, the intellectual demands involved for learners, and the teaching strategy that might be most successful in helping students move from their existing ideas to a science view (Scott, Asoko, & Driver, 1991). The entire spectrum of Shulman's (1987) knowledge base for teaching informs these important pedagogical decisions.

Cochran, DeRuiter, and King (1993), although recognizing the work of Shulman (1986), extended the concept of pedagogical content knowledge to include a more explicit constructivist view of teaching and learning to propose their model of *Pedagogical Content Knowing* (PCKg). In this model they emphasized the importance of the "teacher knowing about the learning of students and the environmental context in which learning and teaching occurs" (p. 263). They argued that because constructivism is a theory of *knowing*, it connotes a dynamic process. In contrast, knowledge as interpreted in pedagogical content *knowledge* appears static. Therefore, the constructivist framework of learning to teach should include learning pedagogical content *knowing*. Cochran et al. wrote: "Pedagogical content knowing [of a teacher is the] integrated understanding of four components of pedagogy, subject matter content, student characteristics, and the environmental context of learning" (p. 266).

When this concept of pedagogical content knowing is juxtaposed against teacher preparation, fundamental issues develop. The first is that prospective teachers must learn about teaching children by direct involvement with children. The second is that teacher education programs should be designed to assist prospective teachers to understand subject matter knowledge which is specific to the discipline of teaching and the subject alike, but different from that of the expert of the subject matter. Additionally, teachers must have an understanding of "social political, cultural and physical" contexts that contribute to the teaching and learning process (Cochran et al., 1993).

The seven alternative curriculum emphases that were suggested by Roberts (1982, 1988) indicate that curriculum developers' perspectives shape what and how science is represented in curricula documents. Smith and Neale (1989) also implied that teachers' perspectives about science influence what they teach as science and how they choose to teach science. Furthermore, science educators are now concerned about the meaning of scientific literacy (Eisenhart, Finkel, & Marion, 1996) and the epistemology of science (Bardules, 1997; Clemenson, 1996) which shape the curricular decisions that teachers make. One finding that is important for teacher education is that teachers draw on several types of knowledge simultaneously and weave different kinds of knowledge together as they reason out what to do, how to proceed, and different actions to take during teaching (Feiman-Nemser & Reminald, 1996; McNamara 1994). One implication is that teacher education programs could provide their students with not only the elements to build their repertoire of knowledge for teaching but also the tools to integrate this repertoire of knowledge into teaching.

Teacher educators, researchers, and policy makers are recognizing that understanding more about teachers and teaching that goes beyond the theory of spontaneous teaching (Murray, 1996) is required for clarifying the role of formal teacher education. Because of the absence of dependable theories about teachers' knowledge that can be applied to teacher education programs, policy makers and teacher educators continue to provide formal education for teachers under the traditional structures of content courses, followed by methods courses (Feiman-Nemser & Remillard, 1996). As knowledge about teaching grows, so does the knowledge about how learners, the milieu, and the subject matter influence teachers and teacher education programs.

Summary

I agree with Corrigan and Haberman (1990) that any profession should have a clearly defined body of knowledge and skills common to the practitioners in the particular field. I also believe that this defined body of knowledge must be negotiated and agreed upon within the field among the practitioners. However, my perspective is that whereas studies from regions such as North America have produced substantial information about teachers' knowledge, this knowledge is context bound. Although I believe that knowledge developed in one context may be transferable to another context because of commonalities between groups of humans, not all aspects of knowledge are transferable. The Jamaican teacher education community and, more specifically, the science teacher education community should now consider negotiating and developing knowledge about science teaching. This knowledge would be more specific to the needs and the peculiarities of the Jamaican context.

Research regarding teachers' knowledge has proliferated within the past two decades. However, there remains an absence of a dependable theory of teachers' knowledge (Feiman-Nemser & Remillard, 1996). Teacher educators have attempted to describe the knowledge that teachers employ during the conundrums of classroom life. These researches are grouped into three categories according to the approach to teachers' knowledge that was used in the studies. Information processing (Shavelson 1983), teachers' personal-practical knowledge (Clandinin, 1985), and teachers' pedagogical-content knowledge (Shulman 1986) were explored, and the types of knowledge that teachers employed in their classrooms were described. These studies were predominantly North American and were conducted in school classrooms. This research is seeking to describe the existing knowledge that prospective teachers are supported in developing through their science teacher education course in Jamaica.

There is growing concern among researchers regarding the social context in which school learning occurs. Studies in teacher education during the 1990s are therefore largely focussed on encouraging prospective teachers to consider social factors and the influences of diversity on teaching and learning. Scholarly arguments and research deliberations have therefore been focussed on issues surrounding constructivism, reflective practice, and multiculturalism in teacher education (e.g., Loughran, 1997; Richardson, 1999; Zeichner, 1996). Because of the cultural diversity among Jamaican children, arguments and research issues such as those advanced by these scholars and researchers are important to the study of Jamaican teacher education.

According to Carter (1990), studies that are seeking to understand teachers' knowledge and the concept of learning to teach should concentrate on examining the task of teacher education. Carter also suggested that the task of teacher education should be examined from the standpoint of those who are accomplishing the task, those who are directly involved. Although previous researchers might have attempted to address this concern of what prospective teachers need to know in order to teach science (e.g., Appleton, 1995), the proposed research is centered on a broad selection of stakeholders who are involved in the task of science teacher education in Jamaican teachers' colleges. The question of the knowledge which is required for prospective Jamaican teachers is pertinent at this time when Jamaica is seeking to improve the quality of primary science teachers. This research deals with the unexplored Jamaican context.

The participants in this research are not characteristic of the participants who were involved in researches with similar concerns to this research. One example of the difference is that colleges providing initial teacher education in Jamaica are largely staffed with lecturers who have the minimum qualification of a first degree along with teacher certification. Initial teacher education in the North American setting occurs largely in universities under the guidance of more qualified teacher educators. Jamaica does not have this structure. The participants in this research will therefore differ from participants who have been studied as teacher educators in other countries.

As teacher education, the area of science teaching and learning is also unexplored in Jamaica. The Jamaican literature has shown that Jamaica is seeking to use science and technology as a means of developing and sustaining its economic wellbeing (e.g., Ministry Paper No. 16, Office of the Prime Minister, 1994). The international literature has shown that there have been similar trends in other countries (e.g., Science Council of Canada, 1984). Teacher educators in these developed countries are becoming increasingly concerned about the emphases that are found within curricula documents (Ostman, 1998; Roberts, 1998), the philosophies of science that are implicit in curricula and teaching (Clemenson, 1990), and the reasons that primary science teachers find difficulty in teaching science (Kruger, Palacio, & Summer, 1992). Consequently, researchers and science teacher educators have been employing different strategies for preparing teachers (Appleton, 1995; Hoban, 1997; Smith; 1997). Based on the preunderstanding of the Jamaican context with which I am entering this research, concerns associated with the difficulty that primary school teachers have with teaching science are considered to influence the science education that is provided for primary science teachers. Cognizance of the factors which influence preparation of prospective science teachers, science education curricula, and science teaching which have been explored by other studies (e.g., Driver & Oldham, 1986; Marion et al., 1998; Munby & Russell, 1997; Roberts, 1998; Summer & Kruger, 1994) will be valuable in helping me to develop new understandings about knowledge for teaching science. These new understandings will enable me to make suggestions regarding a knowledge base for prospective Jamaican primary teachers to teach science.

The view that multiple perspectives of stakeholders within their own context will provide a suitable foundation for a framework of teachers' knowledge is central to this research. Consequently, a qualitative research has been proposed. The methodology for this constructivist-interpretive research is presented in the next chapter.

CHAPTER 3

METHODOLOGY

Introduction

In this chapter I will describe the procedures and methodological considerations that were essential for me to consider as I embarked on this constructivist-interpretive inquiry. The chapter includes descriptions of the research design, the setting and participants, the methods and process of data collection, data analysis, aspects of trustworthiness, and the ethical considerations that guided the study.

Research Orientation

According to Bogdan and Biklen (1998), all research is guided by a way of looking at the world, or a research orientation. Similarly, Denzin and Lincoln (1998) suggested that researchers are guided by abstract principles that direct their beliefs about ontology, epistemology, and methodology: beliefs that guide action in research which were considered by Denzin and Lincoln to be paradigms of research. Bogdan and Biklen considered these guiding principles to be theoretical orientations of which researchers are aware and use as they collect and analyze data. To provide a concise account of the theoretical orientation on which this research is developed, I have chosen to focus on three major themes: the nature of reality, the relationship between the inquirer and the known, and how the inquirer gains knowledge of the world. It is assumed that by exploring these themes I will provide the connections that exist between the purpose of this research, the modes of data collection and analysis, and the nature of the outcomes of the research.

Locating the Research Perspective: Theoretical Orientation

Constructivism, according to Guba and Lincoln (1998), is a deviation from a realist orientation to a relativist orientation regarding the nature of knowledge. Rather than assuming that a reality or truth exists and can be apprehended, constructivism assumes that knowledge or reality is constructed by the inquirer and is likewise alterable. Using the above premise and arguing from a social science perspective, Denzin and Lincoln (1998) and Guba and Lincoln (1998) set constructivism apart from positivism, postpositivism, and critical theory. Additionally, Denzin and Lincoln suggested that all research is interpretive and presented four interpretive paradigms which guide qualitative research: positivist, postpositivist, constructivist-interpretive, and critical and feminist-poststructural. My own research is developed around Denzin and Lincoln's constructivist-interpretive orientation to research. The essential aspects of constructivism and interpretive inquiry, which are central to this research, follow.

Constructivism

Constructivist philosophy, according to Magoon (1977), respects humans as knowing beings. How human beings know and what knowledge is invented by them are bound up with what human beings experience in the world. Human beings actively construct their social reality. It is this notion that humans have the ability to construct social realities and, further, to change these constructs when they become more informed (Guba & Lincoln, 1998) that has impacted on my understanding of reality as an inquirer.

Constructivism involves a relationship between the inquirer and the known or the world in which the inquirer comes to know. Consequently, constructivism acknowledges that human knowledge is contingent: Our experiences and the world in which we live affect and are affected by what we know and come to know. Confrey (1990) said:

> Put into simple terms, constructivism can be described as essentially a theory about the limitations of human knowledge, a belief that all knowledge is necessarily a product of our own cognitive acts. We have no direct or unmediated

> knowledge of any external or objective reality. We construct our understanding through our experiences, and the character of our experience is influenced profoundly by our cognitive lens. (p. 108)

Constructivism is therefore viewed as a philosophy of knowing in which the mental representations that are constructed by the inquirer have no necessary correspondence with an objective and a priori scientific knowledge of the nature of reality (Cobb, 1994). Although constructivism has borne several labels, among them radical constructivism and social constructivism, the idea that knowledge is constructed by mental activity within the inquirer rather than transmitted from one to another is the underpinning perspective on how knowledge develops. Further discussion of two perspectives of constructivism, radical and social constructivism, provides a foundation for my own forestructure with which I came to this research.

von Glasersfeld (1988), a radical constructivist, suggested that knowledge is a product of a person's individual conceptual organization. This conceptual organization becomes necessary as an individual makes sense of experience and eventually expresses understanding as explanations and theories (Confrey, 1994) through conceptual structures. von Glasersfeld argued that as we seek consistently to organize our understanding, conceptual structures are affected. He explains that we determine the value of conceptual structures by evaluating their "experiential adequacy, goodness of fit with experience, [and] their viability as means for solving problems" (p. 320). The function of knowledge is therefore to organize the experiential world (von Glasersfeld, 1988).

Social constructivism goes beyond the emphasis on the individual constructing knowledge of the world from within. In social constructivism, the focus is not on the individual, but on the social elements that are instrumental and essential to the construction and appropriation of knowledge (Richardson, 1997). Gergen (1995), using Vygotsky's demonstration of the effects of cooperative learning, discussed the idea that a process of social interchange is essential to knowing and knowledge. Gergen's discussion as a social constructionist shows how meaning in language is achieved through social interdependence, how meaning in language is context dependent, and that language primarily serves communal functions. Atwater (1996) agreed with Gergen and added that, from the viewpoint of a social constructivist, contextual values in knowledge construction are important. Knowledge construction, or what the inquirer comes to know, is constrained by how the world is perceived.

The constructivist orientation I have discussed here allowed me to embark on the research journey with a view to understanding how stakeholders view the *Science Education Course* provided by Jamaican teachers' colleges. By gaining an understanding of these views, I have also gained an understanding of different approaches that could serve the needs of Jamaican prospective teachers as they prepare to teach science in primary schools. Therefore, through this research I have not proven any theories or made any predictions. Instead, I have provided a description and interpretation of my research journey and the findings resulting from this interpretive inquiry.

Interpretive Inquiry and Hermeneutics

To consider a constructivist-interpretive orientation to research is to acknowledge that being in the world, experiencing the world, and creating knowledge through these experiences lead to understandings that are subject to continuous revision. Interpretive inquiry is one process through which an inquirer creates knowledge of the world. Smith (1991) stated that the "inherent creativity of interpretation, the pivotal role of language in human understanding and the interplay of part and whole in the process of interpretation" (p. 190) are three central themes in hermeneutic inquiry. Ellis (1998a) suggested that the three central themes of hermeneutics be discussed when attempting to clarify guiding ideas in interpretive inquiry.

In interpretive inquiry, the inquirer seeks to creatively gain practical understanding by acknowledging and involving the important relationship that exists between the macro and the micro. This natural activity begins with an everyday participatory understanding of people and events or a "starting place for the interpretation" and leads to a practical understanding which then forms the starting place for further interpretation. Packer and Addison (1989b) described the process of creating understanding as a circle of interpretation or the hermeneutic circle which "works to keep discussion open and alive, to keep the inquiry under way" (p. 35). In the hermeneutic circle, the preunderstandings that the inquirer brings to the research generate the forward arc of the circle. My initial interpretation of the *Science Education Syllabus* and my experience with teacher education in Jamaica have influenced my beliefs and assumptions about the science education to which prospective primary teachers are and should be exposed. These beliefs and assumptions, which I hold, contribute to the preunderstanding with which I entered into the research.

This research is about creating meaning, and Smith (1991) suggested that "hermeneutics is about creating meaning not simply reporting on it" (p. 201). To achieve meaning through the inquiry, as the interpreter in this research, I acknowledge the three key requirements of hermeneutic inquiry discussed by Smith (1991) and Gadamar (1982). The first of these key requirements is that language is at the core of understanding. The second is that understanding is bound and imbedded in history, which includes personal experiences and cultural traditions. The third is that to understand text, the interpreter repeatedly transcends his own horizons to find one's self, and as the horizon of the text and one's own horizon coalesce, the *aboutness* of the text is elucidated. As I re-examined the interpretive accounts and the transcripts and documents, I searched for and became more aware of absences, gaps, and contradictions. This awareness led me to inquire into the literature for alternate theories and other researchers' findings that assisted in purposefully exploring the *aboutness* of the participants' expressed views and the *Science Education Syllabus*. Packer and Addison (1989b) suggested that in interpretive inquiry, when one's own initial interpretation undergoes evaluation, the return arc of the hermeneutic circle is being experienced. It is through interpretive research such as this that existing knowledge is interrogated and complexities refined. Peshkin (1993) identified this as one value of interpretive research.

This qualitative research employs interpretive inquiry within a constructivist-interpretive orientation. The research will be interpretive and descriptive, because stakeholders' perspectives regarding science education for prospective primary school teachers in Jamaica are explored. As well, the research is evaluative, because the issues and concerns generated by the expressed views of stakeholders will be used as a basis for analyzing the *Science Education Syllabus.*

General Principles and Assumptions of Qualitative Research

Purpose and Value

Qualitative research is concerned with the participants' perspectives (Bogdan & Biklen, 1992), as an individual's perspective develops through experiences and relationships with others and with the environment. "By learning the perspectives of participants, qualitative research illuminates the inner dynamics of the situation" (p. 32). Denzin and Lincoln (1998) helped me to clarify my choice of qualitative research as the selected genre. They stated:

> The word *qualitative* implies an emphasis on processes and meanings that are not rigorously examined or measured (if measured at all), in terms of quantity, amount, intensity or frequency. Qualitative researchers stress a socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situational constraints that shape the inquiry. (p. 8)

Therefore, the purpose of this qualitative research is to develop understanding by exploring meaning in text and human experiences (Bogdan & Biklen, 1998).

Because qualitative research is concerned with meaning and process, it is valued among researchers for its ability to capture individuals' points of views, examine the constraints of everyday life, and secure rich descriptions of the social world (Denzin &

Lincoln, 1998). Peshkin (1993) suggested that by providing descriptions in research, the inquirer is able to provide an opportunity for the reader to understand processes, people, and situations. In this research I provide descriptions of participants, the overall setting in which the research was undertaken, and some descriptions of the settings in which participants function on a daily basis. It is hoped that these will provide readers with a foundation for understanding how my understandings developed.

Characteristics of Qualitative Research

Bogdan and Biklen (1998) specified five characteristics that typify qualitative research: Qualitative research (a) has the natural setting as its direct source of data, (b) is descriptive, (c) is concerned with process rather than outcome, (d) employs inductive analysis of data, and (e) holds meaning as a primary concern. In this research the intent was to understand, through stakeholders' views, what knowledge base for primary science teaching was offered and/or should be offered to prospective primary science teachers. Based on the five characteristics listed here, I decided that the intent of the research and the research questions—How does the current *Science Education Course* for Jamaican prospective teachers contribute to knowledge for teaching primary science, according to internal stakeholders? and What knowledge for teaching primary science should a revised *Science Education Course* provide for prospective Jamaican primary teachers, according to internal stakeholders?—were most suited to qualitative inquiry. During the research I was mindful of the characteristics and engaged these and other facets of qualitative research when designing and executing the study. Throughout this chapter I will show how these five characteristics shaped the study.

Setting and Participants

The Overall Setting

As a characteristic of qualitative research, I will describe the natural setting in which the research unfolded. The research was conducted in Jamaica. Jamaica is approximately 200 kilometers between its widest points—Morant Point in the east to Negril Point in the west, as the crow flies (see Figure 3.1). The island is fairly mountainous and is surrounded by the Caribbean Sea (see Figure 3.1). Because of the mountainous terrain, public infrastructures such as schools and roads are constructed on the edges of the mountains. Additionally, schools in rural parishes sometimes have small playgrounds, and inland roads are usually narrow and winding. On the map (see Figure 3.1), the shortest route by car from Buff Bay, Portland, on the North East coast to Kingston on the South East coast goes inland, and although the distance is only 60 kilometers, the journey takes in excess of two hours.

Jamaica's closest neighbor is Cuba, and the two countries share a history of being British colonies, as is the case with most of their Caribbean neighbors. However, the United States of America usually influences the lifestyles of Jamaicans. Approximately 40% of Jamaica's 2.5 million people live in the main city of Kingston. As a result, schools in this area and in other small rural towns are overcrowded. Although teachers' colleges were built at strategic points across the island, they are all governed by the same body (Joint Board of Teacher Education [JBTE]), and all offer similar programs; prospective teachers often attend colleges that are some distance from their hometowns and communities. Upon graduation, they seek jobs wherever they are available. Any primary school will therefore have teachers who have graduated from any of the seven teachers' colleges and six teacher education departments on the island.

For this study, teachers were selected from schools in Kingston, St Andrew, Portland, and St. Mary; college lecturers were selected from colleges in both rural and

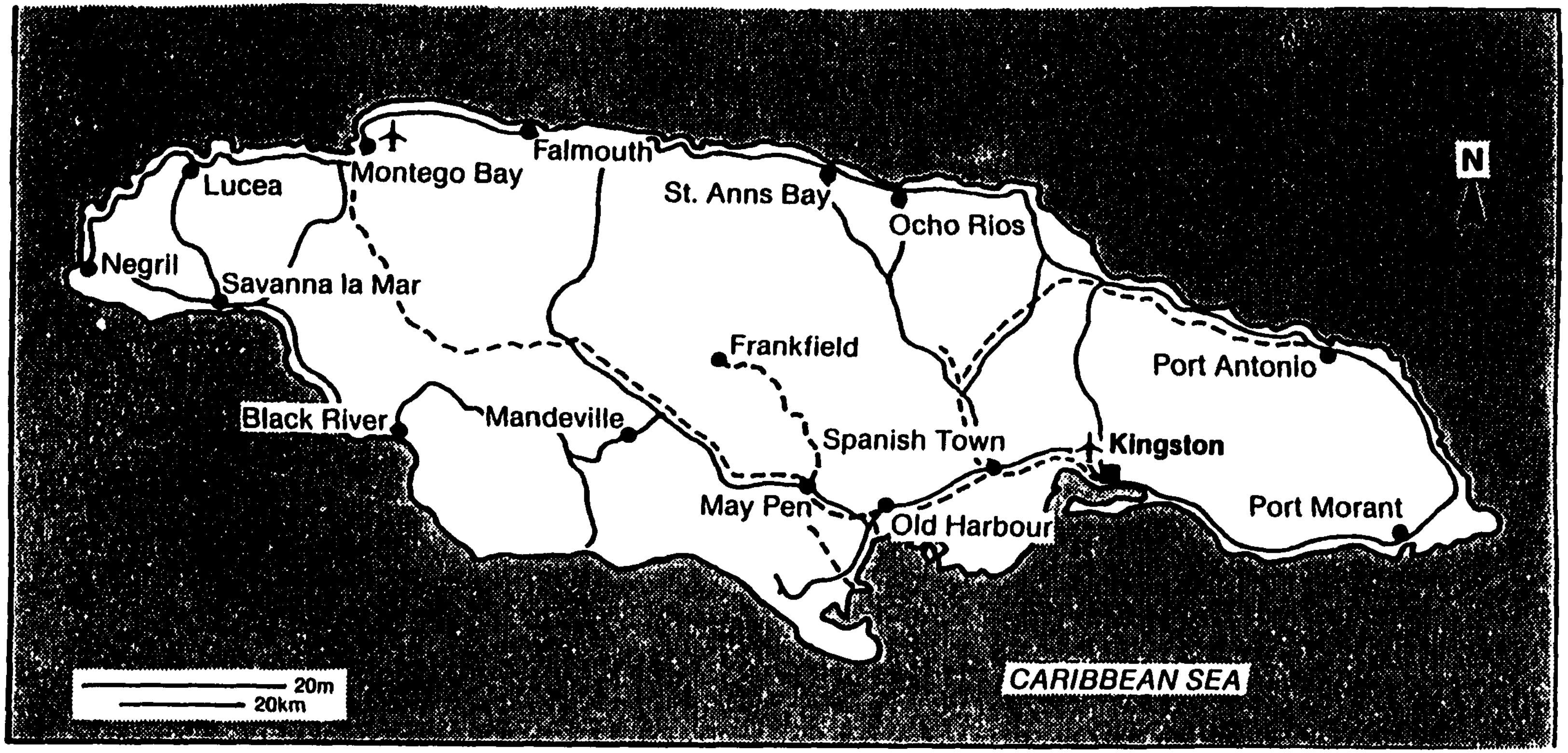

Figure 3.1. Map of Jamaica.

urban locations; and prospective teachers were selected from the same colleges as lecturers. The JBTE appointees and the university lecturer were from Kingston and St. Andrew.

The Participants

All participants in the research were internal stakeholders (Orpwood, 1985) in Jamaican science teacher education. Whereas I acknowledge the contributions of other stakeholders, both internal and external, as important to teacher education, I deliberately limited my research to a small group of internal stakeholders. The internal stakeholders that were involved in the research had been in direct contact with the *Science Education Course* and the science education currently experienced by prospective teachers. Consequently, this target group was most informed about science education and teacher knowledge.

A total of 18 internal stakeholders from five subgroups participated in the research:

- five college science education lecturers who were teaching science education;
- one university lecturer from the area of elementary science education who had knowledge of the science education which is provided at the teachers' college level;
- two members of the JBTE, who had made contributions to elementary science education;
- six practicing teachers who graduated from the Jamaican teacher' college primary education program between 1993 and 1997 and have been actively involved in science-related activities in their schools; and
- four prospective teachers who had completed the *Science Education Course*. Two of them were pretrained and were teaching in primary schools while

attending college part time. One was in her second year, and the other was in her final year at college. Neither of the latter two had any teaching experience.

The participating college lecturers, practicing teachers, and prospective teachers were selected on the basis of their ability to provide rich information about the phenomenon being studied. By selecting participants from different stakeholder subgroups, I was able to produce themes and topical points that reflected the similarities and differences across and within groups of participants (Gall, Borg, & Gall, 1996). This is reflective of the diversity, yet commonality, of meanings that all participants bring to research.

Selecting Participants

Participants for the study were selected by specific criteria, as shown in Table 3.1. In order to understand how the participants viewed the *Science Education Course*, a purposeful sample (Bogdan & Biklen, 1998) of persons who were knowledgeable about the *Science Education Course* in particular, and primary science education and primary science teaching in general, were selected. This research required both insightful and knowledgeable participants who were best identified with the assistance of key informants.

The suggestions from these key informants guided the selection of teachers to participate in the research. According to Bogdan and Biklen (1998), key informants serve as guides to finding persons who are able to provide the intensity of description that is required in qualitative research. Where key informants were used, they were asked to provide a list of possible participants, from which the required number of participants for the study was selected.

Table 3.1

Selection Criteria and List of Prospective Participants

Participants	Location	Criteria for selection	Method of selecting
6 teachers (graduates from a range of Jamaican teachers' colleges)	Kingston and Saint Andrew, Portland, Saint Mary	• Members of the Association of Science Teachers of Jamaica • Involvement in science-related activities at school and national level • General interest or disinterest in science • Willingness to articulate perspectives	Key informants from Ministry of Education, Association of Science Teachers of Jamaica, and school principals
4 prospective teachers	From rural and urban parishes	• Involvement in science-related activities • Willingness to articulate perspectives	Key informants from student council representatives and Heads of Science Departments of each college
5 lecturers	From rural and urban colleges	• By accessibility • Currently or have recently taught science education.	Volunteers
1 university professor 2 members of JBTE	Saint Andrew	• Were involved in professional and other activities related to primary science education	Volunteers

Profiles of Participants by Stakeholder Subgroups

As part of my attempt to maintain the participants' anonymity, I will provide a general description of the participants in subgroups. Each participant will also be assigned a pseudonym.

University lecturer. Valerie had lectured at a Jamaican university for three years. She was a lecturer of secondary and primary science education. She said that her strengths and interests were in the physical sciences, and she was also interested in assessment practices in science teaching. Valerie did not pursue studies at teachers' college; neither had she taught in primary school. However, she had experience working with primary-aged children and teachers in special programs and taught for several years at the secondary level. Valerie was an ardent Christian and was actively involved in her church as a church leader. Valerie commented that her role as a Christian and a church leader and her role as a science educator complemented each other. She expressed her convictions regarding educating teachers for teaching science. Valerie explained that, in her role, she did not view science teaching as an "ordinary thing." She explained that as a science educator in Jamaica, where there are few such people, she felt burdened by the thought that if she "should get it wrong," she would be affecting so many lives in so many generations. This, she felt, was an awesome responsibility.

JBTE appointees. Sophia and Jerry were both appointed by the Joint Board of Teacher Education as external examiners. As a JBTE appointee, Sophia was also responsible for staff development in teacher education institutions. As external examiners, Jerry and Sophia attended to the accreditation of syllabi and vetting and moderation of examinations. Sophia and Jerry were both experienced secondary teachers of science. Neither of them attended teachers' college.

Table 3.2

Profile of Participants

Subgroups	Participants	Affiliation to college science education and professional experiences
University lecturer	Valerie	No teachers' college experience but instructed *Science Education Courses* for the BEd program at university. Was a secondary teacher of physical sciences.
JBTE appointees	Jerry and Sophia	External examiners, no college experience, taught secondary school science.
College lecturers	Pet, Peter, Donna, Ann, and Monica	All are instructors of science education for prospective primary teachers. Experience as teachers' college lecturer ranges from 1 year to 20 years. None had taught at primary school as trained teachers. Three had taught in primary school as pretrained teachers.
Teachers	Kay, Joan, Janice, Nicole, Winsome, and Paul	All attended Jamaican teachers' colleges and achieved a diploma in teaching. Paul attended University and achieved a BEd in primary education. Teaching experiences range from 2 to 8 years.
Prospective teachers	Jessica, Shernette, Henry, and Vicky	Vicky is a second year student, Jessica Henry and Shernette are third year students. Jessica and Henry have taught as pretrained teachers in primary schools. Shernette and Vicky have not taught.

College lecturers. The five college lecturers who participated in the research had between 1 year's and 20 years' experience as college lecturers (see Table 3.2). Only one of the five college lecturers, Monica, was not involved in extracurricular science-related activities. Ann and Monica had no experience with teaching in primary schools, whereas Donna, Pet, and Peter all had one year's experience teaching as pretrained teachers[5] in primary school. Although Donna and Monica said that they acquire scholarly publications from the USA, they did not receive these regularly, because this venture was very costly.

Teachers. Of the six teachers who participated in the research, one (Paul) was a university graduate with a Bachelor of Education degree. All of the other teachers (Joan, Winsome, Kay, Nicole, and Janice) were college graduates with diplomas and were classified as trained teachers. This seems typical of Jamaican primary school teachers. The participating teachers had between three and eight years' teaching experience in Jamaican primary schools. Joan, who had eight years' experience, had been a pretrained teacher for seven years before attending college. All teachers had taught at more than one grade level in primary schools in Jamaica. Two teachers among the six attended the same college.

Joan and Janice were described by key informants as teachers who had little interest in science, whereas Winsome, Nicole, Paul, and Kay were acknowledged as teachers who spearheaded whatever science-related extracurricular activities their schools embarked on. Paul was the science club coordinator in his school, where children participated in regional science fairs and science-related community activities. Winsome was a member of a local environmental organization and was also the coordinator for her school club which was affiliated with this organization.

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[5] Pretrained teachers are persons without teacher education qualification who are employed to teach. Pretrained teachers are usually employed only when trained teachers cannot be found. Pretrained teachers are mostly found in deep rural schools.

Prospective teachers. Four prospective teachers participated in the research. Two of these (Jessica and Henry) attended the same college as part-time students and were teaching as pretrained teachers in primary schools. Jessica had been a pretrained teacher for 20 years, whereas Henry had been teaching for four years. Shernette and Vicky had no teaching experience. All participating prospective teachers said that they liked science, but only Vicky's matriculation for college included a pass in a science subject. Jessica had never taken science at secondary school because she attended for one year only, in Grade 11. Jessica explained that she had not been successful at the Common Entrance exam as a child and therefore was not admitted to a traditional high school. She completed Grade 9 in an all-age school, and one year after "New Secondary" schools were instituted in Jamaica. The different types of schoois found in Jamaica and the Common Entrance Exam were described in Chapter 1. Because of her age, Jessica was allowed to enroll in one of the New Secondary schools for one year only. All other prospective teachers had completed secondary schooling; however, Jessica and Henry did not pursue science subjects after Grades 9.

Data Collection

Data collection was conducted in four phases. First, the *Science Education Syllabus* was analyzed. The outcomes of this analysis provided me with insights into what the *Science Education Syllabus* had to offer prospective teachers, and therefore I entered the setting and the interviews with some knowledge about the syllabus. This knowledge was helpful as a guide for how to proceed with the interviews. Second, the participants were interviewed about their views regarding science teaching in primary schools and the *Science Education Course*. These interviews were transcribed and analyzed. Third, the remaining documents were analyzed, and synopses of the first interviews were prepared from an initial analysis of these interviews. The analysis of the first interview and the reflections that were written after each interview produced further questions for which I sought answers in a second interview. Fourth, the participants were interviewed, and the interviews were then transcribed and analyzed. It must be noted that informal conversations with the participants were important to the data collection. These informal conversations transpired throughout the research process, and the participants seemed more comfortable to disclose their views at these times. The process will be described later in this chapter.

Getting Started

Initially, permission was sought from the Ministry of Education, Youth, and Culture to conduct the research in educational institutions first by letter, then by a conversation with the Chief Education Officer. Permission to conduct the research was subsequently sought by letter from the Joint Board of Teacher Education (JBTE) and the heads of educational institutions and teacher education departments. Permission was granted from both the Ministry of Education and the JBTE before visits to any educational institution started.

I visited each educational institution from which stakeholders were drawn, and I spoke with the heads of departments or the heads of the institutions. These persons were extremely accommodating and supportive, often volunteering suggestions pertaining to possible participants. Before inviting individual members of stakeholder groups to participate in the research, I contacted them by telephone to inform them about my research and to invite them to participate, sent them letters requesting their participation, and made appointments for an initial conversation. See Appendix B for letters of request. Data collection began only after relevant institutions, departments, and participants granted permission and consent to allow people to participate in the research.

Participants were briefed about the research by letter. In these letters I described the research process, associated ethical consideration, and the researcher. A summary of the research proposal was made available for their perusal. See Appendix B for the letter introducing the researcher and providing a summary for the research and the ethical consideration. An initial conversation was arranged with each participant. This initial conversation served two purposes: It dealt with any questions or concerns that participants had about the research, and it created a foundation on which trusting relationships developed between participants and myself. Kvale (1997) advised that "the qualitative research interview is a construction site for knowledge. An interview is literally an *inter view*, an interchange . . . between two persons conversing about a theme of mutual interest" (p. 14). Interviews were scheduled at the convenience of the participants, and with permission they were audiotaped.

I collected data for this research by using field notes, interviews, and documents.

Documents

The main purpose of the documents in this study was to establish prior documentary evidence to support aspects of the field notes and the interviews. The documents were viewed as historical indicators. Therefore, I relied on the documents as a reference when considering recommendations for the research. Yin (1993) suggested that the most important use of documents is as a source of corroboration and as a means of augmenting evidence from other sources. He said that they are usually helpful when providing details such as names, titles, and dates.

Because there was no central archival facility for storing Jamaican education documents, those that I acquired were from

- Ministry of Education curriculum unit offices,
- the office of the JBTE,
- Caenwood Education Library,
- University of the West Indies Faculty of Arts and Education Documentation Center,
- the Office of the Prime Minister of Jamaica, and

- private collections of participants and other Jamaican educators who participated in teacher education and curriculum revision in past years.

Primary Sources

Joint Board of Teacher Education (1990), *Science Education: Primary Program*, was the major source of information about the emphases of the *Science Education Course* and the knowledge base which is currently provided for prospective teachers. Other materials from the JBTE that were of importance for establishing the emphases of science, the knowledge base that is provided for prospective primary science teachers, and the process involved in arriving at the *Science Education Course Syllabus* are:

- *Minutes of meetings from the Curriculum Committee* for 1988, 1989, and 1990, the period during which the current *Science Education Course* was revised (the Rationalization Period)
- *Memos and notes* related to decisions taken at committee meetings during the Rationalization Period
- *Committee reports* about the progress of the rationalization exercise and decisions taken as they relate to the *Science Education Course*
- *Science Education Examination papers and mark schemes* for 1993 to 1998.

Materials that were acquired from the Ministry of Education Curriculum unit are:

- *Appraisal of primary level training programs*
- *Curriculum evaluation study of the primary education system in Jamaica: the executive summary*
- The revised *Conceptual Framework for Primary School Science*
- Drafts of the new *Curriculum for Primary School Grades 1-3 and Grades 4-6.*

These documents provided information about the emphases and proposed emphases of primary school science and the knowledge base that teachers might require for teaching this curriculum. Some documents also provided descriptions of the existing physical conditions of primary schools and an overview of the teacher education program in Jamaican teachers' colleges.

Ministry Paper No. 16 for science and technology (Office of the Prime Minister, 1994) provided a brief overview of what was expected by the government in relation to science and technology as a developmental tool for Jamaica. The Ministry of Development Planning and Production's (1990) *Science and Technology: A National Policy* also provided an overview of the government's expectations for science and technology in terms of industrial development.

Secondary Sources

- *Teaching Primary Science* (Young, 1988) is the recommended text for the *Science Education Course* and was also a good source for the emphases of science education and the views of science to which prospective teachers are exposed.
- *Lecture notes* for aspects of the *Science Education Course* acquired from lecturers in Jamaican teachers' colleges provided additional information about perspectives regarding some approaches to teaching science to which prospective teachers are exposed.
- Chapter III of *Caribbean Region: Access, Quality, and Efficiency in Education* (World Bank, 1993) presented a comprehensive report on the status of Caribbean education. This document described the conditions of Jamaican classrooms, the deficiencies of curricula materials, and the unavailability of teaching materials. Additionally, the document included an agenda for action and recent initiatives that were undertaken to enhance education in the region.

In general, the documents enriched my understandings of the process of development of the *Science Education Syllabus*, Jamaican teacher education, and education in Jamaica in general. By using these documents, I became more knowledgeable about the larger context in which the *Science Education Course* is situated.

Interviewing

Interviewing was the major source of data for the research. As a stage upon which knowledge is constructed, I employed interviewing to seek "nuanced descriptions" (Kvale, 1996). The interviews in this research were designed to obtain the views of participants that led to "understanding and interpretation" (Kvale, 1997; Seidman, 1998) about the kind of science education that is and should be provided for prospective teachers in Jamaican teachers' colleges. Seidman explained, using the works of Ferrarotti (1981), that "social abstractions like 'education' are best understood through the experiences of the individuals whose work and lives are the stuff upon which the abstractions are built" (p. 7). Interviewing was therefore treated as means to allow participants to express their views and relate their experiences about a topic that was of importance and interest to both the participants and myself.

Being semistructured, the interviews allowed me the opportunity to explore participants' ideas as they were articulated. I therefore prepared focus questions for each group of participants (see Appendix C). During the interviews, as participants raised important points, I invited them to clarify and explain them.

The follow-up interviews were also semistructured but were largely designed to encourage participants to reflect and expand on points raised during the first interview and any ensuing informal conversations. I also invited participants to respond to issues raised by participants from other stakeholder subgroups. Except for telephone interviews and e-mail conversations, all participants were interviewed in person at times and places convenient to them.

Participants were not always present for the interviews upon my arrival at the designated locations. On several occasions, I had to wait for as long as two hours for some participants. Some second interviews were done by telephone and by e-mail, but all first interviews were done face to face. With the exception of two face-to-face interviews, all telephone interviews and face-to-face interviews were audiotaped. The initial interviews were conducted between September 1998 and January 1999 and the second interviews between January 1999 and June 1999. Fewer of the second interviews were postponed than the first interviews. Teachers and prospective teachers also seemed more comfortable in the second interviews than in the first and commented that they were reluctant during the first interviews because they were afraid that I would be testing their knowledge of science (Winsome, Vicky, Nicole, Henry, Kay).

Informal Conversations

All unscheduled conversations between participants and myself which were related to aspects of my study were considered to be informal conversations. Although the informal conversations did not usually take place at any designated location, the interviews were always scheduled for both time and location, and I preplanned the subject(s) for the interviews. At no time did I preplan the topics discussed in any informal conversation. Conversations were usually the result of a concern or interest on the part of the participant. Informal conversations occurred by phone or face to face. The face-to-face conversations transpired in corridors, over lunch, in cars, or under trees.

Conducting the Interviews

College Lecturers

The five college lecturers were interviewed in their offices, because all of them, save Donna, occupied offices. Donna's office was the laboratory preparation room; her desk sat in the center of a rectangular-shaped room. There were two small windows close to the roof on each of the short sides of the room. Although I had several informal conversations with all five lecturers, two of the five were not available for a second interview. These lecturers were contacted several times by phone, appointments were scheduled, and visits were made to the colleges, but they were not able to accommodate the second interview. Two of the second interviews with the college lecturers were done by phone and the others by e-mail conversation. The initial interviews lasted for an average of 65 minutes, and the second interviews for an average of 20 minutes.

University Lecturer

For the first interview, the university lecturer (Valerie) was interviewed in her office. For the second interview she was interviewed in an office at another educational institution which we were both visiting when she agreed to do the interview. Valerie and I had numerous conversations by phone and e-mail. We often attended educational functions where we would have informal conversations about issues of interest that related to my research. The initial interview lasted for about 75 minutes and the second interview for approximately 32 minutes.

JBTE Appointees

The JBTE appointees (Jerry and Sophia) were interviewed in their offices. For the second interview one of the JBTE appointees was interviewed in her car, because she was officiating at a science competition and did not wish to have our meeting postponed a third time. Jerry and I engaged in several informal conversations during the data-collection period, because we frequently met for various committee meetings in which we both participated. The duration of the initial interview with Sophia was about 61 minutes and for Jerry, about 68 minutes; and the second interview was about 20 minutes for both Sophia and Jerry.

Teachers

Six teachers participated in the research. For the first set of interviews three teachers were interviewed in their schools' staff rooms, one in a classroom, and the other under a large almond tree on the school grounds. One teacher was interviewed at her home. The initial interviews lasted an average of 55 minutes and the second interviews, an average of 20 minutes. Informal conversations often transpired while teachers had lunch or outside their classrooms during lunch break. Most of the time informal conversations were initiated by questions from teachers or when teachers asked for my assistance in understanding science concepts or in deciding how to approach a lesson. For example, Winsome asked me to help her design a lesson on shapes for her Grade 1 class; she wanted some "fresh ideas."

Prospective Teachers

Four prospective teachers participated in the research. They were interviewed in student common rooms and day lounges. The second interview with one prospective teacher occurred in my car. Informal conversations were rare with prospective teachers. Vicky and I had informal conversations twice, once when she asked for my assistance in helping her interpret a past exam question and on another occasion when she wanted to acquire past papers for the *Science Education Course*.

Field Notes

I have used the term *field notes* to refer to my reflections regarding observations, informal conversations, and interviews during the data-collection period, as well as insights gained throughout the research process. Spradley (1980) and Merriam (1988) referred to this as a *reflective journal*, which is often used as a source of data and as a means of informing decisions during data analysis. My field notes reflected the 'personal side' of the fieldwork and were written whenever time allowed. Sometimes field notes were recorded just after interviews. However, it was almost an impossible task to write field notes after some interviews, so I would sometimes audiotape my thoughts about the interview during my drive home: I was forced to drive as much as four hours on some occasions. At other times I would reflect on my visit after a rest period and during the transcribing of the interviews. Weber (1986) wrote: "For some interviewers, listening to the tapes helps recapture the tone of voice, the twinkling in the eye, the pained expression, the cluttered desks, the laughter, the leaning forward" (p. 71).

I relied on the audiotaped interviews to recollect images of the physical settings, gesticulations, facial expressions, and moods that characterized each participant. These recollections formed a part of my field notes and were useful during data analysis. On the other hand, by revisiting the audiotapes I was moving back and forth from part to whole and vice versa in the interpretive circle, as suggested by Packer and Addison (1989b) earlier in this chapter.

Data Analysis

Data analysis is a process of systematically searching and arranging the interview transcripts, field notes, and other materials that you accumulate to increase your own understanding of them and to enable you to present what you have discovered to others. (Bogdan & Biklen, 1998, p. 157). In this section I present a description of how I worked with the data, organizing, taking apart, and synthesizing them to capture an understanding of the phenomenon I studied.

Data analysis and interpretation began with the collection of data (Bogdan & Biklen, 1998; Merriam, 1988). As I interviewed the participants and made field notes, I began reflecting on and analyzing the notes and the interviews. As a result of reflecting on the interviews, I wrote synopses of no more than two pages for each of the 18 initial interviews. See Appendix D for examples of the synopses. By writing the synopses, I started noticing topical points, recurring views, gaps, and contradictions. Addison (1989) suggested that early analysis helps the researcher to begin detecting patterns and relationships as the researcher moves forward and backward in thinking about the data. Not only did the initial analysis provide a helpful starting point for further analysis, but it also helped to develop new questions that were used for second interviews. By following Bogdan and Biklen's suggestion, I made notes to myself about any topical points, patterns, and gaps that were detected as I listened to the interview tapes and read the transcripts. At the same time that interviews were being conducted and analyzed, I acquired and examined related documents (notes and minutes from JBTE meetings and lecturer notes).

When all the data was collected, I again examined each interview transcript (31 transcripts), listing words and phrases that seemed meaningful at that time. In other words, I took apart or decontextualized the data (Cresswell, 1995). I then grouped these words and phrases into topical points, grouping them according to common ideas which the key words and phrases suggested. These key words and phrases, as indicated by Bogdan and Biklen (1998), became my coding categories (see Appendix E).

The next step in the data analysis was to recontextualize or to bring the decontextualized data back to a condensed representation of the original (Cresswell, 1995). At this time I formulated questions based on each coding category. An example of a question is: *What methods are used or are suggested for use in teaching primary science*? I then reread each transcript and color coded by highlighting each sentence or phrase that pertained to the question under consideration. Later, the transcripts were once again reread; and the names of the interviewees, page number, and interview numbers were noted on index cards to allow me to locate participants' ideas in the transcripts. To ensure that the themes developed would adequately describe the content of participants' experiences and views while arousing the deeper meaning embedded in them (van Manen, 1997), I developed a web using the categories. This web was reorganized as I developed new insights. The interpretive account was written based on the categories discovered in the data. After about six months of rereading, listening to the audiotapes, and reflecting on the interviews and the interpretive account and reading related literature, I began to see themes emerging. Morse (1994) suggested that, at this point in the data analysis when recontextualizing is undertaken, the work of other researchers and established theories become important to provide context for the findings as well as to demonstrate the usefulness and implications of the findings. As well, Bogdan and Biklen (1998) suggested that an examination of relevant literature during data analysis is important to help work through contradictions discovered in the data.

The themes I have developed represent the sense I have made of the data. To do this I had to approach the data with openness and humility and with a desire to appreciate whatever the data had to offer (Ellis, 1998a; van Manen, 1997). The following three chapters will present the findings regarding the science education prospective primary school teachers are exposed to and should be exposed to in Jamaican teachers' colleges.

Trustworthiness

The convictions of positivist research orientation rely on the accuracy, generalizability, and replicability of a study. Qualitative research, on the other hand,

> is ultimately a matter of persuasion, of seeing things in a way that satisfies, or is useful for the purposes we embrace. The evidence employed in qualitative studies comes from multiple sources. We are persuaded by its weight, by the coherence of the case, by the cogency of the interpretation. (Eisner, 1991, p. 39)

Some researchers who work from a constructivist orientation strive to establish standards by employing trustworthiness so that the traditional researcher concerns related to validity and reliability are satisfied (Guba & Lincoln, 1998). Throughout my study I have sought to ensure some measure of trustworthiness by employing member checks, purposeful sampling, detailed descriptions, and a pilot study.

Member Checks

The research was based on the premise that people structure their social world independently and interpret their experiences differently. Merriam (1988) suggested "taking data and interpretation back to the people from whom they were derived and asking them if the results are plausible" (p. 169). Participants were therefore provided with the interview transcripts and my interpretations of these in the form of a synopsis and were encouraged to make commentaries (Erlandson, Harris, Skipper, & Allen, 1993; Kvale, 1996), in writing or verbally. However, participants were tardy in responding, and when they did they were mainly concerned with grammatical errors. Some college lecturers asked me to correct all grammatical errors before using any information from the transcripts. Peter, a college lecturer, was concerned about my interpretation of what he said science was. I revisited the transcript with him and made the necessary adjustments to my initial interpretation.

Purposeful Sampling

The participants who were selected provided rich details about the context in which teacher education in Jamaica was being experienced. Before selecting participants, I made inquiries about their background and their willingness to provide information relevant to the study. Gathering this information was done by employing the assistance of key informants (discussed earlier on page 51), and I also visited schools and colleges and had informal conversations with teachers and prospective teachers. One main consideration was that participants who were willing to divulge information should have lived the experiences of primary science teacher education. Erlandson et al. (1993) suggested that participants with lived experiences of the phenomenon under study would be considered as ideal.

Detailed Descriptions

According to Erlandson et al (1993), qualitative researchers do not insist that knowledge gained through this paradigm of research will have no relevance in other contexts. Instead, they contend that because of shared characteristics among persons and between different contexts, knowledge can be transferred across contexts. To ensure that transferability is possible, I have provided detailed descriptions of the participants, the setting, and the context, and included commonalities among participants about the program I studied (Erlandson et al., 1993; Merriam, 1988).

Pilot Study

Focussing questions for the initial interview were piloted with one respondent from each of the stakeholder subgroups of college lecturers, teachers, and prospective teachers. Before embarking on the study I decided to follow the suggestion of Gall, Borg and Gall (1996) and did a pretest of the interview questions that were developed. By piloting the interviews, I was able to reframe the possible questions and the format for my initial interview and to detect which questions were effective and what order of questions was appropriate. I was then able to decide whether the interview was productive or whether I needed to revise the order of the questions and how they were asked.

Piloting the interview questions also helped me to develop and hone my interviewing skills. I learned to listen more keenly to the participants without interrupting and identified a need to provide wait time for participants to collect their thoughts during the interview. The practice of listening to participants helped me to develop and ask probing questions when I detected important points that were raised but not elaborated. It was also by piloting the interview questions that I decided to include informal conversations as part of the data, because the participants in the pilot were more willing to indulge in conversations when the tape recorder was off.

Although the research questions guided the focus of the interview questions, piloting the interview played a role in deciding which questions to include in the interviews and how these questions could best be formatted. As a neophyte in research, I was guided by experienced researchers (e.g., Merriam, 1988; Seidman, 1991; Yin, 1993) who suggested that conducting a pilot study is a useful preparatory component to research.

Ethical Considerations

The research posed no threat to the physical or mental well-being of the participants. All participants were informed verbally and in writing about the purpose of the research and the purpose for which the data were intended. I provided a consent form along with the letter of request and relied on the signatures of participants as an indication of their consent to participate in the research before starting data collection.

Anonymity of the participants was ensured through the use of pseudonyms. I assured the participants of this provision and of confidentiality, as well as their right to withdraw from the research whenever they wished without penalty.

My thesis supervisor was informed regularly of my progress, and I consistently sought advice about any ethical and other considerations relevant to my work.

Delimitations

Participants included only the persons who had been categorized as internal stakeholders in elementary science teacher education in Jamaica. Additionally, only documentary evidence that was directly related to the preparation and policies of primary science curriculum and the preparation, teaching, and evaluation of the *Science Education Course* for prospective primary teachers were involved in the research. All documents were limited to the time period 1990 to 1998, except for documents related to preparation of the existing *Science Education Course*. These were limited to the time period 1983 to 1990.

Limitations

The findings of the study are applicable to the restricted environment and time period in which the study was conducted. However, issues related to the successes and failures of the *Science Education Course* within the Jamaican teachers' college context will be discernible. In addition, it is possible that participants may have withheld information or that some records were not available for my perusal. The data are therefore a reflection of what participants have chosen to disclose and what information was available from documents that were used in the research.

CHAPTER 4

IN THE PRIMARY SCHOOL CLASSROOM

Introduction

According to stakeholders' views, what is involved in teaching science in primary schools?

In this chapter I present the findings related to the teaching of science in Jamaican primary school classrooms as experienced by teachers and as observed by other stakeholders. I felt that if I could understand science teaching from the viewpoints of persons involved in it in primary school classrooms, I would be able to start considering possibilities for a *Science Education Course* that is in alignment with the needs, issues, and practices of science teaching in primary schools. Some of my own reflections and interpretations are interwoven throughout, and at the end of each subsection I have also presented my reflections about the findings and concerns raised. The points discussed in the reflections are those I noted after reflecting on interviews, informal conversations, available literature and documents, and the interpretive account I wrote. I have also presented a summary of my findings at the end of the chapter.

Before embarking on this research I was involved in science teaching in primary schools at three levels: as a primary school teacher, supervising prospective primary teachers for teaching practice, and participating in a small project undertaken by a teachers' college jointly with Canterbury Christ Church College and The Commonwealth of Learning to introduce teachers to resource materials for teaching science. I am aware that by being involved in science teaching at the local level in Jamaica and by completing graduate courses in Canada, I have developed my own prejudices regarding the teaching of science in primary schools. At the beginning of the research, I believed that teachers in Jamaican primary schools did not teach science the way they should and generally did not understand the meaning of terms, such as *discovery learning* and *process skills*, which they often used in conversations about teaching. However, by acknowledging and examining these preunderstandings that I brought to the research, I am able to look beyond these for further understandings of what teachers understood about science teaching and what was really involved in the teaching of science in primary schools as related by these participants.

To provide a picture of how participants viewed the teaching of science in Jamaican primary school classrooms, I have constructed three main subsections: "out there teaching science," the importance of teaching science in primary schools, and approaches used to teach science in primary schools. Categories explored resulted from topical points raised during interviews with participants.

"Out There Teaching Science"

The phrase *out there teaching science* was used repeatedly by participants as they recounted their experiences or reflected on others' experiences in teaching science in primary schools. Two major elements were expressed as a part of the experience of being out there in the primary schools teaching science. The first is that teachers had to teach science without basic science equipment or classroom furnishings, forcing them to teach science with "bare hands." Second, textbooks were the only teaching materials provided by the Ministry of Education and available in all schools. At no time during the interviews and informal conversations did I ask about the classroom constraints that teachers faced; however, all participants referred to the classroom constraints that teachers faced as they taught science.

With Bare Hands

Studies from other developing countries have presented this problem regarding the lack of equipment for teaching science and dilapidated classroom conditions in which teachers have to conduct classes (Bajracharya & Brouwer, 1997; Thair & Treagust, 1999). I have chosen to present this section as a starting point for further discussion in considering possibilities concerning the knowledge that prospective teachers might require as they are preparing to enter the primary schools in Jamaica as teachers. To illustrate what the problems are for teachers and what teachers do as they are confronted with these multiple problems, I will start off by presenting one teacher's experience, which I learned about through the interviews, informal conversations, and personal observations. Following this story I will present participants' reactions to these problems and what teachers experience and do as they are out there teaching science with bare hands.

Nicole is a teacher at a school in a small rural town. When I visited with her to negotiate the date for a second interview, she escorted me to her classroom. It was break time, and she was busy preparing for her next lesson. We had a conversation about her plan to teach a science lesson later that day on "How Hot a Body Is." She invited my opinion on what she had planned to do in this lesson. Nicole had planned to use an electric kettle to heat water so that children could estimate varying temperatures of water. She, like Joan another teacher, was fearful that she might have a "catastrophe" during the lesson.

"This is my cubicle," she said, as we stepped through the doorway. The classroom had one entry point, and decorative blocks were inserted in the spaces where I expected the windows to be. The temperature of the room might have been more bearable if Nicole had not covered the holes in the decorative blocks with attractive, much-needed charts. These were part of the legacy of the college student who had been in her classroom for teaching practice, and now these charts had become her teaching aids.

The room in which Nicole's class was housed adjoined three other classes. To accommodate all four classes, the large room was partitioned by rows of chalkboards. Nicole's "cubicle" was approximately 10' by 18'. The young, energetic woman related what she visualized her lesson would be, but she wondered whether she should distribute the disposable cups of warm water to children or just have demonstrations. She paced the narrow passage between double rows of benches and asked for suggestions on dealing with the problem of stretching across the first row of children to supervise children sitting in the second row of benches.

"Do you know how many children I have in here?" she asked. Although she was not waiting for an answer, I shook my head to indicate no. She pulled her attendance register from under a pile of exercise books to show me that she had 60 children on roll, with forty attending regularly. "If all of them come to school, I would not have enough benches to seat them," she said.

A bell tolled, and children rushed to the door. After pushing each other for some time, the children settled into two queues, boys in one and girls in the other. Nicole mimed a command to the waiting children; they filed inside. I watched as the children climbed over the benches and others and squeezed into their little spaces.

I have told Nicole's story because what she faces, with only a few differences, seems to be typical of teachers in primary schools in Jamaica.

> There is no equipment in the primary school to teach science, and the only books . . . about science are the textbooks. I have to find my own resources, and sometimes I get really fed up with it. Every time you have to go out and find, make, or borrow things to use. We do not even get assistance to buy little things like vinegar; I have to bring things from my own kitchen. (Paul, Interview 1)

All the teachers in the research shared the same frustrations they felt about the lack of resources and equipment for teaching science in primary schools. Teachers indicated that their teaching was constrained by circumstances such as a lack of basic equipment and resources, the size of the classrooms, the structure of the classrooms, the number of pupils in each class, the types of furniture, and generally overcrowded conditions. These were major factors that created other problems for teaching. Nicole was adamant that under the present classroom condition, the way that she taught science was the best that she could do:

> Well, I teach science as I want to, because I have forty children in this little cubicle here. [Nodding to indicate the space in which we were sitting.] There is no room to store anything, not even enough room to move around from desk to desk to supervise the children. There are three or four children to each of these desks. [She points to the desks that were built to seat two children.] Nobody in their right mind could expect me to do any more than I am doing under these conditions [pause], and every year it gets worse. Sometimes I don't even have chalk, much less equipment, so I wouldn't bother to talk about that. (Interview 1)

Nicole said that most of the time she used the textbook when she taught science. Similarly Joan, another teacher, complained repeatedly about the classroom conditions and lack of "basic equipment and materials" for teaching science.

> There is no electricity [in the classroom] to carry out certain experiments. With regard to the topic that we are doing now, if we had electricity [to use as a source of heating], then I think the children would learn better. You see, instead of taking children outside to build a fire that could harm them, with electricity I could just plug in a kettle [and make a water bath to use as the heat source]. I am not going to do it. I am not going to go outside to make a fire with these children. I would be insane [pause]. Not with these children. (Interview 1)

The teachers did not seem happy about teaching science through "chalk and talk," and some teachers, such as Nicole, were jaded having had to endure these infrastructural constraints for many years. Valerie, a university lecturer, understood the plight of the teachers:

> The truth is, people are going to be frustrated unless we really are go-getters regardless of—unless you have come to the point where you are willing to go all out, and many teachers are not like that. And let's face it: How long can they last when doing that sort of thing? Many people can't be like that, and it is not a matter of not wanting to be like that; they can't. They are constrained by all sorts of factors, economic, time, all kinds of things; so they really can't be persons who will always be gathering little bottles and other things at all times. They won't. And that is a real difficulty that primary school teachers have. (Interview 1)

Although colleges were preparing prospective teachers to function in these schools, some colleges lent basic portable equipment such as thermometers, models, rulers, and balances to prospective teachers when they began their teaching practice. "Finding equipment to use for teaching certain science topics like heat and pulleys during teaching practice is not usually a problem once these are ordered on time from the lab technician at the college" (Shernette, Interview 1). In an informal conversation with Vicky, another prospective teacher, she told me that while she was on teaching practice, she carried all the basic equipment she needed for teaching science, but that her major problems were lack of space and noise from other classes. She had to conduct her science lessons outside, when the weather permitted.

Some college lecturers (Pet, Peter, Ann) mentioned that some colleges lent equipment. Apparently, this practice was intended to assist prospective teachers because "[they] did not need the stress that the lack of equipment for teaching can add" to the initial trepidation they experienced during teaching practice. Prospective teachers from those colleges that lent equipment seemed to appreciate this gesture and welcomed the initiative.

Sophia, a JBTE appointee, was speculative about the constraints associated with teaching science in the primary schools. She commented that the tendency of teachers to focus on teaching basic process skills when teaching primary school science had created the need for basic equipment, which teachers complained that they did not have in schools:

> I would not put the emphasis so much on, yes, manipulation, yes, observation of the simple kinds of things. If we want to stress manipulation skills, we will always complain about lack of equipment; we will always want the expensive thermometers and the expensive balances and all that sort of thing. (Interview 1)

Later, in one informal conversation, Sophia explained that although she was in favor of teaching basic science processes, teachers "can get around the understanding of science processes without the use" of equipment that schools are unable to afford. She favored the creative teacher who is able to "improvise some of the very things that we complain that we do not have in primary schools." But Joan reiterated that improvisation of some materials and equipment can be hazardous to children. She cited the possibility of endangering children by giving an example of using hot water in her classroom where the benches were not sturdy enough. She expressed fear that children would spill hot water on each other as a result of the dilapidated condition of the benches and other classroom furniture.

The feeling of frustration about the conditions of their classrooms and the disparity between the physical dimensions of the classrooms or "cubicles" and the enrollment was obvious among teachers. Teachers defended the way they taught science by referring to the multiple constraints that they faced in the primary schools. Bailey, Brown, and Lofgren (1996) believed that in order to "successfully deliver a curriculum, certain frame factors have to be in place" (p. 3). They suggested that one of these factors is facilities and equipment. Two documents, one produced by Bailey et al. (1996) for the Primary Education Improvement Project (PEIP-2) and the other by the World Bank (1993), confirmed the plight of the teachers with regard to the lack of or poor condition of school facilities and equipment. Bailey et al. found that in Jamaica "science equipment of doubtful quality existed in 78% of urban and rural schools but none was found in deep rural schools" (p. 4). The widespread poor physical facilities are only one of the areas that has significantly affected schools and teaching in Caribbean primary schools (World Bank, 1993).

The cubicles that teachers complained about in this research were found to be one of the factors contributing to the intolerable teaching environment that Bailey et al. (1996) and the World Bank (1993) reported on. The World Bank's report also suggested that the average ratio of teachers to children in primary schools in Jamaica varied with location. The survey showed that the average in urban areas is 1:45, and in the deep rural areas, it is as low as 1:38. The same report indicated that only 16% of the schools surveyed had classrooms that were described as being "in good condition," whereas 37% were deemed to be "in bad or very bad" condition. Bailey et al. reported that 43% of the teachers surveyed indicated that they had between 1 and 20 seats missing from their classrooms. Nicole's classroom reality demonstrated the intensity of the problem.

My Reflection

The daily challenges of teaching science were evidenced in the plethora of observations and experiences related by the participants. Some teachers, such as Joan, might not have had electricity in their classrooms; and other teachers, such as Kay, might have had a separate classroom instead of a shared room partitioned by chalkboards. However, they all complained about the infrastructural constraints. Notwithstanding these constraints, the teachers all seemed to be putting some effort into teaching science so that children could experience some science activities.

It is obvious why lecturers would be apt to lend prospective teachers basic portable science equipment. Understandably, lecturers try to assist prospective teachers in making the transition from the college classroom to the primary school classroom. However, notwithstanding the good intentions of the lecturers, they might help students devise other means of coping with classroom constraints, as if there had been no equipment for loan. Teaching practice should be part of a process preparing teachers to face all aspects of classroom life, and coping with the lack of equipment for teaching science is one part of primary classroom life.

Whereas some stakeholders (Valerie, university lecturer; Pet, college lecturer) showed empathy for teachers, others (Jerry, JBTE appointee; Sophia, JBTE appointee) suggested that teachers could adapt better to classroom conditions. Valerie and Pet were involved in teachers' classroom lives and were often in schools while teachers were teaching science. Valerie and Pet were both doing research in Jamaican classrooms.

Valerie, a university lecturer, indicated that she knew the difficulties that teachers faced but implied that although she had empathy for the teachers, she expected science teaching to be different, more activity oriented, rather than constrained by the lack of resources.

Although other stakeholders did not mention the responsibility of government in assisting with the infrastructural problems, Valerie spoke emotionally about this issue. She suggested that government and policy makers needed to accept responsibility for providing necessary school facilities and teaching materials. But Miller (1997) pointed out that our country's limited economic resources and international indebtedness have greatly affected the resources and infrastructure of Jamaican schools. Evans (1997) agreed with Miller when she found that Jamaican beginning teachers' approach to teaching was greatly influenced and constrained by school facilities and classroom conditions.

It is not surprising that Joan complained about the added frustration of children being aggressive to each other and disruptive during science lessons: "These children who I see pushing each other, throwing things around, just being boisterous, I can't contain them in the classroom under ordinary circumstances; how am I going to do that when I am using hot water?" (Interview 1).

Studies conducted in Jamaican schools have suggested that in the crowded classrooms children become problematic and aggressive, leading to frustration among the teachers (Davis, 1997; Evans, 1997). Therefore, when teachers planned for and reflected on science teaching, they attended to behavior and attitude problems. These ranged from simple disruptive tendencies to insolence, learning problems, different levels of ability, and disabilities (Evans, 1997).

Using Textbooks

It appears that when teachers talked about their experiences out there teaching science, coping with infrastructural constraints was a major issue. Besides feeling that they were teaching with bare hands, some teachers expressed their views on the use of textbooks. I will focus on Janice's experience as I explore the use of textbooks in teaching science.

The small school in which Janice taught was perched on a hill overlooking the sea. The schoolyard was paved; there were no fencing and no playground. The street in which the children played was hardly discernible from the school grounds. Janice's classroom was next to the street parallel to the school building.

Janice, a Grade 1 teacher, was interviewed in her classroom one afternoon when the breeze from the Caribbean Sea was just cooling. Her classroom was much like that of Nicole. It was housed in a large room, which was partitioned by chalkboards so that three other classes could be accommodated. One of the occasional puffs of wind swept through Janice's classroom door, scattering the piles of books she had on her desk and displacing the floral vinyl tablecloth that covered her table. I could sense that she was annoyed when she hissed quietly, looking at me through the corners of her eyes. "Sorry," she said. I retrieved the books from the floor and helped her stack them into neat piles. Janice took four conch shells from the drawer in her desk and placed one at each of the four corners of the table to secure the tablecloth.

While I was stacking the books, I could not help noticing that one set of books was the science workbooks that children in Janice's class had been using. I asked her to let me browse through the books while she finished her lunch. We had a little chat about the use of the books. Janice said that it was so much easier to have children use the books for science rather than having to draw on the board or on charts. "When children have their own books it is much better. I can mark their work and keep up with their progress," she said. Browsing through the pages, I could see that the children had completed several exercises, looking at self and using the senses to determine texture, shapes, color, and sizes. There was a sense that simple activities had to be done with the children in order for them to have completed some of the exercises in the workbooks. One exercise in the workbook showed that the children had grouped real leaves according to color, shape, and size. Janice must have provided the leaves for the exercise. The children had also drawn leaves in their workbooks and described each as large or small, heart shaped or long, green or brown. Janice had a simple science corner of a few charts and some manipulatives, but she told me that the textbooks and the workbooks were her main teaching tools for science. She also mentioned that the children were not allowed to take the books home. They were kept in a cupboard so that the children could not destroy them.

"Science textbooks are the only materials for teaching science that you can find in the school" (Paul, Interview 1) was a commonly expressed view of the teachers and prospective teachers who were interviewed. Teachers repeatedly made mention of teaching science from or with "the textbook." Whereas some teachers defended the use of these books as their major tool for teaching, others considered their use very limited in teaching science. Joan justified the use of the textbook:

> The book you see, the book [pause] for every topic that you are going to teach, the objectives are there, and the information for the particular lessons are there, so it is not a matter of going to seek the information. Whatever you have in the book can help you a lot, even if you don't have previous knowledge. . . . The book is so straightforward that you can deliver the lesson without previous knowledge. (Interview 1)

Kay (a Grade 5 teacher) expressed a different point of view:

> [Science] is kind of boring for the children and the teacher because children do not learn much when we have to do a lot of chalk and talk and look into the textbooks to see activities and draw diagrams. That is not enough. They [the children] take up the book and they read it, and you know that they don't really read it for themselves; they read it because you tell them to read it. They don't enjoy doing it. (Interview 1)

Janice intimated that teachers "rely heavily" on the textbook for direction in teaching science and to provide "ready-made" activities for the children. Janice noted that teachers seldom got to do the activities from the textbook because they required resources and equipment that were not available in the school. She mentioned that nobody had ever taught them how to use textbooks as a teaching tool.

Donna, a college lecturer, voiced concern about the overuse of science textbooks in primary school teaching. She pointed out that because textbooks are so widely used in schools, it is necessary to "teach" this "important skill" in teachers' college as a part of the *Science Education Course*. The conversation continued:

> *Lena:* So do you teach them [the prospective teachers] anything about the use of textbooks since it is such an important aspect of a teacher's classroom life?
>
> *Donna:* How to use textbooks? We really don't have the time to teach them to use textbooks, and, you know, using a science book to find information is not exactly like using a reading book. It is a specialized skill. (Interview 1)

During a second interview with Jerry, a JBTE appointee, he expressed the fear that "teachers out there in the primary schools are relying too heavily on the textbooks as their main teaching tool and as a way of escaping the real teaching of science." Jerry suggested that children in primary schools should be doing activities related to "questions they themselves ask about these [scientific] phenomena" so that science would become more of "investigating to find answers for questions they have about concepts" rather than reading about activities in science textbooks. Like Jerry, Donna, a college lecturer, suggested that most teachers are not confident to teach science and added that most primary teachers "don't have much content" and therefore rely on the students' textbooks:

> They don't seem to be aware that the teachers need to know more than the students, so you will not find them with reference books on their desks or even going through books that they use in college. They use the students' books, and that is about it. (Interview 1)

Valerie, a university lecturer, also observed that "teachers do have the tendency to use textbooks" for teaching science. However, she suggested that this inclination manifested itself "when they [teachers] don't have things at their disposal." Valerie also explained that teachers who had been in primary school classrooms for many years and who had enrolled in the Bachelor of Education program at the university had limited knowledge of science concepts in the primary school curriculum.

During second interviews and informal conversations, the teachers informed me that they preferred to use "hands-on" activities to teach science, but lapsed into teaching from the textbook because the necessary resources and equipment were not provided by the schools. Without the equipment and resources, using the textbook was the easiest way to show children what an activity would yield or what some science apparatus would look like. Joan was the only teacher who indicated that the textbook provided the required science content knowledge, which was welcome because she was "not a science person."

The inadequate numbers of textbooks in primary school classrooms had been an issue until 1988. However, a Primary Textbook Program which was initiated in 1984 addressed that problem so that, by 1991, children in all primary schools were supposed to have access to textbooks for language arts, mathematics, science and social studies (World Bank, 1993). The report also observed changes in teaching practices, because teachers were less apt to use the chalkboard as a textbook substitute.

Although teachers might not have used the chalkboard as a major teaching tool in classrooms, relying on textbooks could result in a repeat of a pedagogical problem that the Government of Jamaica had hoped to solve when the textbook initiative was taken in 1984; that is, a didactic approach to teaching. In the meantime studies by the World Bank (1993) and Bailey et al. (1996) and the voiced experiences of teachers, as shown above, pointed to the adverse conditions under which teachers function in their classrooms. Teachers are therefore using textbooks as a means of decreasing the "chalk and talk" approach to science teaching.

<u>My Reflection</u>

Teachers such as Kay and Nicole indicated that they used textbooks when it was not possible to do otherwise and when children needed to see what some equipment and experiments would be like if they were available in the classroom. One example given by

Joan was teaching about pulleys. Newport (1990) said that many primary school teachers agreed that children are bored reading about science during science lessons, but the textbook offered three attractive alternatives: suggested activities, pictures, and narrative text. Additionally, Joan felt that the textbook assisted when teacher knowledge of science concepts and related experiments was inadequate. Vicky, a prospective teacher, and Joan and Janice, teachers, found the textbook to be helpful in setting and maintaining the desired level of content for each science lesson.

Although textbooks might be helpful to teachers who have limited content knowledge and experience, as suggested by Joan, Janice, and Vicky, relying solely on textbooks for the required content could be less than beneficial to the teaching of science. One possible disadvantage is that science is a practical subject, and when taught as such in primary schools, children learn the methodology of science. If children are not allowed to engage in practical activities, they might not experience and understand how scientists work to develop scientific knowledge. As well, using only textbooks, children might also have a limited view of science: that it is a body of knowledge to be learned from books. Besides the fact that children learn by doing and that they were not doing science when they used textbooks, teachers mentioned no other concerns regarding the use of textbooks in teaching science.

Based on the observation that teachers were inclined to rely on textbooks for teaching science, Rutherford (1987) suggested that science textbooks should be removed from elementary schools because they inhibit good science instruction and provide no forum for children to engage in meaningful science activities. Jerry, a JBTE appointee, did not believe that textbooks should be removed from classrooms; but, as quoted earlier in this section, he felt that teachers were using textbooks when they could be teaching science as more investigative rather than textbook oriented.

Ebenezer and Connor (1998) devoted two pages of their book to explaining how textbooks may be used to support learning in a constructivist-oriented science lesson.

They pointed out that, ideally, students' lessons would not be designed from textbooks but from teachers' understanding of pedagogic and science content knowledge.On the other hand, Appleton (1998) looked at a variety of teaching approaches and techniques and never mentioned the use of textbooks. While these books are not used by Jamaican teachers and prospective teachers, they are indicative of the emphasis that science education book authors and educators place on the use of textbooks in teaching science.

The participants felt that textbooks are an easy means of acquiring suitable activities and scientific principles, textbooks are unable to challenge children's beliefs and conceptions. Ebenezer and Connor (1998) suggested that teachers should explore children's ideas to determine and deal with conceptual conflicts before introducing the children to textbooks. These science educators advised teachers not to expect that when children read textbook explanations regarding scientific problems and concepts, they are reconstructing their personal ideas. Teachers in this study did not elaborate on how they used the textbooks but said only that they used them.

An interesting point to note is that although teachers confirmed and justified the use of textbooks as a large part of the teaching and learning of science, they never mentioned using textbooks as part of their best lesson, which they described in the interviews. This might be an indication that participants did not consider the use of textbooks to be a most appropriate tool for teaching science.

Why Is it Important to Teach Science in Primary Schools?

In the last two sections the expressed views of participants suggested that teachers in primary schools preferred to teach activity-oriented science but tended to teach science using textbooks, which are the most readily available teaching resources in the schools. Because all stakeholders repeatedly stressed that science activities should be or are used during primary science lessons, but also that textbooks are the most-used teaching materials in science lessons, I analyzed their views about why it is important to teach science in primary schools. By gaining an understanding of the participants' ideas about the importance of teaching science, I aimed to achieve two ends: (a) to discover their understanding of the use of activities in science teaching, and (b) to develop insights into aspects of a useful knowledge base for prospective primary school teachers. As expected, they expressed diverse views about the importance of teaching science in primary schools. I identified themes across and within stakeholder subgroups and grouped them as follows: Science was taught so that children would

- become good citizens, and
- develop skills and attitudes related to doing science.

Surprisingly, the view that teaching science was important to ensure that children pass the newly implemented Grade Six Achievement Test (GSAT) was expressed by a few of the participants. Each of the above will be discussed here.

Science Is Important to Help Children Become Good Citizens

The opinion that science was taught in primary schools to help children become good citizens was apparent in several phrases used by participants during the interviews: to achieve scientific literacy, to apply knowledge of science to everyday living, to help children to become socialized, to encourage children to value persons and things in the environment, to encourage children to take responsibility for their actions, and to help children consider the effects of their actions on the environment.

The Science for Living/Scientific Literacy Perspective

For Sophia, a JBTE appointee, teaching science to children in primary school should help develop an understanding of

> some simple concepts to do with matter, materials, and living organisms, and physical processes on the simple level, and doing this mainly through their own investigative work. An understanding too of how science relates to their everyday life; for example, why they should not put bleach down a toilet because it might kill the bacteria which is working on the thing. Or, you know, chemicals in the home: how ecosystems and organisms relate to each other, these things that they

> see about them in ordinary life: how electricity works in the home, what they should or shouldn't do; you know, conservation of water, how science operates in life. Because at this level we are not thinking of future scientists as our primary aim of science teaching. The majority of these people are going to need science for life after. And I think that that should be really the emphasis: They should get an understanding of the nature of science. (Interview 2)

Conversely, university lecturer Valerie felt that science is important to everyday living and added that achieving scientific literacy is an important element to consider when teaching science:

> *Lena* : What are your views about teaching science at primary school level? Why is it important?
>
> *Valerie*: I think science at primary school should . . . build a sense of recognizing that science is important for their daily living, having scientific literacy. This is the business of helping children to become aware of the importance of science for progress, yet without the rigid structure of the content, the content, the content. I think we need really to develop interest, to develop some attitudes, good attitudes toward science, and an openness in discussing scientific issues. Science is really helping children to come to grips with their curiosity and to extend this curiosity to it fullest. (Interview 1)

It seems that these participants were suggesting that by learning science in school, children would be motivated and willing to apply the principles of science to everyday living. Additionally, it appears that these two participants viewed school science activities as the means through which all aspects of science are understood and appreciated. These participants' views also indicated that by learning science in primary school, the populace would be better able to participate in critically analyzing science/society-related issues and would thus be better equipped to make decisions.

College lecturers felt that scientific literacy was supposed to be an important element of science education in Jamaican primary schools. During the second interview, Pet, a college lecturer, suggested that primary school science was the "only avenue" that some children have for developing scientific literacy, because many of "our children, especially those in deep rural areas, do not attend secondary schools; and when they do, they drop science anyway." Our conversation continued:

> *Lena*: Tell me some more about scientific literacy. What does it mean?
>
> *Pet*: Knowing about concepts that will help you to live comfortably in the world. To be able to make judgements about things that are good or bad for them and right or wrong to do.
>
> *Lena*: Give me an example.
>
> *Pet:* Let me see now. Like that media report we had the other day saying that the Halfway tree area had shown a rise in the concentration of lead in the air. The public should be able to make personal decisions about our habits so that we can do some thing about the concentration of lead, because if we knew about the science of it, we would know that lead is not for people to be around. The same thing applies to people who go out of their way to collect and dismantle old car batteries in their yards with their children around. It is because they don't know the dangers of it, why we do it. And teachers should be the first to set the example, to be able to teach others about the dangers and what to do or not to do. Get the children and their parents aware of the implications of doing things.
>
> *Lena*: Would it [scientific literacy] be the same as science for living?
>
> *Pet*: In a way. Science all around us; the same thing as science for living, but scientific literacy goes beyond that, yes. You see, scientific literacy is the end point of science for living. By understanding science for living, we become scientifically literate because we start to make decisions based on what we learn in science for living. (Interview 2)

Like Pet, other lecturers (Monica, Donna), along with Valerie and Sophia, suggested that if primary school science was taught as "science for living" or "science for life," this would promote scientific literacy among children. Their views indicated that science for living or science for life provided a foundation for children to understand how scientific knowledge could be applied to their activities in everyday life. Consequently, primary school science was considered as a gateway for citizens to start considering the consequences of their everyday activities such as using household chemicals and of their conservation and waste-management practices, which appears to be science for living and a starting point for scientific literacy.

The government of Jamaica seems to have had an agenda for science education wherein scientific literacy through science education at all levels of schooling was considered as a means of providing the foundation for Jamaica's economic prosperity. The Ministry Paper No. 16, *Science and Technology* (Office of the Prime Minister, 1994) and *Science and Technology: A National Policy* (Ministry of Development, Planning, and Production, 1990) both referred to scientific literacy. However, the meaning ascribed to the phrase was not clear. Both documents outlined developments in science and technology as the avenue through which Jamaica could acquire substantial economic growth. These documents suggested that the education system was targeted to play a pivotal role in helping Jamaica achieve this end. According to the document *Science and Technology: A National Policy*, "The government of Jamaica recognizes that the education system lies at the heart of this development [of local scientists and scientific knowledge], which requires a broad spectrum of scientific and technical training, including scientific literacy" (p. 5); whereas, according to Ministry Paper No. 16, *Science and Technology*, "The entire education system, from primary to tertiary, will be required to display a greater awareness of science and technology as an important factor in personal and national life" (p. 7). Science and technology were expected to be the vehicle of growth and development of the Jamaican economy, and the education system was the means through which scientific knowledge and technological advancements should materialize. Apparently, Ministry Paper No. 16 implied that to be scientifically literate is to display greater awareness of science and technology as an important factor in personal and national life.

Teachers and prospective teachers made no mention of the nature of science or scientific literacy in the interviews. The teachers considered the importance of teaching science in primary schools from an environmental science perspective.

The Environmental Science Perspective

Winsome, a teacher who was actively involved in a local environmental organization, very forcefully advocated for primary science as an avenue through which primary school children start to analyze the consequences of their actions on the environment. Winsome said:

> As I told you before, it [science] is a part of daily living, a part of the environment. Just about everything that children do, there is some science involved. . . . And when they become adults, if they do not have an understanding of the consequences of some of their actions, the whole world suffers. Primary school is the place to start sensitizing them to science. I do a lot of this with my Grade 1. We talk a lot about the environment and what we can do to protect the environment. . . . When we go outside to collect leaves, because we study leaves, I make sure that they do not destroy the plants. These are little things that we can do in primary school with the children, and it adds up. I think that children should know the good things about it [science] and the bad things about it. (Interview 2)

Whereas Winsome's affiliation to the local environmental organization seemed to be a major influence on her views about the importance of teaching science, Nicole, another teacher said:

> I think it is important to teach science in primary school because children learn to take care of the environment, because primary school science, in primary school science we have to use things from the environment. We don't have fancy equipment, and so we have to use the environment, you know, sticks, stones. And as teachers we have to show the children how to use the environment carefully so that when they grow up they will try to do better than their parents are doing right now. For example in Grade 4 when we look at soil and rocks, we have discussions about soil erosion and how farmers and other humans contribute to soil erosion. Children are aware of what hillside farmers do; you know, this slash-and-burn thing. They talk about it, and they sound so naïve as if, you know, it is nothing. And again, you see, even if it is not in the syllabus, you know to teach them that. But as teachers we have that responsibility to help them to be aware of how to take care of the environment, and primary school science gives us a good chance to do that. (Interview 1)

Janice, another teacher, also suggested that by learning science, children learn to be responsible for the environment; and as they grow into adult citizens, they become more aware of the consequences of their actions and how these affect the environment and, eventually, humans. Neither Nicole nor Janice was associated with an environmental organization. It is not surprising that teachers seemed preoccupied with environmental preservation, because this has been topical in the local media, and issues related to this subject have been raised repeatedly by local environmental protection agencies.

Whereas teachers highlighted an environmental perspective for teaching science for citizenship, lecturers and JBTE appointees highlighted a scientific literacy/science for life perspective. Surprisingly, the expressed views of prospective teachers did not include any aspect of primary science as important for developing good citizens. However, they did indicate that teaching science was important for developing skills and attitudes among children.

Teaching Science so That Children Will Develop Skills and Attitudes

Another commonly expressed view regarding the importance of teaching science in primary school was to help children develop skills and attitudes.

Attending to the Process Skills

Lecture notes acquired from two college lecturers, Pet and Peter, showed that skills were presented in the *Science Education Course* under the heading, "Inquiry Skills/Processes of Science." Additionally, Young (1988), in his textbook which is used for the *Science Education Course* in the colleges, presented observing, manipulating, communicating, measuring, experimenting, classifying, making inferences, and predicting, among others, as skills that scientists use when doing scientific investigations (pp. 9-31). A similar set of skills, under the heading "Inquiry Skills," was presented to teachers at a Government of Jamaica/International Development Bank (GOJ/IDB) workshop. It is important to note that the draft copy of the primary science curriculum, which is still under review (Ministry of Education and Culture, 1998) also emphasizes the development and use of process skills in science teaching/learning.

The following excerpts from participants' responses provided an insight into the expressed views across and within stakeholder subgroups about the place of processes in teaching and learning science in primary school:

1. Prospective Teachers

> *Vicky:* It [science] is a subject that teaches the child the process skills, like how to observe and manipulate objects and how to classify things, teaches them how to record information, experimenting, and so on. (college student, Interview 1)

2. College Lecturers

> *Peter:* Developing skills that are necessary for problem solving, not just in science, but in life. Manipulation skills, attitudes—attitudes are very important. (college lecturer, Interview 1)

> *Monica:* It [science] helps them [children] to develop skills so that they will understand and manipulate their environment. (college lecturer, Interview 1)

> *Ann:* Emphasis on process skills is what I would be looking for [in science teaching in schools], because I am stressing the skills and attitudes and how you can approach an investigation. . . . Students should be given the opportunity to develop their process skills and problem-solving skills, because I believe that these are important. (college lecturer, Interview 1)

3. Primary School Teachers

> *Paul:* So what we do in primary school is to let them [children] do lots of activities, and this helps them to learn the skills. . . . I do not think that any teacher expects children to go out there and try to develop new knowledge. I think that primary school science should be taught to help children acquire the attitudes and skills that will be helpful to them in later years. (Interview 1)

For the second interview Paul was asked, "Tell me a little about skills that children develop in science lessons."

> *Paul:* When they do an activity they have to use their senses, and so they develop the skills like observing and manipulating. (primary school teacher, Interview 2)

> *Winsome:* It [science] helps them to develop their thinking and reasoning skills. (primary school teacher, Interview 1)

In the second interview I said to Winsome, "Say a little about developing thinking and reasoning skills that you mentioned in the first interview."

> *Winsome:* You see, when we have children engaged in activities, even in group discussion when we are not doing an experiment, they have to think. You ask them questions that make them think about things that might not even pertain to science; you let them solve problems about things that happen in the environment, like, "What would you do if when you go to the pipe for water there is none?" Give them things to think about so that, you know, that you are allowing them to use their thinking skills. (primary school teacher, Interview 2)

The above excerpts indicate that these participants viewed skill development as important, and that process skills were important to children in their everyday life and to help them learn science when they advanced to further learning (Paul, Monica, Peter). Surprisingly, participants did not mention that by engaging process skills and maintaining attitudes related to experimenting and investigating, children could begin to understand what constitutes doing science and the development of scientific knowledge. Instead, it seems that participants were preoccupied with developing process skills and attitudes.

Developing the Process Skills

The participants suggested that process skills might be divided into two groups. One group includes manipulation, observation, and classification; and the other group, thinking and problem-solving skills. Participants also seemed preoccupied with the idea that science activities were conducted so that children could develop or learn skills through repeated use of these skills in different science activities.

The development of skills also appeared to be emphasized in the *Science Education Syllabus* for preparing primary teachers (JBTE, 1990) and in the Primary School Curriculum (Ministry of Education, Curriculum Unit, 1985). Young (1988), in his prescribed textbook for the *Science Education Course*, elaborated on teaching science through a "process approach" (p. 32). Examination papers for the prospective teachers (JBTE, 1993-1998) included questions that assessed prospective teachers' knowledge of the importance of developing and using skills in planned science lessons.

The development of science processes was viewed by teachers, prospective teachers, and college lecturers as an important aspect of science teaching and learning in primary schools. The participants seemed to place greater importance on learning some process skills than others. Although the JBTE appointees and the university lecturer did not initially mention skill development as being important, after probing questions, Sophia indicated that in primary science, emphasis should be on thinking and problem-solving skills rather than the basic skills of manipulation and observation:

> *Lena:* Teachers I have spoken with say that they are mainly concerned about developing skills when teaching primary science.
>
> *Sophia:* I am not negating that skills development is important. You know, in understanding science for life, you must have certain skills development. . . . The skills that I would like to see more developed are the thinking skills and the critical-thinking skills and the early practicing of problem-solving skills as emphasis.

Sophia assumed that teachers were interested in developing the more basic skills of manipulation and observation and that they were not being attentive to problem-solving and thinking skills. However, as shown in the excerpts about the use of process skills, science teachers were mainly concerned with problem-solving and thinking skills.

Participants tended to frown at skills such as manipulation and observation. I therefore assume that they viewed some process skills as being more worthy of development than others. If so, it could be argued that these participants felt that when children were doing science, they inadvertently used skills such as manipulation and observation (the more basic skills) to accomplish the higher-order skills associated with problem solving and thinking. Hence, during the interviews, participants might not have considered the basic skills (observation and manipulation) as being important. On the other hand, it is not known from their views whether participants attended to the development of the basic skills before expecting children to accomplish the higher-order skills. It is also not clear whether these skills were presented to prospective teachers in college as hierarchical. Neither the interviews, lecture notes, examination papers, nor the text suggested that a hierarchical perspective of process skills was presented as a part of the *Science Education Course*.

Participants seemed to refer to process skills as the processes used by scientists for accomplishing investigations. This is one characteristic of teaching science through a process approach, as mentioned by the American Association for the Advancement of Science (AAAS, 1965) and Millar and Driver (1987). According to the AAAS, instructional programs associated with the process approach to teaching science are aimed at intellectual development, which is expected to result from an orderly progression of learning activities. Although teachers mentioned that they provided opportunities for children to practice process skills to ensure that they were developed, it is not clear whether a hierarchy of the process skills was considered when teachers designed learning activities for school science. Neither was it clear from the expressed views whether teachers considered a progression of activities. They did not say, for example, that they provided opportunities for children to develop skills of simple observation before moving to more complex process skills such as controlling variables.

Surprisingly, only one participant (Winsome) mentioned that she felt that there were different levels of complexity in each process skill. Although the *Science Education Syllabus* provides a developmental view of how children learn (Unit 2), Winsome explained that it was through activities in a professional development program directed by the Ministry of Education and funded by the Organization of American State (OAS) that she came to this realization. On the other hand, Valerie, a university lecturer, implied that teachers probably referred to Piaget's developmental theory in making pedagogical decisions for science lessons. Valerie argued that the influence of Piaget's developmental stages in learning is a limiting factor in teaching/learning decisions for primary school science:

> You see, Piaget, when we do Piaget, we sometimes end up with the thinking that children can't learn this material now, and that is not necessarily true. Maybe the reason they can't learn it is because of the way they [the teachers] are packaging it, because if this is not his intention, this is how it comes across to the teachers. . . . I said this to my teacher the other day: "Have you ever tried using things like graphs and tables in your assessment?" And there and then the response was, "They can't handle it. It is too abstract." I haven't really done any kind of analysis, but I have a feeling this is really coming from Piaget. (Valerie, Interview 1)

I did not sense that Piaget's developmental theory influenced how teachers choose the process skills they wished to develop in science lessons.

Skills and Attitudes

Along with process skills, participants viewed attitudes as an integral part of primary science. During the interviews participants talked about skills and attitudes as complementing each other:

> Students should be given the opportunity to develop their process skills and problem-solving skills, because I believe that these are important so when they go to the secondary schools at Grade 7, then they would have these skills and these attitudes, desirable attitudes. (Ann, Interview 1)

In the first interview with Valerie, attitudes were presented as a very important aspect of primary school science:

> *Lena*: Tell me about your views regarding the teaching of science in primary schools.
>
> *Valerie*: I think we really need to develop interest, to develop some attitudes, good attitudes toward science. . . . Science is really helping children to come to grips with their curiosity and to extend this curiosity to its fullest. (Interview 1)

In these two excerpts, attitudes and skills not only complemented each other, but they were also seen as a substantial parts of what appeared to be the learning outcomes of primary science.

Notes from a document produced for in-service training of primary teachers, *Science: Attitudes and Values* (Ministry of Education, 1987), demonstrate the longstanding emphasis that has been placed on developing attitudes through science teaching. In this document 17 attitudes of science are listed. Of the 17, 10 required students to be willing participants in the teaching/learning process. Words such as *interest in, willingness to, appreciation of, desire to, sensitivity to, recognition of* and *preference to* were used to state the attitudes. The attitudes focussed on carrying out the process of science, personal safety, sensitivity to living things, skepticism about scientific results, record keeping, the role of science in everyday life, and working together in groups.

In one informal conversation with Valerie and one with Jerry, they mentioned that using skills and possessing the right attitude toward science and scientific investigations were the key attributes of students who would eventually "end up" in science-related vocations. Apparently, to the participants, developing attitudes with the skills used by scientists was a means of encouraging children to work like scientists. Although the data showed that the participants were keen on developing skills and attitudes through science activities, the data did not suggest that learning these skills and attitudes was intended as a means to learning scientific knowledge. Instead, participants seemed to treat process skills as an end rather than a means; for example, where participants never indicated that by using process skills in science activities they were helping children to achieve intellectual competence as is intended by the process approach.

Science Processes or Science Content

During and after the interviews with the participants, I became concerned about their tendency to emphasize the teaching of process skills and to seemingly de-emphasize the development of scientific knowledge. It seems that because the development of processes has been advocated in the college methods course as a central focus of primary science, some participants appeared to be experiencing pedagogical uncertainty regarding the place of science knowledge in teaching and learning at the primary school level. This tendency was discerned among teachers, prospective teachers, and lecturers. Participants were encouraged to elaborate on the role or place of science knowledge as they sought to develop process skills in their teaching. Two examples typified the responses among teachers and lecturers.

Here follows a conversation with Winsome, a primary school teacher:

Lena: What aspect of science do children learn more about in your lessons? Is it these skills and attitudes you have mentioned, or is it the product or knowledge of science?

Winsome: Well, I think it is more of a balance. Based on the context in which it is done, one lesson might be more knowledge and another might be more skills and attitudes.

Lena: What influences whether the children learn more knowledge or skills?

Winsome: Well, it may be the topic. If I can find a way to develop activities and find a way to improvise apparatus, then they will learn more skills than knowledge. I shouldn't say it like that. What I should say is that when they do the activities they get a chance to learn more of the knowledge through the activities, because by doing the activities they learn attitudes, skills, and knowledge. But sometimes when the topic is more of an environmental type, I make a special effort to develop attitudes that will help them to preserve the environment.

This is what Ann, a college lecturer, had to say:

Lena : You said that the process skills are important. How would you rate process skills against knowledge? Would they be on the same level, or would you rate process skills as being more important than content at the primary level?

Ann: That is an interesting question. I have never thought about it before, so I am now thinking on the spot. I think knowledge is important, but I am not so sure how much children will be able to understand at that level, so I am not sure. (Interview 1)

Later in the same interview, Ann mentioned that she would like to see aspects of a "constructivist sequence" included in the science education for primary teachers. At this point I decided to revisit the issue of knowledge versus process skills:

Lena: It is interesting that you should talk about adopting some of a constructivist teaching sequence. If they are going to adopt some of it, would the question of content versus process skill arise?

> *Ann*: Yes, yes, because it is heavily learner centered, and the learner draws upon the process skill and the higher order process skills to learn the content. Well, maybe that is an answer, but I think I was afraid to say that knowledge and process skills should be equal. (Interview 1)

In the second interview with Ann, we continued the conversation:

> *Lena*: Why did you say you were afraid to mention that knowledge and process skills should be taught as equal in primary school science?
>
> *Ann*: Ever since we spoke I have been grappling with the idea, and I really have not come up with a reason. However, I was thinking that maybe none should take precedence over the other. They are both very important for primary-school children to learn, and they really should be engaging in activities so that they can practice the process skills. But while they are practicing the process skills, and especially the higher-order process skills, they are learning some science knowledge. I am thinking aloud here, but that is my feeling. (Interview 2)

It was apparent that both participants were unsure about the place of content in the teaching of primary science and were grappling with the idea of science as involving process, product, and attitude. Science as "process, product, and attitude" was an expression used by several participants and emphasized in the *Science Education Syllabus*. What primary school children were expected to learn through a science activity was an uncertainty. If learning process skills was emphasized, and learning scientific knowledge/content was de-emphasized in primary science teaching, then learning process skills was being treated as an end in itself. Ebenezer and Connor (1998) suggested that although process skills are important in the teaching and learning of science, they should be used by children while they are constructing and negotiating science knowledge during science activities. They suggested that when children use process skills during activities as they construct meanings and negotiate science knowledge, the use of process skills then become a means rather than an end.

If teachers and lecturers are not clear on the role of either process skills or knowledge in science teaching and learning, children might not be benefiting from either in activity-oriented science lessons.

Teaching Science to Prepare Children for the Exam

Participants from all stakeholder groups were concerned about the effect that the newly implemented Grade Six Achievement Test (GSAT) might have on the teaching of science in primary schools. For the first time in the history of Jamaica's primary education, science and social studies became a part of the Grade 6 examination in 1998 with the implementation of the GSAT. This GSAT replaced the Common Entrance examination[6] that screened children for high school[7] placement. Science was not a part of the common entrance exam; therefore, teachers taught science irregularly. With the GSAT now implemented, teachers in primary schools have to teach science to prepare children for the exam. Sophia commented on this:

> *Lena:* What are your views about the present status of science teaching in primary schools?
>
> *Sophia:* Let's put it this way. I am happy on one hand and sad on the other about numerous things. I am happy that science has gained status at the primary level because, whereas it has been in the curriculum officially since 1980, teachers in many schools do not do it because it is not a part of the common entrance exam. Some teachers just did it to expose the children to science processes and so forth. (Interview 1)

Although this initiative to have science as one part of the GSAT has been applauded by some participants, they fear that teachers will now start teaching science

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[6] A Grade 6 examination which was done to screen children for high school. This exam was discontinued in 1997 and replaced by the Grade Six Achievement Test (GSAT). The GSAT is now written by all Grade 6 children. Through this examination, all Grade 6 children are allowed to move on to the secondary level of schooling. The Common Entrance Examination was believed to have created educational inequality at the secondary level of schooling in Jamaica, because only primary school children whom teachers considered to be able were allowed to write the examination. On the other hand, there was limited space in high schools, with sometimes only one third of the total number of children who wrote the exam passing.

[7] High schools were also called traditional grammar schools. These schools enrolled children in Grade 7, or Form 1, if they had passed the Grade 6 examination, called The Common Entrance Examination. High schools accommodated children from 11 years at Grade 7, and they attended through to Grade 11. At Grade 11, the CXC or GCE O'Level exams are taken. Some high schools also have Grade 12, at the end of which the students do the GCE A'Level. Although it was unintentional, the high schools contributed to the inequality of the secondary education system.

exclusively to prepare children to pass the multiple choice test. Ann's observation provides an example of how participants felt towards the GSAT:

> *Lena:* Tell me a little bit about your views with regard to the importance of teaching science in primary school.
>
> *Ann:* I believe that science should be taught in primary schools and time should be spent on it. I do not think that we should be exam driven too, too much, because I think at that level science should be seen as fun and the children given the opportunity to explore various science phenomena. I accept what the new National Assessment Program (NAP) is doing, but somehow I fear that the GSAT will cause teachers to take the fun out of science at that level. (Interview 1)

Peter, a college lecturer, felt that the GSAT would eventually ruin the idea that science should be fun when done in primary schools. He felt that teachers would be so strongly inclined to prepare the children for the exam that they would concentrate on "imparting the knowledge" that children will require to pass the exam even from Grade 1. Peter stated: "Since a lot of emphasis is placed on examinations, students have to know and understand concepts and be able to explain them, and therefore it would make more sense to focus on these [concepts]" (Interview 1). He pointed out that the actions of teachers would result in the same thing that happened with the common entrance: Teachers coached children to pass the exam. As a result, on entering high school, children were unable to cope with science and were unable to apply knowledge and skills which they should have gained in primary schools (Ann, Interview 1). Consequently, participants such as Peter, Valerie, and Ann were fearful that children's experiences of "science as fun" "science for enjoyment" and "fun class, excitement time" as they learn the knowledge, skills, and attitudes of science will diminish with time to learning the rubrics of science.

My Reflection

The participants' articulated views about the use of process skills did not indicate whether they were supporting a process approach to science teaching or simply thought of teaching in terms of developing processes of science through activities. After all, teaching using the process approach requires teachers to design and provide activities so that children can develop each process skill and eventually retain the group of process skills as a progression from concrete to more abstract as they engage in the activities. Progressive intellectual development is a goal of the process approach. There was no mention by participants that intellectual development was to be the outcome of teaching process skills. Moreover, earlier in this chapter the discussion showed that the limitations that teachers said that they encountered in primary school classrooms in Jamaica did not suggest that science could be taught using the process approach.

It is clear that teachers were advocates of teaching to develop process skills as a part of science teaching/learning. However, in this research I could not distinguish between the meanings that participants held of processes, skills, and process skills as used by them and in documents. I therefore conclude that teachers in the study used activities as a medium for children to learn science about process skills and that lecturers and college students felt that science is a medium through which process skills are learned so that they can later be applied to areas of everyday living. The processes suggested include manipulating and observing, along with thinking and problem-solving skills. It is not clear from the interviews which of the skills the participants classified as thinking and problem solving, but upon reflection, some examples of how they encouraged thinking skills could be discerned from the activities that they did. In one such example Winsome that said she allowed children to think about and discuss what they would do if there was no water in their pipes.

Helping Children Learn Science

As part of the process of uncovering the meaning embedded in the conversations between the participants and myself, another phase of my endeavor was to understand which aspects of science teaching they considered to be helpful for children to learn science. I identified three key areas with which participants were mainly concerned: the approaches used to teach science, children's learning deficiencies, and children's prior knowledge and experiences.

Approaches Used to Teach Science

Whereas all the participants suggested that children "learn better when they do science" or that children "learn by doing science," different participants had different ways of teaching lessons that provided opportunities for children to be doing science. All participants seemed to advocate teaching process skills through learning activities and suggested that children should "do science" to learn science. They all seemed to be advocates of teaching process skills in primary science. Interestingly, the participants used the phrases *discovery approach, hands-on approach*, and *child-centered approach* when describing their expectations for teaching science (as in the case of participants not currently in the classroom) and to label the approach used for achieving exemplary science lessons in primary schools. They never mentioned the process approach, although this was one of the approaches suggested by the *Science Education Syllabus* and the text.

The Discovery Approach

According to Smith and Neale (1989), when a discovery orientation is employed in science teaching/learning, the learner is allowed to try different ideas in order to arrive at his/her own conclusions. The teacher's role in this setting is to provide materials and activities, pose questions, and motivate children to try different ways of arriving at a conclusion. There were variations of what participants referred to as the *discovery method*. These variations were implied in descriptions of lesson formats and lesson sequences provided by the participants. I have coalesced these variations into two groups: the developing view of the discovery approach and the naïve or underdeveloped view of the discovery approach.

The developing view of discovery approach. In a conversation with Pet, a college lecturer, she outlined a number of criteria that she would look for in an exemplary primary science lesson. Included in these criteria were the ideas that the lesson would be child centered and would include hands-on activities. I then asked Pet to be more specific about the methods of teaching that she would expect in this science lesson.

> *Lena*: So what specific method(s) of teaching would you look for in that exemplary lesson?
>
> *Pet*: Child-centered, the discovery approach. Science is a doing subject; students have to be involved. You don't really tell them what they will see; you let them do things for themselves and find out.
>
> *Lena*: When you say discover things for themselves, what do you mean?
>
> *Pet*: For example, the teacher intends to do an activity. You do not go to the class and say, "Children we are going to do so and so" or "We are going to find out so and so." Instead, the teacher might take the materials to the children and give them some kind of scenario, and the children use the materials to do the activity and come up with their own findings, and then the teacher can discuss the findings with them.

Pet, like other participants, expressed the view that through the discovery method children were able to learn science "by doing" and "finding things out for themselves." Kay outlined some aspects of what she referred to as the discovery method:

> *Lena*: Tell me about an excellent science lesson. [Pause] What would an excellent science lesson include?
>
> *Kay*: The discovery method.
>
> *Lena:* Tell me about the discovery method. What would happen in a lesson using the discovery method?

> *Kay*: Allowing children to find things out for themselves instead of telling them. Before you start to teach the lesson you would say, "The lesson is about what happens to air when it is hot," but you don't tell them what happens to air; you give them the apparatus and let them go ahead and find this out for themselves. Then they discuss it and tell you what happens and why this happens. When they discuss it, you will tell them that the experiment is showing so and so, but they should discuss it before you tell them really what you are doing. They learn better that way, because when they start to discuss and tell you what they think happened, then you can give them some more information, and then they can say, "Miss, I have learnt so and so from the lesson," instead of telling them.

In this developing view of the discovery method, participants stressed that at the start of the lesson the children are not told what to expect as the outcome of the investigation. Children are provided with materials for the investigation and, according to these participants, children then proceed with the investigation and arrive at findings related to an aim. The operative phrase in the descriptions provided by these participants is "children find out for themselves."

Jerry, a JBTE appointee, suggested that although teachers were aware of the variety of methods that can be used for teaching science, they frequently referred to the discovery method as the one used. He explained that science teaching should involve children "doing simple activities . . . to find answers for questions *they* have." He felt that teachers were not really using the discovery method in this way. On the other hand, Jerry's expectations of what teachers should be doing as the discovery method were questionable. He said:

> I think to a large extent for many teachers, they consider discovery as sending children to do research, which is usually a textbook-oriented thing. They don't consider discovery in the way that children will follow the scientific inquiry method of actually, you know, posing their own questions and doing an investigation, finding explanation for whatever it is you want to answer. (Interview 1)

According to Jerry's idea, children would pose questions and find answers for these questions, but they would do so through "the scientific inquiry method." However, by using "the scientific inquiry method" in science teaching, investigations tend to become linear, with children following a recipe prepared by the teacher. If this happens, the discovery method would not be in use.

For the participants, "children finding out for themselves" carries different meanings. In the case of the developing perspective of the discovery method, it would appear that children do the investigations and arrive at answers under the strict guidance of the teacher. So whereas children might be engaged in doing the activities, the teacher directs the process rather than allowing children to explore possibilities in finding out for themselves. In the underdeveloped view of the discovery method, the meaning seems different.

A naïve or underdeveloped view of discovery approach. Some prospective teachers favored the discovery approach to teaching science. Shernette was in her third year at college and was preparing to embark on eight weeks of teaching practice, her second attempt at teaching. Shernette explained how she was hoping to teach science using a discovery approach:

> *Lena:* You said at the beginning of our conversation that you wanted to learn how to teach science well, but that you were not sure whether you had achieved that expectation. Could you tell me about that?
>
> *Shernette:* Yes. I always liked science, but I was not sure that I could teach it so that children can really understand. In the science course here we learn about teaching science, and the best way to teach science is to let children find out things for themselves. So when I was on teaching practice in second year, I tried using the discovery approach, but I was a bit confused when I tried to teach with the discovery method what I learned in college. It didn't work out. But I think I will have to try again because that is what the assessors want us to do.
>
> *Lena:* Could you tell me a little about the discovery method?
>
> *Shernette:* Well, for the discovery method you have to get the children working with concrete objects, like doing experiments and so on, okay? If you are using the discovery method, you let the children do the experiment to find out something, or you can do a demonstration and the children look at what you are doing, and then you ask them what they find out from what you are doing in the experiment. Sir always tells us that children learn better by doing, but when we

> don't have enough materials to go around in groups, we can demonstrate and let the children pay attention and then question them about what they find out. (Interview 1).

Like Shernette's, Henry's description of the discovery method seemed somewhat underdeveloped. The conversation with Henry, who had been a pretrained teacher for four years, went as follows:

> *Lena*: What aspects of the science methods course have prepared you to think about science teaching in this manner?
>
> *Henry*: The methods of teaching part of it, discovery learning.
>
> *Lena*: could you tell me a little bit about discovery learning?
>
> *Henry*: For example, you are going to teach a lesson on soil. You don't take the soil to the children and tell them everything about it. You would tell them to go and get different soil, and then they come and present it, and then you do different experiments with the soil, and then they tell you what is happening and record it.
>
> *Lena*: How do you allow them to proceed with the experiments? What do you do when you want them to do an experiment?
>
> *Henry*: First you will have to do a demonstration. Like, you get a container and do the experiment, and you tell them to observe your demonstration. When they observe it they will write down what they see. Then they will do theirs, and then they can compare it to what you did. (Interview 1)

Apparently Henry had not fully understood discovery learning and was therefore grappling with including aspects of a discovery approach in a lesson sequence. Henry's struggle with the development of a science lesson using a discovery approach and Shernette's confusion in applying a discovery approach to actual classroom teaching were not surprising. Ann, a college lecturer, acknowledged that students in her pedagogy sessions had difficulty applying the teaching methods learned in the *Science Education Course* to lesson planning.

Both prospective teachers had acquired the term *discovery approach/method* through the *Science Education Course*, and both were showing signs that they had not fully understood the principles underlying the use of such an approach. Apparently, although Shernette had done micro teaching and Henry was still involved in classroom teaching, neither of them had an accurate or functional understanding of what was involved in using a discovery approach to teaching science. Their understanding of discovery learning was naïve or underdeveloped.

Hands-On Activities

Those participants who did not label the teaching methods they employed or expected to see teachers employ in primary school science teaching talked about engaging children in "hands-on activities" and doing simple "investigations." They also expressed the view that allowing the children to handle the objects during the activities was beneficial:

> My children do hands-on activities when I can find the materials, and it really helps them to understand the topic. Take a topic like soils. When children do the soil profile, they can see the different layers, and they can understand what I am talking about. They can tell me; I don't have to tell them. And the slower ones who can't write, they can draw. You know, especially when they get to do the experiments themselves, you really see a difference in their work. I tell you, even the slow ones. (Nicole, Interview 1)

Paul, a teacher, also explained that having children involved in doing different activities during science lessons is an integral part of the teaching/learning process. Joan, a teacher who said she "is not a science person," had this to say about her most memorable lesson, which was also the exemplary lesson she described:

> *Joan*: I asked the children to take in food items, and we made that display in the classroom, and I realized that that was the question that the children did best on their examination because of the concrete objects that were used in the lesson.
>
> *Lena*: What influenced you to do this kind of thing?
>
> *Joan*: When I looked at the topic itself, I realized that if children were able to touch or handle the food items and place them in the particular groups, it would be easier for them to understand the different groups that we have. And I found it working well that particular lesson. (Interview 1)

According to a lesson format provided by Paul, a science lesson would have three main sets of activities:

1. an introductory activity to stimulate children;
2. several activities, either preplanned or done spontaneously, to test and retest the ideas suggested by children and by himself; and
3. a culminating activity, where children attended to inferences.

Janice, Nicole, and Winsome also indicated that they engaged their children in a number of activities during science lessons. These activities were not always in the form of experiments. Winsome provided a synopsis of other activities in which she engaged her children as they learned science:

> I make sure that they learn to think, to value things, to go and search and find answers to question. Sometimes they have to ask questions of other persons, because sometimes I give my children things and tell them that "In order to find out about this, you might need to talk to other persons around you in your community, like the nurse or the farmer," because, you know, this develops sort of an interest when they realize that other people are important; and when it comes from these sources, it is not only teacher that has the knowledge that they must learn, but other persons in the community can help them to learn. I also hope that by doing this they will want to know more about the concept if they see the relevance of it to their daily living. They learn to read and pick out relevant information; they learn to communicate. You know, we talk back and forth in class and learn to appreciate other people's opinion and that kind of thing. (Interview 2)

Nicole allowed the children in her class to do research from books and to role-play and draw pictures related to inferences developed from the science lessons; whereas Janice, a teacher, used the science workbooks, had resource persons come into her class, and told stories from which children made inferences.

Reading Deficiencies and Science Teaching

Some of the stakeholders (Paul, Joan, Jerry, Nicole) recognized that Jamaican primary schools children had reading deficiencies and that this influenced how children were taught in science. Most of these stakeholders felt that "slow learners" or children with "reading problems" or "learning problems" could not be taught science through reading, but should be actively engaged in science investigations.

> With these children you can't initially think of reading in science to find information. They have to find scientific information in other ways. The most likely way is for them to do investigations and discuss their findings and give their interpretations. (Jerry, Interview 1)

On the other hand, Joan suggested that the textbooks that are provided for children gave slow learners a chance to learn science. She said: " I think the book really tries to make the science lesson as practical as possible so that even the slow learners are given a chance to really think and can cooperate in the lesson" (Interview 1).

Paul's strategy for teaching was different from Joan's. When Paul talked about how he arranged his lesson for teaching an aspect of rocks, he indicated that at the end of the lesson children wrote sentences to state the inferences they had developed from the lesson activities. Paul then mentioned that he assisted the "slow learners" by writing key words on the chalkboard so that these children could participate in all aspects of the lesson. Additionally, Paul's story about his most memorable teaching occasion (see Appendix F) showed how slow learners learned difficult concepts when they became involved in simple science investigations. Like Paul, Nicole seemed to engage slow learners in doing simple science investigations and to provide them with a nonthreatening environment where they felt comfortable to talk about what they learned from the investigations.

> Most of the children I have can't read. So when I teach science I make sure they are involved in the group activities. I have to do that in order to get their attention, to keep them quiet for a while. I ask them questions about what they are doing, what they observe, what they think; and I write some of these things on the board.

> I always have them in mixed groups, and so sometimes I let the ones who can read and write do the recording of their observations. If I don't do that, I couldn't have a class; the slow learners would disrupt the class. (Interview 1)

Surprisingly, none of the participants mentioned the influences of the Jamaican Creole on the learning of science. The Jamaican Creole is the mother tongue or home language of Jamaicans but was not addressed as a pedagogical issue.

Children's Prior Knowledge and Science Teaching

Paul, Winsome, and Nicole recognized that the knowledge that children bring to science lessons is important. They indicated that they utilized children's "previous knowledge" "previous experiences," and "home experiences," respectively, during science lessons. For all three teachers, children's prior knowledge and experiences seemed to be essential to the development of science lessons. All three participants also suggested that they formulated questions throughout science lessons using the knowledge that children bring to science lessons as their starting points and for setting context. The teaching accounts given by Winsome and Nicole when describing aspects of their best lessons provide good examples of how children's prior knowledge of science concepts is utilized. The question I asked these teachers was:

> If you were thinking about the best science lesson that you could teach, how would you proceed?

Winsome's response:

> Okay. First I would, um, take a topic like water. I would take them from their personal experience; find out what they know about water or whatever area about water that I would like to cover; for example, uses of water. I would question them about the uses of water that they know; then I would find out why is it that they need to have water for these uses. So we would be moving into the importance of water through what they say: When they can't get water, what happens? How far they have to go to get water? Then I would show them that just as we need water for daily activities at home, it is important in the bodies of plants and animals. (Interview 1)

Nicole's response:

> I always start with what the children know. They come into the lesson with home experiences, and I start with that. Some of these experiences are not about science; they learn them from their parents. In this community people are very superstitious, you know. [*In what way? Lena asked.*] Well, they believe in their do-good man, their *obeah* man. Haven't had much of that this year yet, but last year when we reached the section of the syllabus on plants and animals I had it in abundance. [*Lena: Do you remember any examples?*] Well [pause], one child told me that his father who works at the banana company was told to bush [cut the trees from] a spot near a cemetery, and because his father knew what would happen if he bushed the place without protection, he had to go and fix up himself. So this man went to the *obeah* man and got something to use on his body and to sprinkle on the ground near around the area he was supposed to bush. Oh, and his father also had to use white rum on the ground too and, of course, take a drink to ward off the *duppies*. You know how them things go. Yes, so when a child comes to school with all that rubbish, I have to deal with it. So I will let the children talk about their experiences a little, and then I will ask the question again. Why should we preserve trees? Why shouldn't we just cut trees without thinking? Other children will give good answers, like protecting animal's homes and to provide cover for the land so that rain does not wash away the soil and so on. Then we can do role-play or write stories about effects of cutting trees. Children enjoy doing these things, you know. Then I can tell the superstitious child that this has nothing to do with ghosts. (Interview 1)

Like Winsome and Nicole, Paul encouraged children to talk about their previous experiences and seemed to use these to develop science lessons. Teacher questioning seemed to form a major part of these science lessons, but it was not clear whether the teachers considered the children's questioning to be as important. Paul also allowed the children to talk and used children's daily experiences and creativity as a part of the lesson. He explained:

> The children could not read or write, but they were very responsive, and I liked that. I got them involved in everything I did, and they liked that. So for forces I asked them to bring discarded materials from home, and they brought so much. Then I provided things like tape and paste and strings. I allowed them to just make things that they use as toys or in the home, and they went to town on that. (Interview 1)

Paul went on to describe how he developed a lesson on force by utilizing the children's initiative and previous experiences with building and using toys.

My reflection. Participants seemed dedicated to teaching activity-oriented science. However, the lesson sequences and formats described by participants did not indicate the use of a discovery approach, which participants suggested they were using. I did not view an actual lesson being taught during my data collection and therefore could not be certain that the participants who advocated a hands-on activity method in teaching science could be giving a more accurate label to the kind of teaching that occurred in teaching science rather than saying a discovery approach was employed.

Teachers were all concerned about children's learning deficiencies. It seemed that teachers' strategies of dealing with these children who could not read were aimed first at keeping them attentive and then at teaching some aspect of science. Surprisingly, Paul was the only teacher who mentioned that he incorporated reading strategies into science teaching so that children could be learning to read while doing science. It is not clear how Joan approached her teaching through the use of textbooks when children were not able to read.

All three teachers who spoke about children's prior knowledge and science teaching, Nicole, Winsome, and Paul, were from different areas in Jamaica; and therefore children's backgrounds and everyday experiences were different. In some rural communities in Jamaica such as the one in which Nicole taught, the traditional culture and beliefs related to cause and effect are more dominant than in other communities. Usually the traditional beliefs are scoffed at, and in the case of Nicole, the beliefs are brushed aside as a "child talking rubbish." Nicole did not attend to or use the children's prior experiences about cutting trees. Paul, on the other hand, taught in an inner-city school where children construct their own toys from waste materials such as boxes, cord, and wood. Play time and child talk for them were not about *duppy* stories as in rural areas where evenings are spent telling adventure and *duppy* stories. Paul used his children's background in his teaching. Winsome taught in a small school in a rural town where children have to fetch water from nearby tanks and standpipes. She too seemed to use her knowledge of the community practices and the children's experiences to develop her lessons.

It seems that in order for teachers to utilize children's ideas and prior experiences in teaching, they have to be knowledgeable about the customs and practices of the communities from which children came. Looking at the differences in how all three teachers dealt with the children's views, it appears that when the children's experiences and traditional beliefs that they brought to the classroom were in opposition to the scientific views, teachers were apt to dismiss the children's traditional views without dealing with them.

Summary of the Findings

Every participant in this research recognized the complex social reality that constitutes being "out there" in the primary school classroom. Science teaching, which is one part of this reality, is influenced or constrained by several interwoven physical factors and constraints which shape the daily instructional context of the classroom and influence how teachers plan for and teach science. Their first consideration seems to be the materials and resources available, and then they decide on the best approach to the lesson. Interestingly, under the guidance and influence of the teachers' colleges, prospective teachers are sometimes cushioned from experiences that force them to plan and teach lessons without available materials and resources which are characteristic of the practice of teachers in primary school classrooms. It seems that, because of the generally overcrowded conditions and inadequate furniture in the classrooms, some teachers resort to teaching in a way that will restrain children who are likely to become disruptive and aggressive. Therefore, some teachers do not do science activities that may present a danger to children.

The teachers all used textbooks as one of the main tools for teaching science, but some felt that textbooks as the main teaching tool were inadequate because children were not enjoying science or learning enough science. One teacher suggested that using the textbook was more beneficial to children than the "chalk and talk" method of teaching. Another teacher found that the supplementary workbooks provided an easy means of conducting formative evaluations of the children's progress in science. All teachers suggested that the textbooks were used as a means of showing children what activities and or equipment would look like. Some teachers also indicated that the textbook provided ideas for activities that they did in class. One teacher who repeatedly reminded me that she was not a science person said that the textbook had everything she wanted for a lesson: objectives, activities, and the science content knowledge. Lecturers and JBTE appointees observed that although teachers relied on the textbooks as their primary teaching tool, the *Science Education Course* did not address the use of the textbook as a teaching tool.

Classroom subcultures influenced science teaching in primary schools. Subcultures of the teachers' colleges, the school, and the larger community in which teachers practiced all influenced how teachers taught science and how they thought about science teaching. Embedded in subcultural forces were teachers' perceptions about science teaching. Some examples of influential subcultures that were implicit in teachers' views are:

- the college with its syllabi, courses, and lecturers;
- science as shown by a science curriculum and the textbooks; and
- the school with its administrative constraints such as timetabling; and children and their cultural differences, learning needs, and behavior problems.

The ideas expressed by participants about what science teaching should be like and the experiences related by them regarding how they teach indicate the conflicts they experienced in the practice of teaching science in Jamaican primary schools.

According to stakeholders' views, there are two major purposes for teaching science in primary schools: to help children become good citizens and to help children develop the skills and attitudes of science. A secondary purpose is for children to be successful in the GSAT. To help children become good citizens, the participants' main focuses were to use science as a means of developing environmental awareness and preservation, and to help children develop an awareness of science for living. Teachers confined their teaching of science for good citizenship to environmental awareness, whereas lecturers and JBTE appointees centered their views on science for living. Surprisingly, prospective teachers did not mention science for good citizenship as a purpose of teaching science in primary schools.

Teaching science to develop skills and attitudes was the other major purpose of teaching science in primary schools. Although all participants were in favor of teaching science to develop skills and attitudes, JBTE appointees seemed dissatisfied that teachers focussed mainly on the process skills, which they thought were lower-order skills such as manipulation and observation. However, according to the expressed views of the teachers, I concluded that these teachers have considered the use of thinking and problem-solving skills to be most important in the teaching and learning of science. On the other hand, it concerns me that the teachers' views appear to indicate that when science activities are used as a part of science lessons, process skills become ends in themselves and are not employed as a means of teaching about scientific concepts. As well, participants seemed reluctant to openly emphasize the teaching of scientific knowledge to primary school children as they did with process and attitude. I was bothered by this finding and reflected deeply on the conversations, interviews, and unscheduled observations of teachers for several days. I have come to realize that teaching the knowledge of science is not deliberately ignored when process skills are being emphasized during science teaching, but that teachers are taking the opportunity to have children use process skills whenever they have adequate materials and resources. I therefore believe that these teachers used science activities and teach process skills as a supplement to textbooks which children read to find explanations of the science concepts.

If this is happening, the children are not being allowed to utilize thinking and problem-solving skills in constructing knowledge of science. To explore this theory, I would need to examine teaching practices during science teaching.

Participants in this research attributed more importance to developing the practical-technical values and the moral values, rather than to developing the epistemological values of science. The exploration into the importance that participants ascribed to teaching science in primary schools provided some interesting outcomes. The participants' expressed ideas about science teaching in primary schools did not suggest that they viewed primary science as a means to providing correct explanations of scientific happenings or the epistemological view of science. Instead, they suggested that children were led to understand how science was important in controlling and interacting with nature and in making decisions about the way humans should treat nature. JBTE appointees, lecturers, and teachers suggested various aspects of science for living/scientific literacy and science for environmental awareness and preservation as a main purpose for teaching primary science. It appears that the participants in this research attributed more importance to developing the practical-technical values and the moral values associated with science teaching/learning; characteristics that Ostman (1998) regarded as part of the companion meanings associated with science teaching/learning.

One significant aspect of the purpose of teaching science that was not expressed by participants was the development of self. Whereas development of self was implied in the expressed views of the participants about science for good citizenship, notions of self-awareness and self-development through the learning of science appeared to be a minor consideration among participants.

The participants in this study are concerned, as am I, about the fate of science when the GSAT becomes established in Jamaican primary schools. As expressed by the participants, because a component of the GSAT is science, teachers will be making every effort to "impart the knowledge" required for passing the exam. I know that the science component of the GSAT is written in a multiple-choice format. This, according to the participants, will encourage teachers to coach children to pass the exam.

All participants believed that children learn science by doing science. Participants therefore suggested that teaching science by using activities was most appropriate for children to learn science by doing. Participants did not readily attach labels to the methods of teaching in which they engaged. However, when probing questions were asked, the participants suggested that they favored the use of or used the discovery method, the hands-on method, and the child-centered approach for teaching. Initially, I probed for participants' understandings of these terms. My intent was to find out whether they knew what processes were involved in using these methods correctly. What became evident was that the participants were describing steps they used for teaching science or what they expected from an exemplary science lesson by situating their responses within their experiences in classrooms that were heavily constrained by classroom conditions. The meanings that these teachers and prospective teachers developed regarding the approaches used for teaching science were situated in the practice of teaching science within the constraints they faced in the primary schools. I therefore conclude that the teachers' pedagogical content knowledge and general pedagogical knowledge developed through practice and was contingent on situational factors.

Teachers were aware that children come to science with prior experiences and traditional views regarding natural occurrences. As well, teachers allowed children to relate their experiences and express their views, and some teachers explained how they used children's experiences as a starting point for discussions in the teaching/learning of science. However, I am concerned that some teachers, as suggested by the excerpt of Nicole's experience, paid little attention to the children's traditional/cultural beliefs and practices and the underlying implications that these ideas could have on what and how children learned in and about science.

Teachers' pedagogical content knowledge developed through practice as they maneuvered factors that contributed to classroom climate, science content, and curriculum materials. According to the expressed views of stakeholders, it seems that teachers developed their pedagogical content knowledge as they were forced to make decisions concerning teaching alongside different factors they felt influenced how they teach science. Teachers and prospective teachers seemed to feel that it was only after they were exposed to micro teaching and lesson planning in college that they gained ideas about how to teach. Conversely, the prospective teachers who were pretrained teachers before and during their years in college felt that, by having the opportunity to practice and reflect on their use of the teaching techniques, they developed more confidence and competence in combining content knowledge and knowledge of teaching techniques.

The teachers' awareness of themselves contributed to their development and to what they came to know about their classroom and about the teaching of science. They suggested that they were aware of their weaknesses and strengths regarding science teaching, their aspirations as teachers of science, and their responsibilities to the children and to Jamaica. Teachers' awareness of self is apparent in their views about the purposes of teaching science and in how they talked about their experiences and challenges when trying to devise means of teaching science. Their reflection on themselves and on their roles as teachers resulted in their desire to acquire further knowledge about teaching science. It appears that, through reflection of self, their growth, and the factors that contributed to this growth, the teachers began to speculate about the readiness of prospective teachers to cope with practice teaching.

I started this chapter with a desire to understand what knowledge base for primary science teaching was offered and/or should be offered to prospective primary science teachers and what the stakeholders viewed as being involved in teaching science in primary schools. In spite of the primary school classroom climate in which teachers teach science, they are concerned with making science learning meaningful for children. In my continued journey toward an understanding of what it is that the *Science Education Course* provides or should provide for prospective teachers, the next chapter will examine stakeholders' views about their teachers' college experiences and observations.

CHAPTER 5

IN THE TEACHERS' COLLEGES

Introduction

The intent of the study was to develop an understanding of a knowledge base that prospective primary science teachers are offered and/or should be offered in Jamaican teachers' colleges. I begin with the following research question.

How is the Science Education Course preparing prospective teachers to meet the challenges of teaching science in primary schools?

Chapter IV has provided a starting point for my understanding of the challenges which the *Science Education Course* should be preparing prospective teachers to face. Constraints related to the infrastructure and the physical conditions of primary school classrooms and a lack of basic science resources, along with varied cultural and community-related differences among children, have influenced how teachers plan for teaching and teach science. Consequently, teachers are compelled constantly to revisit their pedagogical content knowledge and general pedagogical knowledge as they plan and teach each science lesson.

This chapter will explore stakeholders' views regarding the knowledge and opportunities that the *Science Education Course* provides as prospective teachers prepare for the demands of primary science teaching. I feel that by understanding, through the stakeholders' points of views, how and what the *Science Education Course* is offering to prospective teachers, coupled with understandings I gained about teaching science in primary schools, I should be better able to suggest possibilities for a context-sensitive *Science Education Course*.

The interpretive account presented in this chapter focuses on four main categories: the students who are enrolled in the primary education program, the role of the teacher educator, instructional methods, and the *Science Education Syllabus*. Some of the titles for these categories are direct quotations from interviews with lecturers, which I chose to use because I felt that they captured the essence of the topical points I have included. On my journey through the analysis, one of the first observations I made was that teacher educators felt that teachers entered teacher education with existing views about science. Subsequently, I explore how lecturers located themselves and considered their role in preparing teachers to teach science in primary schools. Finally, my focus shifted to the factors that impacted on the benefits that students derive from the *Science Education Course*. I have interspersed my own reflections regarding different topical points throughout the chapter. The chapter concludes with a summary of my findings.

"The Students Who Come to Us . . .": Their Views About Science

All of the lecturers who participated in the research mentioned four main areas that they observed about prospective teachers who entered teachers' colleges. They suggested that prospective teachers come to college with a limited knowledge of science, diverse ideas about what science is, traditional beliefs about science, and beliefs about teaching and learning science. My understanding of the views that participants held regarding the characteristics of prospective teachers is elaborated here.

Prospective Teachers' Science Content Knowledge

One major concern of the lecturers is that students enter the primary teaching program with little or no science content knowledge. Ann lamented that some students coming to college have not taken science above Grade 9, and this places them at serious disadvantage to the students who had gained science passes in Caribbean Examination Council (CXC). Ann, Monica, Pet, and Donna pointed out that students within groups in college have varying backgrounds in science. Unfortunately, this heterogeneity creates discomfort and anxiety among students within groups. Ann said:

> I encourage them to talk about how they feel, and if they hear me talking and they do not understand, they must speak up, because, as with any group, they are mixed: Some have done science up to CXC; some haven't. So some fear it, some get impatient, and they say things like, "Miss, how come I said this and you did not deal with it?" I have to tell them, "This is not the time; I have to go slowly for the benefit of everyone." (Interview 1)

Students with limited background in science enter college with a fear for science that may have resulted from "previous experiences" or the lack of adequate exposure to a formal science teaching/learning background. Jessica is one of those students who had not overcome her fear of science even after she had successfully completed science courses in the first and second years of college:

> Well, I was a bit scared when I heard about the science in college, because at my time when I went to school, I didn't do much science. I must say, really, I didn't go to a high school; I went to a secondary school,[8] . . . and I spent a year, so I did not do much science. When I started [Blaise College] I had a hard time, . . . so then I failed. (Interview 1)

Although Jessica had been teaching for 20 years before going to college, she said that she had little science knowledge, which she gained from "reading on her own."

Peter suggested that this lack of science knowledge influenced the way that prospective teachers planned lessons and talked about science concepts. Lecturers have observed that "the science language and understanding of concepts" (Peter, Interview 1) that was not developed prior to entering college was a deficiency that was apparently difficult to overcome even after the student completed the 90-hour science content course

[8] Also called *new secondary schools*, these schools were first implemented in the early 1980s to accommodate students leaving Grade 6, but who did not pass the Common Entrance Examination. These secondary schools provided vocational subjects such as clothing and textiles, wood work, metal work, catering, auto mechanics, and agriculture, which are not offered in high schools. Children enter new secondary schools at Grade 7 and remain until Grade 11. At the end of Grade 11, the majority of students take the Secondary School Certificate examination, whereas a few who are considered able are allowed to do the CXC or GCE O'Level examination. The curriculum at secondary schools is therefore different from that of the high schools. Recent initiatives by the government have seen a mandate to have all schools accommodating children from Grade 7 teach the same curriculum. It is believed that this initiative will dissolve the disparities that exist between secondary and high schools.

in the first year. Ann commented that this lack of knowledge impacted on how well the students handle some aspects of the *Science Education Course*:

> Well, I have to let them know, first of all, that for many of them the content is weak, and if the science content is weak, it can affect how they handle the *Science Education Course*, especially the unit on lesson planning where they have to prepare plans to teach. So because I know that, then I have to be encouraging them to revise the content before they begin to write the lesson plan. And they know this now, so whenever we are talking I say, "Remember your content is weak You need to do so and so. (Ann, Interview 1)

Jessica's experience is different from what Ann observed. Jessica explained that she did not do well with the science content course in her first year but did well with the *Science Education Course*. She attributed this difference in her achievement on both courses to the lengthy teaching experience she had before going to college:

> *Jessica*: What stands out in my mind with the science methods course is how blessed I was to pass the science content course the second time and the science methods course at one go.
>
> *Lena*: How do you think that happened?
>
> *Jessica*: Well, I think that because I was teaching for a long time, my teaching experience helped me to answer the questions [on the science methods exam]. I had a little understanding of teaching, but for the first-year science [science content course] I knew nothing at all about it, but the experience in the classroom helped me in the science methods. (Interview 1)

Henry, another prospective, teacher who was a pretrained teacher for several years before going to college, indicated that although he was not "weak on the content," the college content course helped him to develop clearer explanations for some science concepts. One example he gave was the difference between respiration and breathing. He also suggested that his teaching background contributed to his performance in the *Science Education Course*.

Beliefs About Science and Science Teaching/Learning

On one of my visits to Waterbank College to meet with one of the participants, I was asked to "take a look at" some sample science methods test items that were being submitted to JBTE for an exam. As explained previously in this study, the lecturers of each course from every college submit test items to the JBTE. The external examiner for the course then writes the exam using any of the questions submitted by the lecturers, as well as other questions from an item bank.

While I waited for the participant to come out of a meeting, I browsed through the test items. One particular item caught my attention. It was asking prospective teachers to explain why science was important as an agent for "changing traditional beliefs" (superstitions) with which children come to primary school. The question went on to ask prospective teachers to state other reasons for teaching science in primary school. One reason for teaching science that had been stressed in the course is that of alleviating "superstitious beliefs" among children.

Peter, a college lecturer who taught this *Science Education Course* for one year prior to his participation in the study, described the views of science with which prospective teachers entered college:

> *Peter*: Well, for one, when you said science, they saw it as learning biology, chemistry, and physics; they also saw it as a part of everyday activities, how they lived and things they did. They even saw science in terms of how they think. Then there were some views related to superstitions and Jamaican myths. A number of them cited *obeah* as a part of science. They were not able to, or they did not believe in the whole business of cause and effect. Things for some of them just happened because they were supposed to happen this way. It was more superstitious beliefs that influenced happenings around them. So the *obeah* man was viewed as a scientist. (Interview 1)

Additionally, Donna, a college lecturer, pointed to the views that prospective teachers have of scientists:

> Donna: Students who come in have absolutely no idea how to define science, absolutely none whatever. What they do know is that science is hard, and they are afraid of science, and they are not sure if they can teach science. And some of them are very sure that all scientists are atheists, and therefore they shouldn't listen to what scientists and science teacher say, or they will lose their faith, and there are all kinds of weird ideas. (Interview 1)

Pet and Donna also suggested that as the course progressed, and they referred to some of the prospective teachers' initial views of science in some lessons, the same prospective teachers would find the views amusing:

> Pet: On the first day the students were asked to write in one sentence on a piece of paper what *science* is. They wrote it, and some of them were asked to read it, and at the end of the time they were asked to do the same thing. When I showed them the first piece of paper, they laughed at it. (Interview 1)

Lecturers also indicated that prospective teachers had views about science teaching and learning through their past experiences:

> *Monica*: For some of them they come in [to college] having been accustomed to science being a place where they take notes. So when you are going to teach a lesson, all they expect is notes, and in the methodology course they expect you to give them notes all the time. You see, what they are accustomed to in the normal science content classes is lecture, and some of them do not let go of that. Very few of them come in here, the college, with any experience of hands-on, because even though they have done science subjects before, they never really had a chance to do much practical, you know; so some of them are at sea when it comes to manipulating and handling things. . . . They haven't been accustomed to that, and they expect that this is how we should continue.

Using Prospective Teachers' Conceptions About What Science Is

All of the lecturers indicated that they asked prospective teachers at the beginning of the *Science Education Course* to write the answer to the question "What is science?" The lecturers also indicated that the views of science with which prospective teachers start the course are usually distorted and show a general lack of science content knowledge. The purpose of asking prospective teachers to respond to this question was to find out how they viewed science. It was not clear in the interviews what ends were accomplished by ascertaining these views. Surprisingly, two lecturers, Donna and Pet, indicated that they did not use the responses as guidelines when structuring lessons in the course.

> *Lena*: How much of these responses do you try to accommodate when structuring your course?
>
> *Donna*: It isn't really possible to structure the course to help them to understand, but wherever you get the chance you call it to mind and point out to them that this is one place where you can see that this view is incorrect. That is about all you can do. (Donna, Interview 1).
>
> *Lena*: Do the responses that you collect from students at the beginning of the course have anything to do with how you structure your lessons?
>
> *Pet*: No. It is just what happens from previous years, how I saw things happening. I might structure my lessons from that. (Pet, Interview 1)

Other lecturers—Ann, Peter, and Monica—apparently planned the course based on general ideas that emanated from the responses. Examples suggested were the prospective teachers' lack of content knowledge, fear of science and traditional beliefs about science and scientists, and beliefs about teaching and learning science.

Apparently, because of the demands and length of the *Science Education Course*, syllabus lecturers are unable to help prospective teachers "change their views about science":

> *Donna*: It isn't really possible to structure the course to help them to understand, but wherever you get the chance, you call it to mind and point out to them that this is one place where you can see that this view is incorrect. That is about all you can do.
>
> *Lena*: At the end of the course, do you then go back to these and say something about them or ask them to review their feelings and views about it?
>
> *Donna*: I have done, that but it is not something we get the chance to do every year, because of the time, you know. But from time to time it comes up during the course, and I try to get some feedback from them. Sometimes it is very discouraging because, you know, they come in with a set of ideas, and some of

> them are determined to leave with the same set of ideas no matter what you say. Sometimes some of their ideas do change. (Interview 1)

The scope of research did not allow lecturers to elaborate more or for me to observe the measures they employed to help prospective teachers "change their views about science."

As a Teacher Educator "My Role is to Prepare Prospective Teachers for Teaching Primary School Science"

Teacher educators seemed to consider their role in preparing prospective teachers very seriously. They talked about their role and their experiences with purpose and passion. They seemed to savor the good moments and reflect on the not-so-good moments that characterized life as a lecturer in Jamaican teachers' college classrooms. They were immersed, totally involved in the lives of the prospective teachers, and they were aware of their impact on the lives of persons who would some day be teachers of children between 6 and 12 years of age.

Helping Prospective Teachers Understand What Science Is

Teacher Educators as Models

As Peter explained, "I see myself as a role model. If you cannot be a role model for how and what should be taught as far as teaching science goes, then as a teacher educator a large part of the training is missing." All of the lecturers suggested that they teach so that prospective teachers can model their teaching. Although some lecturers seemed to be subtle with this practice, Peter, Ann, Donna, and Pet indicated that they made deliberate attempts to model teaching for the prospective teachers to follow:

> I try to use the [methods] too, . . . and as I do, I tell them that I am using this particular method, and I go through it with the hope that they will implement it, you know, in their own teaching. (Ann, Interview 1)

> In the preparation process . . . the way I teach, I teach by modeling: Whatever I do in the classroom, I expect my student teachers to do the same thing. I do not just stand up and lecture them; I get them involved. . . . When I am teaching I draw reference to teaching in the primary school, so I would say to them, "if you were

> in the primary school you could do this and that" or "If you were teaching in the primary school, how would you teach this to a primary school class?" and let them tell me. So I always take my lesson back to that. (Pet, Interview 1)

> I try to show them by what I do, because I know that to a large extent with students, it's monkey see, monkey do. They are going to do what they see you do, so I try to teach them the way I want them to teach. Sometimes it works; sometimes it doesn't. We bring children over from the practicing school, and I do demonstration lessons for them. Then when I set them to teach I make sure that their lesson plan reflects this kind of teaching philosophy. (Donna, Interview 1)

Monica indicated that she demonstrated some teaching methods to prospective teachers as part of her instructional strategies. However, there was no indication from the interviews whether prospective teachers who were instructed by Monica were made aware that the actual teaching methods were being used.

None of the four student teachers who participated in the study, and were students of four of the participating lecturers, mentioned that lecturers modeled teaching methods. However, some teachers suggested that what they remembered most from the science courses in college were lecturers who modeled teaching methods. Paul recalled:

> My college lecturer was a teacher, not a lecturer. When she was finished with a lesson, you would remember it for days. She would teach us, and she would tell us that she taught us, so we could get ideas for how to teach science in the schools. This was the content lecturer. Although it was a content course, she would keep saying for every topic, "How would you do this for your primary school kids?" or "This is how you would do it for the primary school kids." She was always reminding us that we were being prepared to teach primary school children, and so we had to think about it all the time. (Interview 1)

Surprisingly, Paul's recollection was about the content course and not the methods course. Nicole and Kay also remembered learning how to teach some science concepts from the methods that lecturers used when teaching the content course. On the other hand, Joan and Janice, teachers, said that they wished lecturers or someone would demonstrate how to teach some science concepts:

> *Lena*: What do you think would help you to like [science]?

Joan: To help me? Well maybe teach a few lessons for me so that I could get some ideas of how to proceed, . . . you know, from the primary science syllabus. (Interview 1)

Lena: You said the science methods course needs to be more practical so students can learn to teach from it. Tell me what you mean.

Janice: Well, when I got into the classroom and was on my own, I realized that I did not know what to do, how to go about teaching some of the concepts. [Pause] If the lecturer had taught me how to teach some of the concepts by showing me how to teach them, I would have a better idea of what to do. But because you are just told what to do, it is not of much help because you are not in the situation, out there in the classroom, so you really don't know what you are up against. It is different in theory than when you come to do the actual thing, so they should show us in college how to teach. (Interview 1)

For prospective teachers, learning to teach science by watching others do the teaching would provide a better foundation on which they could develop their own teaching styles. Lecturers (Pet and Valerie) and teachers (Paul and Nicole) who had this learning experience from their teacher education programs talked about emulating and imitating the persons who modeled science teaching for them.

Peter had been a college lecturer for only one year before participating in the study. He was pursuing a Master of Education, with a focus on science education. Peter indicated that his debut into teacher education was less than comfortable, because his educational background did not provide much support "in terms of teaching the [primary science methods] course." Peter said that because he was trained as a secondary teacher, he had to rely on courses he was taking in the master's program as a means of support for preparing lessons and instructing prospective teachers to teach in primary schools. However, Peter felt that this was also insufficient "as primary teaching is different from secondary science teaching." He explained:

In secondary school you are dealing with children with a different level of thinking and reasoning, and also the secondary students to me have already developed in their minds, whether from school or home, how they will shape their lives, and will start focusing on the different subject areas to suit their goals. With primary children it is different. You the teacher is a part and parcel of this shaping

> process, and you become a part of the influence on these children's life goals. So preparing teachers with this primary *Science Education Course* is a serious business, and it was a learning experience for me. (Interview 1)

As indicated in Chapter III, none of the participating lecturers ever taught at the primary school level as trained teachers. Peter identified this as an encumbrance to his attempt to provide proper guidance for prospective primary school teachers. Paul, who is often a participating teacher for practicum, said:

> When students come on TP they can't deal with it. Some of them crumble under the pressure, especially if they have supervisors who can't help them. And that is another thing: Most of these people in the colleges who are teaching students to be primary school teachers have never been primary school teachers themselves, and that is a big drawback in our system because the students need people who can model teach for them. I think that is why this science lecturer stands out in my mind so much, because she used to model the teaching of primary science, and I appreciated that because she gave me ideas that I could build on. (Interview 1)

Apparently, the deficiencies associated with the lack of primary school experience may have been more prominent in lecturers who also had little experience in teacher education. The lecturer who was identified by Paul as making an impact on his teaching was never a primary school teacher but had been a lecturer for four years before Paul entered college. In addition to Peter, Ann also had concerns about her lack of experience with primary school teaching, but used the experience she had acquired through teaching as a basis for making instructional decisions. Day (1999) referred to Leithwood's interrelated dimensions of teacher development in discussing the idea of how professional development of teachers occurs over time, starting with the development of survival skills and growing in sophistication, allowing teachers to be able to contribute to educational decisions. Although Day's discussion was about teachers and the need to provide support for beginning teachers' induction into classroom life, his discussion bears significance to teacher educators. The experiences and observations describing lecturers in the above discussion show that lecturers might need to be assisted during their beginning years as teacher educators making the transition from teaching children to instructing prospective teachers.

Methods of Instruction

The expressed views of the lecturers who participated in the study were that prospective teachers should be actively involved in learning to teach. Lecturers seemed to employ several approaches to instruction. Although not explicitly stated by the lecturers, it seemed that the approach chosen for each lesson was dictated by the types of students.

Helping "Students Take Charge of Their Learning"

Pet, a college lecturer for over eight years and the only lecturer who had experience in teaching primary school science, related an experience she had when she decided to change her instructional approach to allow prospective teachers to "take charge of their learning" rather than using a "spoon-feeding" approach. Apparently, Pet decided to change her instructional approach after she found that a group of prospective teachers she had for the *Science Education Course* could not use a ruler accurately. Pet related the details involved in having students do a project on measurement. This approach apparently paid off, because Pet said that she was encouraged by the results and was "really shocked" by the high quality of the displays and the creativity with which the students had presented the project. I asked Pet to help me understand what this experience meant to her. She replied:

> I was trying too hard to teach in previous years by belaboring the concept of measurement in different lessons. And by trying a new strategy, I now realize that I did more than one aspect of science teaching. They better understood the concept of measurement, and they could decide different ways of improvising materials. I also realized that if I leave these students on their own to go and find out things, to let them take charge of their learning and how they learn, that that would be a good way of teaching. And students learn this way as well; I now realize that, and now I try to structure my lessons so that students can actually learn from experiencing the concepts, not only with that topic but with other topics as well. These students are adults, and I believe that we are treating them too much like children. We spoon-feed them too much. We do not allow them to be taking charge of their learning, and then they become so dependent on this

> when they go out into the schools and are faced with new challenges in science teaching, they are at a loss. They need to learn not just how to teach science to children, but how to learn for themselves, and this will also help them to teach and to organize themselves and their lessons for teaching. (Interview 1)

Here Pet has indicated that prospective teachers were allowed to learn by doing a research project, and she suggested that they were left on their own to learn about a selected topic. There was no indication of the role that the lecturer played in this approach. Monica and Donna also indicated that they felt prospective teachers should be given the chance to be more autonomous in their learning, because this would help them to become more creative teachers of science. It seemed that lecturers attempted to develop autonomy in learning by allowing students to do more project types of assignments.

Doing Research and "Reading on Their Own"

An approach which is frequently used, apparently, to help "students take charge of their learning" is having prospective teachers do some "reading on their own" to find information. This, coupled with "doing research," seemed to be a common practice among lecturers. Donna explained:

> Well, [prospective teachers] need time to do research. To know, for example, when I take up a book and I want a certain knowledge from it, how do I proceed? This is something that they don't know. They will come to you very often and say, "Miss, do you have a book on the human body?" and, you know, you wonder, Where do we start now? They need to know how to find information, how to use the library, and where is the information most available. We try to teach them these things, but we need to be able to take them to these places so that they will get the hands-on experience. We need to show them how to access information from these places, the institute of Jamaica, even the ---- library and the school library. (Interview 1)

Donna, along with Pet and Ann, indicated that they usually tell prospective teachers to read on their own from textbooks, supplementary materials, and other materials from the college libraries.

Prospective teachers Jessica, Shernette, and Henry told me that they sometimes learned "by reading on their own," especially when the lecturer moved through the lesson at a faster pace than usual. Shernette said that, although she did not think this was always helpful, "sometimes it helped [her] to learn something [she] did not understand in class." She said that she learned better when the lecturer took time in the class to "cover a topic properly and not leave [them] to read up on [their] own." In addition to an overload of assignments, prospective teachers complained that the college libraries were not adequately equipped to accommodate the types of research projects or the reading on their own that they were often asked to do. A very disgruntled Shernette said:

> Sometimes you have to go all the way to Kingston to the UWI library to do the research. Our library doesn't have a good book in it, and as soon as any book comes, it disappears. It is not fair to ask students to do something, go and read up on this, and they know that the books are not in the library. (Interview 1)

There were obvious differences in lecturers' approaches to doing research. For Pet, doing research seemed to be the same as doing a project. Prospective teachers take the topic and use various means of acquiring information about the topic, then make a presentation of their findings. For Donna, doing research was going to books and printed material for information about the selected topic. Lecturers also seemed to vary in their ideas about materials that prospective teachers should read on their own. It seemed that lecturers required prospective teachers to read on their own from textbooks, supplementary materials which they provided, and whatever materials were available in the college libraries.

Learning Through Practice

Micro-teaching. Vicky shared her understanding of how to organize herself for teaching by describing her experience in micro teaching:

> So we had to prepare lessons and teach in pairs, and that was very enlightening for me because, although we had to teach our peers, we got a good idea of how to prepare lessons and organize ourselves to teach children. (Interview 1)

Apparently this approach was most commonly used among lecturers. It is also the approach which seemed to be the most highly rated as a means of giving prospective teachers "hands-on experience" with teaching. All lecturers indicated that micro teaching was an integral part of the 45 hours allotted for the *Science Education Course*. In the first interview Monica said, "Most of the time is spent on lesson planning and the actual teaching." During the second interview Monica explained:

> I spend a lot of time on this unit because it is here that the students actually get a chance to have some hands-on with the lesson planning and teaching, and they need that, especially those who have no experience and have no clue as to what to do with a lesson; you know, planning it and teaching it. So you give them a chance here to develop their skills. I find that it does good for them. And they enjoy doing it. You know, they work with their partners, plan the lesson, and then they do sort of team teaching. So it is a good thing for them. (Interview 2)

All lecturers seemed to follow the same sequence for the micro-teaching exercise. Prospective teachers work in pairs, select a grade and a concept, and prepare a lesson plan, which is corrected before the pair of prospective teachers teach the lesson to their peers. Shernette and Vicky suggested that this approach was extremely useful as part of their preparation for teaching practice.

> Lena: Tell me what parts of the science methods course helped you to be prepared for the year two teaching practice.
>
> *Shernette*: When I did the micro teaching, I got the chance to see what it was like to teach. It was good, a good experience. I learned about the concept, and I learned how to develop the concept into a lesson. (Interview 1)
>
> *Lena*: Could you share some examples of how the *Science Education Course* helped to prepare you for teaching. [No response from Vicky] Is there anything in the course that helped you on teaching practice?
>
> *Vicky*: The micro teaching helped me a lot because when we did the micro teaching in class, that was when I really saw how difficult it was to prepare a lesson, and that was what gave me confidence in order for me to go out there and teach in front of a class of students, because when I taught my peers in class in micro teaching, I tried some of the approaches and techniques such as grouping, and they participated, and it was very good. So I learnt a lot through micro

> teaching; I developed a lot of confidence. Also the lesson planning and unit planning was a good section. (Interview 1)

Apparently, Henry and Jessica did not do micro teaching, because they were involved in classroom teaching throughout the program. Teachers who participated in the study suggested that the micro-teaching exercise was one of the most beneficial parts of the *Science Education Course*.

Limiting Factors to Lecturers' Practices: "You Need to Have Flexibility and Freedom"

"Unfortunately We Have a Syllabus" and "Then There Is the Common Exam"

Valerie, a vibrant and sprightly lecturer at a Jamaican University, spoke with me about her role as a teacher educator. She never taught in primary school, but was always involved with science education in several other facets of Jamaican education, such as science fairs, teacher education development, secondary science teachers' workshops, and lecturing in science education for primary teachers. Valerie's story was replete with several motifs that connoted a very textured and colorful teaching life. In order to demonstrate what it means to have flexibility and freedom in educating teachers, I have chosen to excerpt one of these motifs. Apparently, when Valerie accepted the position of a lecturer at a university, she inherited a primary *Science Education Course* that she felt gave teachers an idea of how to teach science using a "skills approach":

> It was done in a very isolated kind of way. "I don't think that you can teach skills in an isolated kind of way, I think you have to teach skills in an integrated way alongside the content. You are teaching your content through your skills. I didn't like how it was structured.

After wading through the course during her first year as a lecturer, Valerie said that she proceeded to add other dimensions of science education which were lacking in the course, but which she felt were necessary for primary science teachers to have. Not only did Valerie revise the course content, but she also evaluated and revised her own teaching strategies and approaches to befit primary school teaching. She used materials and basic chemicals such as vinegar which were easily accessible: "Most of the stuff we use now I really take them from my home . . . because the truth is, [the teacher] may have to do the same thing as well." She said that she and the group of teachers in the Bachelor of Education program had gone on field trips, analyzed case studies, done simple investigations from the primary school syllabus, and used and developed concept maps throughout the *Science Education Course*. With passion in her voice and a look of wonder in her eyes, she said, "I don't know what I will do next year. I really don't like to do the same thing too many times."

Valerie is not and has never been a college lecturer or a primary school teacher, but I have chosen to tell her story because it is an example of how one member of the family of science teacher educators appreciated and utilized freedom and flexibility within a teacher education institution. The stories of the college lecturers do not suggest that they feel that they have this autonomy which allowed Valerie to exercise creativity and to incorporate aspects of science education that *they* believe are important to prospective teachers. The common exam and hence the need to adhere to the course syllabus, plus the limited time to complete the course, were the main limiting factors mentioned by college lecturers.

As shown in the Table 5.1, time and the common exam were factors that seemed to constrain lecturers. However, it was the common exam that seemed to be of most concern, because lecturers' choice of instructional activities and the time spent on each unit seemed relative to the expectations regarding the common exam. As well, comments from lecturers shown in the column *Common Exam* indicate that how lecturers view the common exam and the external examiner impinged on their approach to completing the syllabus.

Table 5.1

Limiting Factors to How the Course Syllabus Is Approached

Common examination	Limited time
The course syllabus was used as "a guide, because it pointed me to what needed to be completed, what the students should cover in order to do the exam." (Peter)	"Because you have to complete the syllabus in a certain time, there are certain things that you have to cut short." (Monica)
"The syllabus is not clear, so I believe the external examiner of this course has to be open." (Ann)	"Where you would like to go into a little more depth and give the students a little more time for experimenting and demonstrations, you find you really don't have the time for that." (Monica)
"She will have to understand that the exam will be done by all colleges and that different lecturers' approaches are different, so exam items will have to be set so that all colleges will be able to do the exam." (Ann)	"We find that we have to spend less time on certain parts of the syllabus than we would like to." (Donna)
"You see, you are given a list of activities that the students are expected to do, and this is where the examination questions are going to come from." (Donna)	"I think that we as lecturers should be more flexible I don't think that it [the course] should be so tightly structured that there is no time to play with." (Donna)
"So you find that activities that you would like to do . . . you just can't do it because you will not finish in time. And then there is a common exam." (Monica)	"They [the prospective teachers] are introduced to pedagogical knowledge and . . . the content knowledge, but they do not know how to bring the two together, so [they] find it extremely difficult to write a lesson plan. . . . And I must confess, I myself found it difficult to tell them how to do it, and because of the constraint of time I could not get a model." (Ann)
	"There is only three hours per week for the course, and this time is already tight. . . . Probably we could increase the time, but this would have to be recommended to the Joint Board for approval." (Peter)

For many of the lecturers, preparing the prospective teachers to pass the common exam was foremost. As I interacted with the lecturers, I realized that they did recognize that how they approached the course was less than adequate. Table 5.1 shows where lecturers indicated having to compromise, and this meant meeting a deadline and providing a course of less quality.

From conversations with lecturers and teachers, I discovered that they were disturbed by the constraints associated with the JBTE. A recurrent concern was that there was little room for flexibility and innovation on the part of the teacher educator. However, foremost was the concern regarding the limited input that lecturers could provide in decisions, such as what gets included on an exam. Lecturers suggested that even if they do make recommendations with regard to the course through the Board of Studies, final decisions are made at the JBTE level (JBTE, 1993). Informal conversations with Monica and Ann indicated that sometimes students are at a disadvantage when they do not have adequate choices on exam papers. Pet, Donna, and Nicole related incidences where prospective teachers were unable to do test items that appeared on examination papers. The explanation given by lecturers Pet and Monica was that because that section of the syllabus was not specific enough, the external examiner and other lecturers could include new trends in their teaching which would be attractive to an external examiner and be added to the exam. Monica explained:

> There is a section in the syllabus that deals with approaches to teaching, and as I told you, a lot more approaches could be added to those that are there, and also those that are there in the syllabus can be grouped differently. Well, that particular year someone submitted an item that grouped the approaches as discovery and guided discovery and traditional. Some lecturers say they talked about it at the vetting. I wasn't there at the vetting, but sure enough, the item came on the exam. Well, if students had read the question, they might have been able to figure out which was the same as the ones we did. Once students saw the new words, they didn't even read the question; they just decided they couldn't do it. They came out of the exam complaining that they were at a disadvantage because there were six questions on the paper, for them to do four, and they weren't given a fair chance at the choices. (Interview 2)

Donna tersely mentioned, "I make sure that they learn what is in the syllabus so that they will be able to answer the questions on the examination." Later in the interview I asked her to help me understand what this meant. She explained that lecturers needed "more flexibility" to manipulate the course content. She elaborated on some aspects of science education that could be incorporated in the course if there was enough time. She mused over the idea for a little while, then added: "We do add some things, you know, but sometimes it is at the risk of leaving out some things that might be on the examination" (Interview 1).

From the interviews with the lecturers it appeared that although some lecturers, such as Ann and Donna, added aspects of science education where they identified deficiencies in the course, they had little control over the content which was emphasized in the common exam. Consequently, they had little control over the course content that was presented to prospective teachers for a *Science Education Course*.

On the other hand, some lecturers—namely, Pet and Monica—mentioned that they did not add content because the course syllabus was already lengthy, with little time to cover what was already there, and adding content would not benefit students in the exam. Where the lecturers chose to be divergent in their instructional strategies or to include aspects of science education that were not part of the syllabus, they were placing the students at risk of not passing the exam.

The lecturers seemed to think that there was little difference between their philosophies and those suggested in the course syllabus concerning science education and science teaching. Pet indicated that the syllabus supported her view of "child-centered and activity-based teaching." From informal conversations and interviews with the lecturers, it became apparent that they all believed that the syllabus stressed child-centered and activity-based teaching. Conversely, they all believed that science teaching should be child centered and activity based. Where there were differences between the lecturers' beliefs and philosophies and that of the course syllabus, lecturers such as Peter and Donna compromised some of their own beliefs and philosophies so that the course syllabus was completed intact to befit the common exam:

> There was not much differences in how I was thinking, in my philosophy and the course outline, but primarily I went about the course as was stated in the syllabus, because the exam was foremost in my mind. (Peter, Interview 1)

> I teach the syllabus so that the students can pass their exam, but it does not alter my philosophy in any way. (Donna, Interview 1)

Lecturers such as Ann and Monica indicated that they made a concerted effort to incorporate their beliefs and philosophies about science teaching through the instructional strategies that they used.

A common view among the lecturers was that the JBTE could allow more freedom for the lecturers so that they could incorporate aspects of science education into the course. Lecturers felt that if there were autonomy, there would be more innovations within the *Science Education Course*. Without a common exam, lecturers could incorporate these trends into the *Science Education Course* without having to be concerned for prospective teachers in other colleges. With the common exam, lecturers have to carefully select what they choose to add to the existing course content. Nevertheless, some college lecturers do add content that they feel is relevant for prospective teachers to learn from the *Science Education Course*.

A common exam forces all lecturers to include the same changes to the course at the same time. I discerned that some lecturers and the external examiners sometimes obtain information regarding current trends in science education and science teaching more readily than other lecturers do. From my experience the geographic locations of colleges do not allow college lecturers to meet at least intermediately and reflect with each other about science teaching and learning to teach. Therefore, for the entire semester lecturers remain isolated while they prepare prospective teachers for a common exam.

The *Science Education Course*

All the lecturers in the study indicated that the *Science Education Syllabus* was considered as a guide to what should be accomplished in the course. However, because of the common exam that loomed, they were also circumspect about the content on which they chose to focus during instruction. Lecturers seemed to adhere to concepts covered by the specific course content and course objectives. In this section I will explore the views expressed by prospective teachers, teachers, and lecturers about the factors that impacted on benefits derived from the course.

Prior Teaching Experience

According to prospective teachers, the most beneficial aspects of the *Science Education Course* were lesson planning and approaches to teaching. Prospective teachers who had no teaching experience before going on teaching practice indicated that micro teaching was most helpful in developing their confidence and preparedness for the actual classroom experience.

> *Lena:* What aspects of the Science Methods Course were helpful in preparing you for the second year teaching practice?
>
> *Shernette:* To be honest with you, Miss Walton, the micro teaching. You see, because I did not have any teaching experience before I came to college, I was glad for the micro teaching—not that I really liked how it was done; you know, the other students and their attitude toward students who were not as knowledgeable as them. But in the end it helped me to be more confident. You know, if I could teach my group mates who thought they knew more than me, I could teach children. [Pause]
>
> *Lena:* So the micro teaching was the only section that helped you?
>
> *Shernette:* Well, in a way, um, lesson planning. I didn't know lesson planning was so difficult. I took a long time to plan my lesson for micro teaching. I just learned the different teaching approaches and Sir said he wanted us to think about the topic we were going to teach and choose the best approach that we thought would help children to learn. It was difficult. Some people just copied from their seniors' lesson plans. It was difficult; maybe that is why they do it. But Sir was really

helpful. He marked the plan and gave me comments that were helpful to me on TP. [*Lena:* What about for the actual micro teaching?] Sir marked them after we teach the lesson, so it didn't help me for the micro teaching. And not only that, he commented on each lesson after we taught, so if you are going to teach next, you can go and fix your plan based on the comments he gave the other students.

As shown earlier, Vicky also explained that her micro-teaching experience along with lesson planning gave her confidence for her debut into classroom teaching.

Prospective teachers such as Henry and Jessica, who had been teaching prior to attending college, suggested that learning about the approaches/methods to teaching science was most beneficial because it provided greater understanding of how they could engage children in activities, while helping them to understand science concepts.

Lena: Did the science program help you to realize [your expectations]?

Henry: Yes, man, it did, because I took things for granted. Like, if we are teaching science the textbook alone can do it; we don't need materials that children can learn things from the teacher. You know, you just teach it and the children are supposed to understand. But when I went to college now, things were different. I learnt that the children need hands-on experiences and materials to work with to help them to learn. And when you teach the lesson like that, it helps them to understand things easier. You know, when they have something to work with and you let them do things, they learn more.

Later in the same interview the conversation about the benefits of the *Science Education Course* continued:

Lena: How do you think science should be taught in schools?

Henry: First you have to be aware of what you are going to teach; you have to acquire the materials—not necessarily buying them but anything that you can find around to really use with the children, something that the children might be close to; you know, they should be familiar with it, so that when you are teaching they will be able to understand easier rather than using things that they have never seen before. Also you have to use terms that they are used to, and then you would have to do the science language because it is very hard for children to understand when they don't know the meaning of terms. You have to do it in *their* language, and then as they understand in their language, then you can impart the science to them in the science language.

> *Lena*: What aspects of the Science Methods Course prepared you to think about science teaching in this manner?
>
> *Henry*: The methods of teaching part of it, discovery learning.

Here Henry indicated that teaching science required thought about children's backgrounds and how these influenced teaching. Although he suggested that learning about the discovery method of teaching/learning was useful by helping him to think about these aspects of teaching, it is not clear how the understanding of relating children's background to the science topic was achieved by learning about the discovery approach. On the other hand, the conversation revealed that Henry was concerned about helping children develop an understanding of science. Conversation with Jessica also showed that by doing the *Science Education Course*, she developed concerns regarding how to assist children in understanding science concepts.

> *Lena*: Okay. How did the Science Methods Course help to enhance your teaching in the classroom? [Pause] Did it help you in any way?
>
> *Jessica*: Well, yes, I did science in the first year of college and the second year. Well, for the second year *[Science Education Course]*, that one really did help me because I am teaching, but I really did not know how to put across the science to the children in the classroom, so it has helped in that way. (Interview 1)

Prospective teachers who had experience teaching in primary schools prior to attending college seemed to become more concerned about the children's learning needs. This indicates a certain level of maturity in their approach to classroom practice. Henry and Jessica may have developed this concern for children as a result of their experience in the classroom as pretrained teachers and may have consolidated the knowledge they developed through experiences with knowledge developed from the college program. This was substantiated when during the second interview Jessica elaborated on what it meant "to put across a lesson" to children. She explained:

> After doing the Science Methods Course I had a better understanding of the different approaches to teaching science. This helped me to break down the topics and sequence the science topics in each science lesson, it helped me to prepare for

> doing experiments, and it helped me to appreciate that it is important to allow children to do experiments in science lessons. It helped me to see how I could take the children through the lesson. The Science Methods Course got me thinking about all aspects of the lesson, the children, the concepts, the experiments, and even how I could help the slow ones. (Interview 2)

Apparently, Jessica realized that because she understood more about teaching science, she was able to help children to better understand science concepts. Before attending college, Jessica became aware of her weakness in "putting across the lesson" when she encountered a situation in which she was unable to help a child understand a concept while she was being visited by an Education Officer from Ministry of Education. (See Appendix G for Jessica's story about this encounter.) From the interviews, it seemed that Jessica started to make every effort to help children understand science concepts by attending to the pedagogical content knowledge of science.

<u>Relevance of Course Content and Activities</u>

Shernette was a final-year prospective teacher who had no experience teaching before going on teaching practice in her second year at college. Her view was that, although "in the long run the students benefited from the course," at the onset of the course they had difficulty identifying its relevance. Shernette recalled that the lecturer followed the text book (Young, 1989) very closely and referred to past exam papers throughout the course. Shernette said that she finally saw the relevance of the course when they started doing lesson planning and when they went on teaching practice:

> I was really happy that we did the lesson planning and the micro teaching, because when we went on TP a lot of the science topics that were taught by the students were the ones we had to teach in the schools, and so we could refer to Sir's comments and modify the lesson plans we had used in the micro teaching and then use them in the schools. We borrowed each other's plans that were used for micro teaching, so I am glad we did that part. (Interview 1)

Lecturers', prospective teachers', and teachers' views about benefits derived from the *Science Education Course* corroborated. The units that included the approaches to teaching (Unit 4) and lesson preparation (Unit 5) provided knowledge considered most useful to science teaching in primary schools. The interviews with teachers and prospective teachers indicated two reasons for suggesting that Units 4 (Approaches Used in Science Teaching) and 5 (Lesson Preparation and Evaluation) were most beneficial to prospective teachers. The first is that this section of the course may have been more relevant, providing opportunities for prospective teachers to tackle pragmatic issues relating to science teaching in primary schools:

> She did a lot of activities, but for some parts of the course she did a lot of talking. We did a lot of activities in areas of how to prepare lessons and teach in pairs, and that was very enlightening for me. (Vicky, Interview 1)

> The lecturer let us do a lot of lesson planning from the primary curriculum, and then we teach one of the lessons. That part was good, but then it was kind of slow when we did things like Piaget.. At that time we mostly listened to Sir talk. (Shernette, Interview 1)

> As I said, we mostly used books and past papers, but the lesson planning helped me a lot. We had to plan lessons and then discuss the strengths and weaknesses in class, and then this was marked so we could see where we could improve. (Jessica, Interview 2)

The second reason is that the lecturers might have provided a more student-oriented, activity-based learning environment and allotted most contact hours to sections of Units 4 and 5 than they do with other units. Instructional activities and the content therefore seemed to be more satisfying for prospective teachers. According to the responses shown above, prospective teachers were more actively involved in and were allowed to reflect on this aspect of the course. Apparently, prospective teachers became motivated when they saw the relevance and practicality of activities that allowed them to explore classroom issues.

Allowing Prospective Teachers to Explore

Pet indicated that by allowing prospective teachers "to go out and find out things for themselves," she expected them to "take charge of their learning." Her intent was for prospective teachers to become more independent. She wanted them to stop expecting "spoon-feeding," which she said was a practice of college lecturers:

> These students are adults, and I believe that we are treating them too much like children. We spoon-feed them too much; we do not allow them to take charge of their learning. And then they become so dependent on this, when they go out into the schools and are faced with new challenges in science teaching, they are at a loss. They need to learn not just how to teach science to children, but how to learn for themselves, and this will also help them to teach and to organize themselves and their lessons for teaching. (Interview 1)

On the other hand, Monica explained that when she allowed prospective teachers to embark on these planning exercises on their own, students copied from printed materials. Monica seemed concerned about the lack of initiative and creativity the students showed when they were expected to do things such as lesson planning on their own. She explained:

> Because we have that syllabus where there are examples [the core curriculum], the students think that you must stick to them, and I am saying to them, "I don't want those examples at all. You must come up with something new, because that is just one person's idea of carrying out that lesson; but there must be other ways that you can do the thing; use the same content, the same information, but in a different way. (Interview 1)

Not withstanding Monica's experience, teachers such as Paul, Kay, Nicole, and Winsome and lecturers—namely, Pet, Donna, and Ann—mentioned that lesson planning and peer teaching were beneficial to prospective teachers because it was their first attempt at learning about aspects of classroom life.

The college lecturers attempted to motivate prospective teachers by providing relevant, practical, and activity-oriented lessons in some units. Lessons that centered around activities about learning to teach promoted different levels of learning. Jere

Confrey, in a recent conversation at the University of Alberta (January 2000), suggested that by the way that learning activities are designed, they could achieve learning through either *conditioning*, *challenging*, or *exploring*. If the aim of a lesson is conditioning, the activity would include reading textbooks, taking notes, and listening to lectures to acquire knowledge. Activities that foster challenge would allow for application of textbook ideas, but without a context; whereas exploration activities would foster interaction, reflection, and problem solving within an appropriate context. It seemed that prospective teachers benefited from sections of the course where they were confronted with challenge activities, such as practicing lesson planning and peer teaching, and exploration activities, such as the practicum.

My Reflections and Summary of Findings

The prospective teachers' limited backgrounds in subject-matter knowledge created significant concern among the lecturers. The lecturers felt that it affected their learning in several ways. Prospective teachers with limited subject-matter knowledge had a fear of science, found planning science lessons difficult, were reluctant to participate in group discussions about science, and experienced difficulty using scientific language. On the other hand, those prospective teachers who had teaching experiences before entering college and who also had limited subject-matter knowledge seemed to have little difficulty in planning for science lessons.

The lecturers were aware that prospective teachers entered college with traditional and cultural beliefs or alternate conceptions about scientific phenomena. However, it seems that the lecturers' desire to assist prospective teachers in dealing with these alternate conceptions was overshadowed by the overwhelming demands created by the lengthy syllabus, the limited time for completing the syllabus, and the common exam. It seems that although there were sections of the course that provided the opportunity for prospective teachers to recognize that traditional/cultural beliefs existed among Jamaican children, there was no emphasis on dealing with these same beliefs also held by the prospective teachers themselves. Prospective teachers could therefore leave the *Science Education Course* without reflecting on and dealing with their own beliefs about scientific phenomena.

Lecturers recognized that the prospective teachers' views about teaching science have been influenced by the ways in which they were taught as students in school. The lecturers were also aware that these views about teaching which prospective teachers bring to college influence their expectations regarding how they will learn and how they will teach. Again there is no indication that lecturers explicitly gave any special attention to prospective teachers' beliefs about teaching and learning. On the other hand, it seemed that lecturers did design course instructions based on their experiences with prospective teachers over the years. When lecturers had little experience with instructing the course, they drew on knowledge from their own educational background as they tried to make sense of the syllabus.

Lecturers' educational background and teaching experiences influenced their choice of instructional methods, whether they added to the existing course content and the aspects of the course they chose to emphasize. Lecturers had varying educational and experiential backgrounds and therefore had different perspectives regarding science education and teaching. It is thus no surprise that lecturers seemed to approach the *Science Education Course* differently while keeping the common exam as the primary goal.

Lecturers believed that prospective teachers should be guided toward becoming autonomous. Several lecturers indicated that they came to realize that prospective teachers learned more than just the content of the *Science Education Course* when they became involved in activities that fostered independent learning. Two of these activities that were mentioned by lecturers, prospective teachers, and teachers were project types of assignments and "students reading on their own." Whereas some lecturers indicated that prospective teachers were not always willing or innovative enough to read on their own or do research to find information, students indicated that reading on their own and doing research were sometimes unrealistic because reading materials were not readily available. On the other hand, prospective teachers mentioned that when reading materials were available and the exercise purposeful, reading on their own and researching promoted learning.

The aspects of the course that were most beneficial to prospective teachers came from moments when they could experience aspects of the practice of teaching science. Teachers and prospective teachers suggested that micro teaching, lesson planning, and watching others use the approaches to science teaching were most beneficial. One underlying strand that runs through all of these exercises is that prospective teachers were allowed to reflect on the activities and have collegial discussions about the exercises. On the other hand, although prospective teachers suggested that they were intimidated by the micro-teaching exercises, they were also appreciative of the chance to make mistakes in a safe, familiar surrounding in which they were being observed and guided by the lecturer and their peers.

Lecturers suggested that they were inclined to teach the content of the syllabus which students needed to pass the exam. Therefore, they suggested that for the most part they adhered to the *Science Education Syllabus.* As I reflect on the interpretive account I have provided so far, I discern that the greatest impact of the *Science Education Course* on prospective teachers came from the lecturers themselves. When prospective teachers and teachers related their experiences and made observations about the course, they inadvertently referred to the lecturer. The lecturer of the course therefore seemed to be more than just a person preparing teachers from a syllabus, but was also considered to be the central figure in the process of teacher preparation. According to the discussions with JBTE appointees, teachers, and prospective teachers, the syllabus seemed secondary. Teachers and prospective teachers were not concerned about the limiting factors that impinged on what and how lecturers could prepare them for teaching science. Because lecturers seemed aware that they were fundamental in the process of learning to teach science, aspects of the syllabus that were not in keeping with their beliefs and ideas about teaching often agitated them. For example, I discerned unease among lecturers Donna, Ann, and Monica, particularly with regard to the approaches to teaching science that are suggested by the *Science Education Syllabus.* Lecturers Donna and Monica suggested that they had added to or disregarded those categories provided by the syllabus regarding the approaches to teaching and have provided prospective teachers with new categories that they feel are more general and less confining than those in the syllabus.

Lecturers' experiences with and beliefs about the role of the *Science Education Syllabus* impacted on how they approached the *Science Education Course*. All the lecturers seemed to rearrange the format of the syllabus to make the topics more coherent and to reduce the time spent on some sections, giving more time to other sections; but not all lecturers allowed their beliefs and philosophies to direct their approach to the course. Lecturers' experiences with the syllabus suggest that if they adhere to the syllabus content, emphasizing particular sections and the suggested activities, prospective teachers' chances of passing the common exam will most likely be greater than if they chose to include areas they felt would be appropriate. On the other hand, lecturers Monica and Ann indicated that they openly incorporated their own beliefs and philosophies about science and science teaching into the *Science Education Course.* Peter, Pet, and Donna suggested that where their beliefs and philosophies were different, they would be subtle about incorporating these or would not incorporate them at all. Ann and Monica were two of the lecturers who suggested that they added to the content of the course when they felt it necessary. Lecturers such as Ann, Pet, and Monica provided examples of how they varied the instructional methods rather than looking to the learning activities suggested in the syllabus. Although it appears that there were conflicting views among lecturers about restrictions they face when using the syllabus, lecturers who considered the syllabus to be an outline of what might be relevant for prospective teachers to learn about science teaching, and how these might be learned, seem more divergent in their approach to the syllabus content and activities. Conversely, lecturers who considered the syllabus to be a guide to passing the final exam became preoccupied with the suggested activities and tried to complete all the suggested content within the time specified for the course. I therefore conclude that lecturers' views about the role of the syllabus influenced their approach to the *Science Education Course*.

I started with the question, *How is the Science Education Course preparing prospective teachers to meet the challenges of teaching science in primary schools?* It appears that in order to answer this question, I need to do a close examination of the *Science Education Syllabus*. However, from the analysis of the experiences and observations about the science education provided by the teachers' colleges, I discern that there are some satisfactions and some discontent among stakeholders regarding the contributions of the course to the preparation of teachers. The most commonly expressed satisfaction was the opportunity that prospective teachers who have never taught before get during the course to plan for and do micro teaching in a nonthreatening environment. As well, prospective teachers who had taught before going to college applauded the aspect of the course which allowed them to write lesson plans, then engage in collegial discussions and personal reflections about their strengths and weaknesses. The lecturers seem to be largely discontented about the restrictions the syllabus and the common exam created on their ability to be innovative. On the other hand, the analysis appears to indicate that it was the lecturers themselves who made the greatest impact on what the course offered and how well prospective teachers were prepared to teach science. I will present an analysis of the *Science Education Syllabus* in the next chapter.

CHAPTER 6

THE *SCIENCE EDUCATION SYLLABUS*

Introduction

The initial intent of this study was to understand through stakeholders' views what knowledge base for primary science teaching was offered and/or should be offered to prospective primary science teachers. After careful and repeated examination of the interviews and by writing and examining the interpretive accounts in Chapters 4 and 5, I realized that these stakeholders' views are only part of the big picture regarding teacher preparation. The *Science Education Syllabus* also contributes to a large part of the whole of what makes the *Science Education Course*. Whereas the findings reported in Chapter 5 indicate that lecturers were considered to be the most influential in shaping prospective teachers through the *Science Education Course*, the findings also show that lecturers were inclined to teach whatever was suggested by the syllabus in order to prepare prospective teachers to pass the common exam. As well, the findings suggest that how lecturers approach the course is dependent on two main factors: how they view and experience the role of the syllabus in the preparation of prospective teachers to teach science, and the educational and experiential background they bring to the course. According to the views of lecturers, additional consideration about their teaching is directed by the time allotted for the completion of each section of the course, as well as the entire course. Surprisingly, some college lecturers even seemed to de-emphasize their beliefs related to science teaching where these differed from those of the syllabus. Given the issues and concerns identified in my analysis of stakeholders' views, it appears important to examine the *Science Education Syllabus* and consider its role in the development of a knowledge base for primary science teaching.

There will be two components in the examination of the syllabus: (a) a description of its organization and substance, and (b) an analysis of how the substance relates to particular issues and concerns that became apparent in the findings of Chapters 4 and 5. Issues and concerns that may bear some relationship to the syllabus were:

1. Preparedness of prospective teachers to undertake the teaching of science in classrooms which were characterized by
   - Poor physical conditions and facilities and general overcrowding
     - lack of teaching materials, basic science equipment, and resources in primary school classrooms
     - inadequate classroom space and dilapidated classroom furniture
     - overcrowded teaching spaces with insufficient seating for children
     - inadequate ventilation of classrooms
     - teachers' use of textbooks as their main teaching tool
     - teachers' dependence on textbooks to inform their science content knowledge for showing children what science experiments would be like
   - Subcultural influences
     - Teachers' expressed views about how science should be taught appeared to be influenced by the college course, lecturers, and the textbooks. However, the way they teach science seems to be influenced by the scheduling of science lessons on the school's timetable, availability of materials and resources, learning differences among children, cultural beliefs among children, community practices, and behavior problems among children.
     - The main purposes for teaching science were to help children become good citizens and to help children develop process skills and attitudes.

    - A secondary purpose for teaching science was to prepare children to pass the GSAT.
    - teachers' expressed views that science activities were being done as a means to developing skills and attitudes while de-emphasizing the development of scientific knowledge
    - scheduling of science lessons, which are usually after morning break or lunch break when children are exhausted from the heat and play
  - Learner characteristics
    - Participants believed that children learn science by doing.
    - teachers' awareness that children came to science lessons with prior experiences and beliefs regarding natural occurrences and science-related issues. However, teachers did not seem to be adequately prepared to handle some of the beliefs that were characteristic of children's traditional/cultural backgrounds.

2. Developing and evaluating teaching/learning techniques and strategies
   - the expressed views about how prospective teachers experienced difficulty in developing teaching techniques and using them to plan and teach science lessons
   - The meanings that participants developed about the approaches and techniques for teaching science were derived through their experiences in primary school classrooms.

3. Reflective practice in teacher education
   - Teachers' awareness of their own strengths and weaknesses regarding science teaching and their roles as science teachers appeared to inspire their desires for further growth and for speculating about prospective teachers' preparedness to meet the challenges associated with science teaching in primary schools.

- lecturers' acknowledgement that prospective teachers entered college with beliefs about science which were derived from traditional/cultural beliefs and practices and could complete the *Science Education Course* without having reflected on these beliefs and their influences on how they teach science

As well as the three main groups of issues listed above, I reflected on the following issues regarding the scope and emphases of the substance of the syllabus:

- Prospective teachers' limited background in science with which they entered college was a major concern among lecturers.
- lecturers' impact on how prospective teachers and teachers came to consider the relevance and benefits of the *Science Education Course*
- influence of lecturers' educational background and teaching experiences on their choice of instructional methods and their approach to and use of the syllabus
- lecturers' tendency to adhere to the *Science Education Syllabus*
- Lecturers' experiences with the syllabus and their beliefs about the role of the syllabus influence their approach to the course.

The key question in my analysis of the syllabus were:

What according to the Science Education Syllabus is the course providing so prospective teachers may (a) be prepared to undertake science teaching within the complex classroom context of primary schools? (b) develop and be able to evaluate appropriate teaching/learning strategies? and (c) develop reflective practice in learning to teach and teaching science?

Organization and Substance of the Syllabus

The *Science Education Syllabus* (February 1990) for prospective primary school teachers included a short rationale, goals of the syllabus, outline of six units, a scheme of assessment, and learning resources. Each unit of the syllabus provided educational objectives, an outline of the relevant content, and a selection and organization of learning experiences. The overall syllabus indicated the mode of evaluation of the planned program.

The overall duration of the course was to be 45 hours. Each unit of the course stipulated a title, the suggested time for completing each unit, unit objectives, an outline of the content and corresponding suggested activities. These units are listed in Table 6.1.

Table 6.1

Sequence of Units and Number of Hours Allotted to Each Unit of the *Science Education Syllabus*

Unit number	Unit title	Number of hours
1	Reasons for Teaching Primary Science	2
2	How Children Learn	2
3	The Spiral Curriculum	6
4	Approaches Used in Teaching Science	18
5	Lesson Preparation and Evaluation	16
6	Resources Around Us	1

As stipulated by the syllabus, to take the course, prospective teachers should have completed *Science for Living*, which is a 90-hour course offered in the first year of the three-year diploma program in teaching and should be in the second year of the three-year program. Assessment of prospective teachers was to be in two parts: by course work and by a final exam. Prospective teachers were expected to complete at least three pieces of course work, with a final weighting of 40% of the total overall course grade. Suggested assignments for course work were included. The final examination was to be written in a single sitting. This final examination was valued at 60% of prospective teachers' total overall grade for the course. Prospective teachers were expected to answer four of six questions on the exam in two-and-one-half hours. The suggested learning resources were all printed materials dated between 1980 and 1988.

Relating the Substance to Issues and Concerns Raised by Participants

Classroom Context as it Relates to Teaching Science

As highlighted in the interpretive accounts in Chapters 4 and 5, three main groups of factors seem to contribute to the complex context of primary school classrooms. According to stakeholders', factors such as poor physical conditions, lack of teaching learning resources, subcultural influences, and learner characteristics have an impact on teachers' decisions when they are planning and teaching science.

Poor Physical Conditions and Lack of Teaching/Learning Resources

Stakeholders suggested that teachers in primary schools have to be aware of the physical constraints and availability of materials and equipment before they embark on planning and teaching science. In the syllabus, Unit 4, Objectives 2 and 3, and Unit 5, Objectives 3 and 4, along with the corresponding content and activities, suggest that prospective teachers should be forewarned about the constraints associated with teaching science in primary schools. As well, these sections of the syllabus require that prospective teachers under the guidance of the lecturer devise means of dealing with some of the possible constraints. Table 6.2 shows the objectives and suggested content and teaching/learning activities for achieving the objectives that I identified as directing lecturers to deal with constraints of teaching and designing teaching materials for primary science.

Table 6.2

Aspects of Units 4 and 5 That Imply Some Classroom Constraints That May Influence Planning for and Teaching Science

Unit	Objectives	Content	Teaching/learning activities
Unit 4: Approaches Used in Science Teaching	Students should be able to 1. improvise science equipment 2. construct instructional aids.	Improvisation of science equipment	Construction of charts, . . . models, word cards, science corners in relation to topics in the science syllabus. Collection of items from the environment, and show how these can be used to teach science at the primary level.
Unit 5: Lesson Preparation and Evaluation	Students should be able to 3. demonstrate a knowledge of the factors to be borne in mind when planning science lessons 4. demonstrate management skills in the classroom.		Guided discussion on lesson planning and classroom management.

In Unit 5 both objectives that deal with classroom management and factors to be considered when planning and teaching science are vague; for example, "Students should be able to demonstrate management skills in the classroom," and there is no corresponding content to provide direction to lecturers. This presumes that lecturers have a strong background in the area of classroom management in primary schools and that prospective teachers have working knowledge of management skills and primary school classrooms. To be adequately prepared to demonstrate management skills for a science lesson, knowledge of the primary school classroom context, precautionary measures required to ensure the safety of children, and knowledge of the children themselves are only some of the background information which are required. Teaching about management skills in science must be done in context. Appropriate approaches to teaching management skills to prospective teachers could include the use of case studies and lecturers modeling management skills. Simulation exercises as suggested by the syllabus might be inadequate for such an intricate, context-sensitive, and important aspect of science teaching.

Additionally, the sections indicated in Table 6.2 provide ample indication that prospective teachers were to be well informed about some physical constraints they might have encountered in primary schools. As well, prospective teachers should be made aware, through the suggested activities, of possible actions for dealing with some classroom constraints.

The syllabus does not provide an adequate overview of the specific types of constraints, and if lecturers were not conversant with the specific types of constraints, prospective teachers would not be exposed to a variety of these constraints. The syllabus therefore needs to be more specific with regard to the types of constraints to which prospective teachers should be exposed.

There is no mention of the use of textbooks, which is a major tool used by primary school teachers for teaching science because of the physical constraints that prevent the use of hands-on activities. With the use of textbooks being so central to the teaching of science in primary schools, suggestions about its use as a teaching tool might be welcomed by prospective teachers who use them as alternatives to science activities. Interestingly, the syllabus has provided detailed suggestion for prospective teachers to learn about and explore the science curriculum for primary schools. Unit 3 of the syllabus, *The Spiral Curriculum*, states as the first objective "Students should be able to demonstrate an understanding of the spiral development of the topics within the curriculum." As well, Unit 4, *Approaches Used in Science Teaching*, Objective 1, reads, "Students should be able to demonstrate a knowledge of the content of the science syllabus for primary schools." Clearly, prospective teachers are to be provided with a basic understanding of the curriculum so that they will be able to use it for developing lessons; however, the findings in Chapter 4 suggest that classroom teachers seem to refer to the curriculum much less frequently than the textbooks. In the interviews all prospective teachers indicated that during teaching practice, teachers provide them with science textbooks from which they are asked to develop science lessons. It is therefore significant that there is a total absence of ideas about good use of textbooks for teaching science in the *Science Education Syllabus*.

The syllabus has suggested that prospective teachers be made aware that physical constraints and the lack of teaching/learning resources impinge on planning for and teaching science. The syllabus also advises that prospective teachers be informed about the means of dealing with some specific constraints, as shown in Table 6.2; however, because these constraints may not be general across primary schools, teachers will always have to be innovative in dealing with problems as they arise. Implied in these aspects of the syllabus are constraints such as lack of equipment and teaching materials, which justifies the need to help prospective teachers develop teaching aids and improvised equipment. Although this initiative is worthwhile for prospective teachers to have in light of the circumstances described in Chapter 4, lecturers such as Ann suggested that this section could be omitted as prospective teachers learn to design and make teaching aids in the instructional technology course, which is a program requirement. Ann said:

> I think it [*Improvisation of Science Equipment*] could be removed because it is addressed in another course, instructional technology. For example, they are asked to construct instructional aids. I think that could be removed in order for us to spend more time on essential parts, which are the approaches . . . and the lesson planning. (Interview 1, p. 6)

On the other hand Sophia, a JBTE appointee, observed that although prospective teachers had several teaching aids in their classrooms during teaching practice, they were unable to use teaching aids effectively for teaching. Sophia elaborated:

> As beginning practicing teachers they see it [teaching science] as a whole heap of aids to be produced. And I mean that. You can see that they are so distressed if we look at the aids and we are not giving them enough credit for them, but as I would say to them, "Doing the aids is one thing, and I can compliment you for that. How you use the aids in the classroom is what I am more interested in seeing," and that is what they have not gotten enough practice doing, how those aids would assist in the students' learning, because they have not been utilizing aids themselves, and that, I think, is part of the problem. (Interview 1, p. 2)

According to Sophia's observation, prospective teachers construct teaching aids, but they have limited knowledge of how to use them. She attributed this to the limited use of teaching aids during the college course. The syllabus has not indicated that prospective teachers should be learning the appropriate use of teaching aids which they construct, such as charts. Because the construction of teaching aids is included in Unit 4, *Approaches to Teaching*, two questions arise as a result of Sophia's observations: What is it that lecturers explore in their evaluation of prospective teachers' micro-teaching exercises which should occur during this unit? What do lecturers do to assist prospective teachers in utilizing teaching aids during teaching? If teaching aids are used for the micro-teaching exercise, I hope that lecturers' evaluations would include the use of these teaching aids as teaching/learning tools. Teaching aids that teachers construct for themselves, along with improvised equipment, may be the only materials and resources that teachers have for teaching science in primary schools. This aspect of the syllabus is therefore essential to helping prospective teachers prepare to deal with some of the constraints associated with classroom context.

Subcultural Influences

Another finding that resulted from the analysis in Chapters 4 and 5 is that subcultural influences impact on planning for and teaching science. As indicated in Chapter 4, teachers are constantly confronted with ideas and beliefs about science and about how science should be taught. These ideas and beliefs are suggested through:

- community practices such as traditional and cultural beliefs about science, farming practices, religious practices, and beliefs;
- scientific practices, which may be implied in textbooks and college science courses, as well as through the media;
- school science practices as suggested in the children's textbooks;
- practices of teaching science as experienced and learned in college; and
- administrative and school practices such as scheduling of science lessons, budgeting and allocation of available funds, and emphasis of professional development activities.

Interestingly the practice of science as suggested by the curriculum did not affect how teachers planned and taught science, because they indicated that for the most part they did not use the curriculum; they used the children's textbooks.

Examination of the syllabus shows that only brief mention is made about some of these subcultures and their practices in relation to science teaching. Therefore lecturers would have to look at the syllabus for logical units through which subcultural influences could be made known and explored by prospective teachers. The first of these units is *Reasons for Teaching Science*. Table 6.3 shows the substance of the unit.

Table 6.3

The Substance of Unit 1 as Stated in the *Science Education Syllabus*

Objectives	Content	Activities
Students should 1. show an awareness of the processes of science and the application of these to everyday life; 2. demonstrate a knowledge of the attitudes generated by the practice of science; e.g., awareness, curiosity, inquiry, desire to know and understand.	Reasons for teaching science: 1. definition of science; emphasize process, product, attitude; 2. attitudes generated by practice of science; e.g., awareness, curiosity, desire to know and understand 3. application to everyday life.	Research paper utilizing resource personnel and text.

The only practice which is explicitly suggested in the unit shown in the table is that of scientists. However, because the unit suggests that the attitudes generated by the practice of science should be applied to everyday life, there is scope for exploring other beliefs and practices in relation to science teaching. Again, although the substance of the syllabus suggests that resource personnel be utilized, it presumes that the knowledge that lecturers bring to the course will be adequate to generate relevant applications of the reasons for teaching science to everyday life if no resource person is available. On the other hand, a lecturer with limited experience in instructing a *Science Education Course* for prospective teachers might be misled by the suggested content. Consequently, such persons might focus on simply developing a definition, discussing what the attitudes are, and then applying science to everyday life without exploring what is involved in doing science and developing theories and laws and without discussing the fallibility and tentativeness of knowledge developed through scientific research.

Influences associated with scientist science, school science, and textbook science. Because the title of the unit is *Reasons for Teaching Science*, it appears that perusal of the nature of science and its implications for the practice of teaching science in primary schools could be explicated here. From the findings it appears that prospective teachers have limited understanding of the importance of teaching science in primary schools; they suggest that the importance of teaching science is to develop process skills. By examining the nature of science along with how science and scientists are represented in textbooks and the implications of these representations on science teaching, a more diverse view of the purposes of teaching science in primary schools might be developed.

Community and traditional influences. Unit 1, *Reasons for Teaching Science*, also has scope for prospective teachers to explore traditional beliefs related to science and the causes and effects of natural occurrences, as well as the ideas that children bring to science lessons. There are very powerful and common beliefs among families living in deep rural communities regarding the *obeah* man/woman or the medicine man/woman who is considered to be a scientist. This person is held in high regard for curing both physical and spiritual ailments and for predicting natural disasters, misfortunes, fortunes, and life expectancy. Other prevalent beliefs and practices are associated with religion. As mentioned in Chapter 5, Peter, a college lecturer, found that prospective teachers hold these beliefs, but there is no indication that the scope of the *Science Education Course* allows prospective teachers to consider multiple perspectives about science. By exploring origins of cultural/traditional and community beliefs and practices, along with the practices and attitudes of scientists, science educators could help prospective teachers to learn how different cultures have developed their science over the years as a means of meeting their own purposes. Consequently, prospective teachers could be exploring the reasons for teaching science in schools and ultimately to consider these multiple perspectives about science as a factor that helps to create the complex context of classrooms.

An important consideration that might limit lecturers' views of the scope of Unit 1 is the time allotted for the unit. The suggested time of two hours would not allow for such explorations as I have suggested here; it is therefore likely that lecturers may not consider exploring the reasons for teaching science further than is explicitly stated in the syllabus.

Administrative and school influences. Another area of the syllabus that could encourage prospective teachers to think about the complex context of classrooms and their influences on science teaching is Unit 4, Objective 6: "Students should be able to recognize problems inherent in teaching science at the primary school. . . . The corresponding content suggested by the syllabus states, 'Problems in teach science (a) teachers' problems (b) children's problems.'" Depending on how lecturers interpret this objective and the suggested content, this unit could be used as an avenue for discussing how practices of administration could impact on how a teacher teaches science and on what children learn in science. Administrative practices such as scheduling of science lessons and allocation of available funds are suggestive of how significant science is considered to be in the school. Children from the school in which Paul teaches have always been involved in science-related competitions and national activities. He does not have adequate science equipment and materials for teaching, but the school administration budgets a very small portion of the school funds for science. Winsome, another teacher from another school, is allowed a small sum of money for assisting with science-related activities. Both teachers, Paul and Winsome, have science lessons scheduled for 1½ hours per week with one lesson scheduled in the morning and the other in the afternoon on different days. Each lesson has a duration of 45 minutes each. Other teachers who participated in this research have science lessons scheduled for one hour per week, and both science lessons in these schools are scheduled as two half-hour lessons, both in the afternoons. On the other hand, Paul and Winsome are allowed to engage in several science-related extracurricular activities and teacher education development sessions. It is not expected that the *Science Education Course* would solve these problems, but an awareness of these and other administration-related issues could help prospective teachers prepare to handle science teaching in primary schools.

Overall it seems that it was not the intent of the syllabus to have subcultural practices included as a significant part of the course. The syllabus does not specify most of the issues discussed in this section. Therefore preparation of teachers to handle the complex classroom contexts of primary schools is dependent on lecturers' knowledge about primary school classrooms, their awareness of the significance of the issues, and their willingness to explore the issues discussed in this section.

Learner Characteristics

As discussed in Chapter 4, I observed that children's learning needs, how children learn, and children's beliefs about science-related issues all contribute to the complex nature of teaching science in primary schools. The only learner characteristic which is explicitly addressed by the syllabus is how children learn. The second goal stated in the syllabus is, "This syllabus should develop an awareness of the learning process in children" (p. 15), and the title of Unit 2 is *How Children Learn* (p. 16). One would expect that different theories of learning would be explored so that prospective teachers could begin to understand that by recognizing different perspectives of how children learn, they can develop and evaluate different ways for teaching science to children. I expected to see at least two central ideas about how children learn in the syllabus: (a) Bruner's (1960) ideas related to the coding systems that facilitate transfer and improve problem-solving ability and motivation. These ideas led to the suggestion of the discovery method of teaching which participants advocate; and (b) constructivism, from Piaget's point of view, as well as from the points of view of science education researchers such as Driver (social constructivism) and Osborne and Witrock (generative learning). Surprisingly, the syllabus provided a very sparse representation of how children learn by presenting only

Piaget's theory of the stages of development (i.e., sensorimotor, preoperational, concrete operational, formal operational) as the way children learn. The entire unit reads:

Unit 2

Title: How Children Learn

Number of hours: two

Objectives:

Students should be able to demonstrate a knowledge of

1. *stages of development of children's thinking.*
2. *Implications for science teaching.*

Content	*Activities*
1. Piaget's Theory	*1. Research Presentation*
	2. Discussion on above.

During interviews with college lecturers Ann and Donna, they had reported that they do not do Unit 2 of the syllabus as it was already done as a part of the child development course which is taken by all prospective primary teachers. On the other hand, Pet and Donna mentioned that since Piaget's learning theory is done in the child development course; they simply incorporated this theory into Unit 3, *The Spiral Curriculum*, because the syllabus suggested that Piaget's theory could be applied to the concept of the spiral curriculum.

Unit 3, as shown in Table 6.4, also states that Piaget's developmental approach to learning was emphasized. Unit 3 suggests that students (prospective teachers) correlate Piaget's stages of development to the idea of the spiral nature of the primary school science curriculum. This could lead students to assume that the spiral curriculum is a direct result of Piaget's theory of development. Additionally, one of the suggested resources (Young, 1988, p. 46) and the text used by prospective teachers in the course indicate that the spiral approach to curriculum development provides a step-by-step view of teaching science concepts by introducing the same concepts at different stages of

Table 6.4

Components and Substance of Unit 3 as Stated by the Syllabus (p. 17)

No. of hours	Objectives	Content	Activities
Six	Student should be able to 1. demonstrate an understanding of the spiral development of the topics within the curriculum, 2. correlate the above with stages of development of children.	1. Definition and explanation of spiral curriculum. 2. Application of Piaget's theory	1. Choose concepts in primary science curriculum and show how these are treated in the spiral curriculum. 2. Simulate class situations where the same concept is taught to different age groups. 3. Discussion and evaluation of above.

schooling. Young suggested that this approach starts with introducing concepts through simple comparisons, moving to simple application of principles governing these concepts, and finally moving to more sophisticated ideas, leading to abstractions. Young then discussed implications for science teaching by using Piaget's theory of development. It was Bruner's (1960) suggestion that in teaching and learning, children should be introduced to concepts in a developmentally appropriate fashion. Because Bruner's idea is the direct influence on the spiral approach to the Jamaican primary science curriculum, these ideas should be included in the syllabus to explain the background and implications of such a curriculum.

An exploration of how children learn would be beneficial to prospective teachers who are learning to teach science, but the *Science Education Syllabus* does not adequately address this topic. By examining the syllabus, I have shown that by including Bruner's (1960) ideas about learning, along with different constructivist learning theories and postulates, prospective teachers would be better equipped to negotiate selection and use of different learning activities and teaching techniques. Additionally, although the process approach is included in the syllabus as a teaching approach (p. 18) and is advocated by the textbook, Gagne's (1985) ideas about outcomes of learning are not included in the syllabus. The findings of Chapter 4 indicate that teachers in the study felt that children learn by doing, but their expressed views indicated that their use of activities in science lessons might be limited to learning process skills rather than children using them as a medium for constructing understanding about science concepts. A more diverse consideration of how children learn might therefore benefit prospective teachers as they construct their knowledge about developing and evaluating teaching/learning strategies.

Developing and Evaluating Teaching/Learning Strategies

The findings in Chapter 4 suggest that teachers in primary schools considered it best to teach science using hands-on activities. However, the findings also show that, for the most part, these same teachers were using textbooks as the primary medium through which science is taught. In Chapter 4 I also showed that teachers' expressed views suggest that they were trying to avoid the use of "chalk and talk" as the teaching method and believed that children should be enjoying science lessons while learning. Conversely, in Chapter 4 prospective teachers indicated that their attempts at teaching science during second-year teaching practice were met with mixed feelings. They talked about the difficult and unpleasant times and the challenges they had to overcome (see Appendix H for Vicky's story), and lecturers suggested that prospective teachers' found it difficult to develop and show appropriate use of teaching techniques when teaching different science topics.

A significant portion of the syllabus is devoted to developing and evaluating appropriate strategies and techniques and incorporating them into unit plans and lesson plans. Goal number 4 of the syllabus states: "This syllabus should examine the primary school curriculum and develop effective teaching strategies to foster interest and knowledge of science in students at the primary level" (p. 15). Two of the seven objectives specified in Unit 4 are related to the selection and use of teaching/learning strategies. The objectives read:

Students should be able to

- *find out for themselves about the various approaches for teaching science;*
- *select appropriate approaches and demonstrate these in teaching specific concepts.*

The corresponding content and activities are shown in Table 6.5.

Table 6.5

Content and Activities as Suggested by the Syllabus in Unit 4

Content	Activities
Approaches to science teaching; e.g., traditional content/syllabus, process, project, concept.	Teacher uses appropriate teaching strategies to illustrate teaching of science topics selected.
Teaching techniques; e.g., drama , story telling, games, questioning, visual aids, using children's interests.	Students view videotapes of student teachers using various approaches to teaching—appraisal of each. Micro teaching.
	Study and discussion on approaches to and techniques used in science teaching.

As well Unit 5, *Lesson Preparation and Evaluation,* which is allotted 16 hours, requires that prospective teachers formulate objectives and sequence subtopics in the unit plan by practicing writing them. I therefore conclude that the syllabus indicates that selecting and using teaching techniques appropriately is most important to the preparation of prospective teachers to teach science. My conclusion is based on two facts: (a) 34 of the

45 hours available in the course are allotted between Units 4 and 5, and (b) both Units 4 and 5 are largely devoted to selecting and using teaching techniques to write lesson plans and unit plans and to experiencing the use of these approaches in teaching. This finding raises concerns regarding the inability of prospective teachers to select appropriate teaching approaches and techniques and to plan and teach science lessons when such a large portion of the syllabus is devoted to the same. After reflecting on this concern, I refer to the interviews with prospective teachers who taught before entering college and to interviews with teachers, along with the literature regarding the development of teachers' knowledge (Connelly & Clandinin, 1995; Shulman, 1987). I have come to realize that in order for teachers to transform content knowledge and pedagogical content knowledge into meaningful instructional strategies, they must refer to the entire repertoire of Shulman's knowledge base for teaching and to their own preferences, purpose, and background experiences in order to know what will and will not work.

Reflective Practice in Learning to Teach and Teaching Science

This section will explore the contributions of the syllabus to the idea of reflective practice as a necessary and natural activity in learning to teach and in teaching. I come to this section of the chapter with preunderstandings that I developed from the literature I have explored (Clandinin, 1995; Loughran & Russell, 1997; Zeichner 1996), from the previous chapters of this study, and from my own experiences as a teacher and a teacher educator. The literature has helped me to appreciate that by using reflection as an integral part of teacher education, prospective teachers are poised for further learning as they embark on their teaching journey. In the previous chapters I began to understand how teachers in their classrooms, prospective teachers who were learning to teach, and college lecturers on their quest to prepare teachers used their knowledge of past experiences, knowledge of the present, and aspirations for the future to learn about and teach science. Coupled with the influences above, my own experiences has led me to consider the importance of the development of self as a part of science education for prospective teachers.

Although the rationale presented at the beginning of the *Science Education Syllabus* does not mention aspects of the aims of education or science education or teacher education, it does attempt to initiate reflective practice in science teaching. The section reads: "With the advent of the 21st century and the advances in science and technology, it is imperative that science teachers evaluate their role and consolidate the methods used in the teaching of science" (p. 15). There is no mention of any aspect of the role of reflection or reflective practice in the seven goals stated on page 15 of the syllabus. However, Unit 4, Objective 7, reads, "Students should be able to understand their role and attitude as science teachers" (p. 18). Corresponding content and activities are as follows

Content

Role and attitude of the science teacher

Activities

Panel discussion on the role and attitude of the science teacher.

As stated in the syllabus, the role and attitude of the science teacher is a wide-open topic and could be approached from different viewpoints. The lecturer could choose to explore the topic by looking at the teacher as motivator, diagnostician, guide, innovator, experimenter, and researcher (Osborne & Freyberg, 1994, p. 91). The topic could also be explored from the viewpoint of the science teachers' management styles and ways of managing a science lesson through the techniques and approaches used for teaching (Appleton, 1997, pp. 139-148). As well, the role of the teacher could be approached from Koch's (1999) point of view: the teacher as a guide and mediator who provides conditions for learning to take place (p. 250). However, whichever viewpoint a lecturer chooses to explore, the basic starting point will be that teachers of primary science will be reflecting on self. With this in mind, one learning activity that would be central to this topic and should be included in the syllabus are writing reflective journals and discussing cases which are analogous to Jamaican primary school classrooms. There is no indication that this is a practice of any of the college lecturers interviewed; neither was it mentioned by prospective teachers or teachers as being a part of the activities in which they engaged.

During the interviews, participants reflected on their experiences and observations regarding teaching in primary schools and on the *Science Education Course*. Teachers talked about how they viewed their strengths and their weaknesses and what they did to overcome or deal with their weaknesses so that they could provide children with the best possible science education. Lecturers talked about themselves as role models and looked into themselves and their experiences for means of helping prospective teachers develop skills and knowledge required for teaching science. JBTE appointees reflected on their own experiences as teacher education students (see Appendix I for Sophia's story) and suggested that by becoming aware of themselves, their beliefs, and their deficiencies, they were able to interpret and appreciate past experiences and to achieve professional growth through this reflective process. Jerry, another JBTE appointee, suggested that although it is important for prospective teachers to learn the content of science and the theories of how children learn, the most important thing that they can learn is about themselves as teachers and learners. Jerry said:

> To my mind, certainly they need to be comfortable with content at or above the level that they are going to deliver for the children. Let's say they are going to be doing motion. They must be comfortable with concepts in motion above that of the level they teach so that they can in a sense follow in some ways what the children might be exploring and be able to give guidance to the children during their exploration. But I think—and this might be the hard one for them—I think what is most important is that they know about themselves, where they have deficiencies. . . . Teachers should not only have self-confidence but, more so, awareness of self and their limitations; you know, to say, "Well, I am deficient here. I need to solve it." (Interview 1)

The syllabus suggests that science teachers should be aware of their role as science teachers, but because there was no examples or expansion of the idea, the importance of such an important aspect of being a science teacher might be overlooked. I have shown in this section that stakeholders who participated in this study indicated that, by reflecting on their role and on how to achieve goals and desires they hold for science and for children, they achieved professional growth. Some participants, such as prospective teachers, might not be aware of this growth. For example, Vicky explained that she had great difficulty with teaching a lesson on measurement. By reflecting on the difficulties she had encountered, Vicky was able to suggest some reasons she thought had contributed to the difficulties she encountered. She was also able to make adjustments to her planning and teaching in subsequent lessons (see Appendix H for Vicky's story). It appears that reflective practice as a central aspect of the *Science Education Course* would help prospective teachers to start practicing an aspect of teaching which will ultimately form a necessary part of their classroom practice.

Summary of the Findings

The *Science Education Syllabus*, which is being used to prepare prospective primary school teachers to teach science, is organized to show rationale, course goals, unit objectives, course content, teaching/learning activities, and mode of evaluation. The course is designed for prospective teachers in their second year of the Three-Year Diploma Program and specifies a prerequisite, *Science for Living*, which is the science content course in year one of the Diploma Program. The course consists of six units.

The findings of Chapters 4 and 5 show constraints related to complex classroom context, developing and evaluating teaching techniques, and reflective practice as being three important considerations when teaching science in primary schools. The analysis of the syllabus which was presented in this chapter explored the three main groups of factors in relation to the preparation of teachers for meeting the challenges of teaching science in primary schools. A summary of the findings is presented here.

Sections of two units show that prospective teachers should be made aware of constraints such as poor physical conditions and lack of teaching learning resources and equipment in primary schools. However, the syllabus does not provide adequate indications of the types of constraints or the instructional activities that could be explored during the course. Consequently, important issues related to physical conditions and availability of learning resources and equipment in the science classrooms may remain unexplored if lecturers' professional and experiential backgrounds do not adequately inform their knowledge regarding these issues.

There is no indication from the syllabus that prospective teachers are exposed to good use of textbooks which, according to teachers, are the most used teaching tools for primary school science. On the other hand, although teachers have not indicated that they refer to the primary school science curriculum for planning or teaching, the syllabus devotes a significant part of the course to the organization and content of the primary school science curriculum.

Unit 1, *Reasons for Teaching Science*, is the most probable section of the syllabus for introducing prospective teachers to subcultural influences, such as those associated with community and cultural traditions, scientists' science, school science, and the textbook image of science. The attitudes generated by the practice of scientists are the only influences associated with subcultures that are mentioned by the syllabus. Although the unit has the scope for extending the discussion of subcultural influences and their impact on reasons for teaching science, the time allotted for the unit does not suggest that any other subculture is intended by the syllabus. If a variety of subcultural influences are omitted from the *Science Education Course*, there is the possibility that prospective teachers would not be allowed to explore multiple perspectives of the meaning of science and implications for science teaching.

Objective 6 of Unit 4 suggests that prospective teachers could be allowed to explore administrative practices that could impact on the atmosphere of the school with regard to science teaching and learning. The syllabus provides a framework for explicating this aspect of subcultural influence but does not expand the idea. Lecturers' expertise is again propositioned, as the relevant subtopics presented in the syllabus are vague.

How children learn, their learning needs, and their beliefs in science are all learner characteristics which are suggested by different sections of the syllabus. How children learn is presumed to be a major consideration in the syllabus, because an entire unit was allotted to this topic. However, upon examination of the unit I have concluded that the topic was not fully developed. The only theory to which the unit referred was Piaget's theory of the stages of development. This theory is inadequate for assisting prospective teachers to develop more sophisticated understandings of children's learning in science. Additionally, whereas the syllabus refers to the spiral development of curriculum and the process approach to teaching science, it has omitted the postulates of Bruner and Gagne, from whom these ideas were developed. Because the idea of how children learn is essential to developing and evaluating teaching/learning situations and activities, expansion of this unit on how children learn is required.

A significant portion of the syllabus is devoted to how prospective teachers can develop, evaluate, and incorporate teaching/learning strategies and techniques into unit and lesson plans as well as into teaching. Units 4 and 5 are the main sections of the syllabus in which strategies and techniques for teaching science are considered. The total time allotted to both units is 34 hours out of the 45-hour course. Therefore, it appears that the main intent of this syllabus is to guide prospective teachers towards an understanding of how to develop and evaluate teaching/learning strategies and techniques and how to incorporate them into planning for and teaching science lessons.

The syllabus has mentioned the idea that science teachers should be aware of the role and attitudes of science teachers. This aspect of the syllabus, along with how learning to teach and teaching are presented throughout the course, has potential for initiating reflective practice among prospective teachers. I have shown that stakeholders who participated in this study indicated that that reflection pays a central role in how teachers consider their professional development and teaching practices. It appears that reflective practice as a central aspect of the *Science Education Course* would help prospective teachers to start reflecting on themselves in relation to learning to teach and teaching science.

I believe the findings presented and discussed in this chapter have contributed further to my developing understanding of the *Science Education Course* for prospective Jamaican primary teachers for teaching science. By exploring participants' views and observations about the teaching of science in primary schools, I came to understand that there are three main factors related to science teaching which would be beneficial for prospective teachers to be aware of before they begin to teach in primary school classrooms: the complex classroom context, developing and evaluating teaching learning activities, and reflective practice. Through the expressed views of the participants I also gained insights into the process of learning to teach science as provided by the *Science Education Course* in teachers' colleges. Finally, the combined findings uncovered through this research enable me to suggest implications for primary science education for Jamaica's prospective teachers.

CHAPTER 7

DISCUSSION AND IMPLICATIONS

Introduction

This research journey began with my desire to understand what it is that prospective primary teachers needed to have as a knowledge base for teaching science in primary schools in Jamaica. Because this desire emerged out of my experiences as a teacher educator, I considered the research to be a significant part of my own professional development. Therefore the purpose of doing the study was to develop my understanding of how the *Science Education Course,* which is a part of the teacher education program, has contributed to the preparedness of prospective teachers to teach science in primary schools. In the study I examined stakeholders' views about science teaching and the *Science Education Course* which is provided for prospective primary teachers in Jamaican teachers' colleges. Participants shared their views, experiences, and observations with me through semistructured interviews and informal conversations. Results of the analysis of the transcripts of these interviews suggest the need for a thorough examination of the *Science Education Course*. I examined the syllabus with a view to clarifying concerns and questions raised by the interviews and from my own perspective as a science educator.

My research was not intended to prove theory or make predictions. Undertaken as a constructivist-interpretive inquiry, its intent was pragmatic. I believed that by constructing an understanding of what it is that prospective primary teachers were and should be exposed to in the *Science Education Course*, I would be able to make informed recommendations regarding the practice of educating teachers in Jamaican teacher education programs. Packer and Addison (1989b) asserted that "interpretive inquiry is intrinsically linked to practical activity. The motivation for an interpretive inquiry is a practical concern, and what is uncovered when things go well is an answer to this concern. This answer should have direct implications for practice" (p. 287). I came to this research with a practical concern: to understand what knowledge base for primary science teaching was offered and/or should be offered to prospective primary science teachers in Jamaica. The understandings I developed through this research enabled me to offer suggestions for helpful practice in science teacher education in Jamaica.

In this chapter I review important findings and discuss these with a focus on the two research questions that guided the study:

1. How does the current *Science Education Course* for Jamaican prospective teachers contribute to knowledge for teaching primary science, according to internal stakeholders?

2. What knowledge for teaching primary science should a revised *Science Education Course* provide for prospective Jamaican primary teachers, according to internal stakeholders?

A discussion of the findings will be presented using focussing topics which were developed when the findings in Chapters 4, 5, and 6 were juxtaposed and connections were made across the findings of the three chapters. The following topics were formed:

- Starting with what prospective teachers know and believe about science, and about teaching and learning
- Constructing pedagogical content knowledge
- Purpose of teaching science
- Participants' reflections on the *Science Education Course*
- Further development of the *Science Education Course*

Implications for primary science teacher education will then be presented, followed by my own reflections regarding the research process and the role of this constructivist-interpretive inquiry in opening up new perspectives and possibilities rather than seeking to justify existing ones. Finally, I present recommendations for further research.

Summary of Important Findings

Prior to discussion of the topics listed above, I will list a number of key findings from this research. The first research question is used as the starting point for framing these key findings:

How does the current Science Education Course for Jamaican prospective teachers contribute to knowledge for teaching primary science?

The contributions that the *Science Education Course* makes to the knowledge for teaching science that prospective teachers require for teaching in primary schools was determined by considering what is and is not provided by the course according to stakeholders' views and examination of the *Science Education Syllabus*. To consider the adequacy of the course, I have to consider the course as experienced by the prospective teachers, teachers, and lecturers; the course as perceived by the JBTE Appointees; and the course as suggested in the syllabus. I therefore revisited the combined findings in Chapters 4 and 5 and juxtaposed these against the findings in Chapter 6. Through this process of juxtaposing and connecting, I conclude that the current *Science Education Course* for Jamaican prospective teachers contributes little to their knowledge for teaching science in Jamaican primary schools. Like Loughran and Russell (1997) and Northfield and Gunstone (1997), it is my belief that preservice education is only a starting point from which prospective teachers extend their knowledge about teaching. However, I also believe that the preservice teacher education program should lay a worthwhile and relevant foundation on which these prospective teachers can start to develop, professionally. The following statements identify some of the key limitations of the *Science Education Course*:

- Although the course suggested a variety of strategies and techniques for use in teaching science lessons, it did not adequately support prospective teachers in learning how to select, develop, or modify these for use in the classroom context.

Only prospective teachers with prior classroom teaching experiences were able to benefit from this component of the *Science Education Course*.

- Although at the beginning of the course lecturers ask prospective teachers to make their views about science known, they seldom had time during the course to follow up on the changes that prospective teachers may have made to these beliefs. Lecturers did not suggest that they ascertained prospective teachers' beliefs about teaching and learning; neither did they indicate that they considered these to be an influence on learning to teach.
- Although micro-teaching opportunities in the course provided prospective teachers with a safe environment for learning the intricacies of planning lessons, they did not require them to consider the constraints of planning and teaching in actual primary classrooms.
- Although the course offered theoretical ideas about the ways in which the classroom context influences planning and teaching science, it did not provide opportunities to plan for teaching science within the conditions found in typical Jamaican primary classrooms. Prospective teachers without prior classroom teaching experiences had great difficulty in planning to teach science in the context of the actual Jamaican primary classroom.
- Although the course effectively introduced the idea that hands-on activities were an appropriate starting point for designing science lessons, it did not seem to extend the purpose of hands-on activities in science teaching beyond the learning of process skills and attitudes, and for enjoyment.
- Although the course effectively emphasized the process skills and attitudes as essential elements of the practice of science, it did not help prospective teachers to incorporate broader views of science associated with diverse science subcultures and community practices and to consider these views when planning and teaching.

- Although the course suggested that the primary school science curriculum is a valuable reference for planning and teaching, it did not help prospective teachers learn how best to use the textbooks available for teaching science in primary schools.
- Although the course required that prospective teachers be made aware of the purpose of teaching science in primary school, approaches for teaching and learning, and their roles as science teachers, it did not require them to reflect on these before, during, and after teaching science The prospective teachers with prior classroom teaching experience spontaneously used planning assignments as an opportunity for such reflection and spoke of its value. Prospective teachers without prior experiences, however, only mentioned that they appreciated the planning activities and found the plans useful on teaching practice.

Discussion

Starting With What Prospective Teachers Know and Believe About Science, and Teaching and Learning

From the expressed views of all lecturers, I identified that at the beginning of the *Science Education Course* for prospective primary teachers, lecturers ascertained the beliefs of prospective teachers regarding "what is science." Lecturers indicated that the views of prospective teachers were diverse, ranging from beliefs consistent with school science to beliefs representing cultural practices, which lecturers referred to as *superstitions*. For example, Peter, a college lecturer, indicated that the group of prospective teachers that he had considered science to be learning a combination of physics, chemistry, and biology; a part of everyday activities; how they lived and things they did; and the practice of the *obeah* man. None of the lecturers seemed to inquire after prospective teachers' beliefs and knowledge regarding teaching and learning.

Although lecturers seemed interested in the beliefs and knowledge of science with which prospective teachers entered the *Science Education Course*, during the course they did not mention providing challenges to the students' initial knowledge and beliefs. Lecturers referred to factors such as time and the impending common exam as constraints on their desire to attend to the prospective teachers' initial beliefs and knowledge of science during the course.

The practice of eliciting and then developing or challenging views about science and teaching and learning with which prospective teachers enter *Science Education Courses* has received considerable attention in the literature (Appleton, 1995; Feiman-Nemser & Remilard, 1996; Gustafson & Rowell, 1995; Marion et al., 1999; Stofflett, 1994). These science educators and teacher educators are predominantly advocates for conceptual change pedagogy. Conceptual change pedagogy is grounded in constructivism, which recognizes that the theories which are brought to classrooms are powerful and affect the learning of new material (Driver et al., 1994, Stofflett, 1994).

Among those science educators and teacher education researchers mentioned above, some of the main purposes they have for eliciting the beliefs and knowledge of prospective teachers are to determine the needs of prospective teachers so that they are able to design appropriate instruction for the course and study the changes that occur through instruction during the course. A common understanding among these and other science educators and teacher education researchers is that prospective teachers enter *Science Education Courses* with existing knowledge and beliefs about science and teaching and learning. This current view among teacher educators influences their choice of instructional strategies that seek to close the gap that exists between prospective teachers' beliefs and knowledge and the contemporary knowledge about science and teaching and learning. Jamaican science education lecturers who participated in this study did not suggest that they considered prospective teachers' beliefs and knowledge with which they entered the *Science Education Course* as an important influence on how they planned for and instructed the course. Lecturers also did not indicate a purpose for eliciting the initial views with which prospective teachers entered the *Science Education Course*.

Lecturers seemed to feel considerably constrained by the syllabus and the time to complete the course in order to be ready for the exam. As well, lecturers' choices of what they included in the course and how they instructed the course also seemed largely a consequence of how they perceived the role of the *Science Education Syllabus*. From the data it appears that lecturers' desire to complete the given course syllabus overshadowed their desire to have prospective teachers learn about relevant and useful elements of teaching science in primary schools. Consequently, because the syllabus does not suggest that the *Science Education Course* is grounded in a constructivist philosophy, it is unlikely that lecturers would be considering constructivist instructional sequences in the course. The first main element of a constructivist instructional sequence is to elicit learners' existing views.

I recognize the daunting task that Jamaican science education lecturers have when faced with interpreting a syllabus, preparing students for an exam by completing the syllabus on time, and preparing prospective teachers to enter their beginning year of teaching with adequate knowledge about teaching that the context may require. In such a situation lecturers may first be considering the immediate rather than the long-term implications and consequences associated with instructing the course; that is, having prospective teachers pass the exam.

Goodlad (1990) maintained that professional circumstances within teacher education institutions have succeeded in eroding the autonomy of teacher educators. He cited a growing tension between state mandates and the beliefs of teacher educators. In this study the mandates of the JBTE and the educational context mitigated against some lecturers' visions for an ideal science education and against all lecturers' desire to provide more authentic avenues for prospective teachers to learn to teach science. Notwithstanding this finding, the beliefs and knowledge about teaching and learning that prospective teachers bring to the *Science Education Course* is an element of teacher identity which should be considered essential to teacher education (Bullough, 1997; Northfield & Gunstone, 1997). As discussed above, lecturers' preoccupation with the mandates of the JBTE, including those related to the common exam, took precedence over concern for factors that might hinder learning in the *Science Education Course*. One such possible factor is the powerful and prevailing belief system that prospective teachers bring to college about teaching and learning science.

Constructing Pedagogical Content Knowledge

The *Science Education Course* seems to provide prospective teachers with a variety of techniques and strategies for teaching science in primary schools, principles regarding the formulation of lesson and unit plans, and suggestions about other classroom factors that should be considered when planning for teaching. The data also reveal that prospective teachers construct unit and lesson plans and teach lessons to their peers during the course. Although all participants felt that this exercise of planning and teaching is a worthwhile experience, they indicated that prospective teachers who have never taught have difficulty with the amalgamation of content knowledge and pedagogical knowledge during this exercise. Some lecturers suggested that the lack of content knowledge handicaps prospective teachers' ability to do effective planning, whereas others attributed the difficulty with planning to the lack of creativity among prospective teachers.

Jessica's story (see Appendix G) tells of her inability to help a child understand a science concept during a lesson when she was a pretrained teacher. Her reflection regarding the growth in pedagogical knowledge that she experienced through the *Science Education Course* is different from the reflections of other prospective teachers. Jessica explained that the *Science Education Course* has helped her to "put across the science" to the children so that they understand. Vicky and Shernette indicated that the *Science*

Education Course helped them to plan lessons and to understand the different approaches they could use in teaching. After her first practicum experience, Vicky indicated that it was only when she had encountered the classroom context that she was able to tailor her lessons to satisfy the complex classroom context she faced. Jessica had been a pretrained teacher for several years before going to college. Vicky and Shernette had their first teaching experience during micro teaching in the *Science Education Course*. These findings suggest that the *Science Education Course* is more helpful if the prospective teachers have already had some classroom teaching experience.

The differing perspectives and experiences of the prospective teachers could be explained in terms of the stages through which teachers progress in learning to teach, as categorized in the 1980s by researchers such as Berliner (1983) and Watts (1980), who suggested that, generally, beginning teachers undergo a stage of survival and discovery, followed by a stage of experimentation, leading to the stage of mastery by the time the teacher gets to the level of tenure. Berliner and Watts also suggested that eventually there is stabilization in the teaching development of teachers.

Shulman's (1986) pedagogical content knowledge and Connelly and Clandinin's (1987) personal-practical knowledge provide more comprehensive perspectives from which to understand the experiences of the prospective teachers in this study than do Watts's (1980) and Berliner's (1983) stages. Although pedagogical content knowledge and personal-practical knowledge have differences between them, with the former having its grounding in disciplines, both develop with experience. Pedagogical content knowledge as described by Shulman consists of an intersection of subject matter knowledge, knowledge of children, and milieu. Personal practical knowledge is based on past and present experiences (Connelly & Clandinin, 1987) and embodies personal emotional, professional, and moral knowledge to form a community within the classroom (Skau, 1990). The term *personal-practical knowledge* is an indication of the importance of the human element within the classroom setting as well as the classroom setting as an important element in constructing knowledge about teaching.

The human element which is characteristic of classroom practice implies that pedagogical content knowledge is always changing to accommodate classroom experiences. Teachers in the study have provided several synopses of their classroom lives. These synopses indicate how powerful knowledge about the classroom and all the factors that influence decision making are on the development of teachers' pedagogical content knowledge, as well as how their personal-practical knowledge helps them to deal with classroom constraints.

Loughran (1997) argued that modeling in teacher education offers the opportunity for prospective teachers to understand how and why pedagogical knowledge is used in teaching by demonstrating the processes, thoughts, and knowledge on which experienced teachers rely. The synopses of teachers' experiences, along with concerns expressed by college lecturers and prospective teachers regarding prospective teachers' ability to develop pedagogical content knowledge in planning and teaching science, indicate that without the direct experience of teaching, prospective teachers have great difficulty constructing the meaning of pedagogical content knowledge. Marion et al. (1999) supported this finding. They used modeling and demonstrations, coupled with reflective assignments, as major instructional strategies in a teacher education program for prospective elementary teachers. However, limited opportunity for these prospective teachers to teach science during practicum restricted their chances to successfully develop the conceptual change model of teaching to which they were exposed in teacher education. Marion et al. anticipated that the practicum would help prospective teachers to further develop pedagogical content knowledge by putting what they learned during the course into practice.

Although lecturers suggested that they modeled teaching for prospective teachers, the findings of this study suggest that prospective teachers and teachers did not begin to understand the how and why of pedagogical content knowledge until they had to design and teach lessons. Some teachers recalled learning nuances of teaching, from the modeling of the lecturers, but no prospective teacher mentioned modeling. The scope of the study did not allow me to examine the demonstrations and modeling of teaching in which lecturers said they had engaged.

Understanding the Difficulty of Constructing Pedagogical Content Knowledge

My understanding about the difficulty experienced by prospective teachers in constructing pedagogical content knowledge broadened through this research. Just as prospective teachers, who had no teaching experience, had difficulty writing lesson plans to demonstrate the merging of pedagogical knowledge and content knowledge, lecturers suggested that they had difficulty assisting prospective teachers to create this merger. In the college classroom it appears that prospective teachers were required to visualize what would happen in the primary school classroom and then plan lessons to fit this setting. College lecturers knew what they wanted the prospective teachers to learn about pedagogical content knowledge, but it seems that they found no established principle for guiding prospective teachers toward their intended goal. According to Ann, although she had models for teaching prospective teachers how to use approaches such as cooperative learning which she used herself, she had no model for teaching prospective teachers how to merge content knowledge and pedagogical knowledge. Prospective teachers had no guiding principles on which to rely when trying to develop the merger between pedagogical and content knowledge. Consequently, they had difficulty developing lesson and unit plans and further problems transferring these plans to science teaching in primary schools.

Another important growth in my understanding of prospective teachers' development of pedagogical content knowledge relates to the factors to be considered when assisting them to construct this knowledge. The stories and expressed views of teachers indicated that although there are some routine actions involved in teaching science, such as the routine of preparation, every science lesson requires them to give new thought to the subject matter, the children, the milieu, pedagogical knowledge, and self. A science lesson therefore does not exist outside of the realm of all these factors. Teachers who experienced difficulty teaching science because of inadequate content knowledge found the textbook to be a welcome source of all that was required for a science lesson. Without having to think about what to teach, how to teach it, what materials are available, how much they know about the topic, and what children know about the topic, teachers such as Joan conducted textbook lessons

The college syllabus may suggest that prospective teachers should consider "problems inherent in teaching science" and "factors to be borne in mind when planning," but these ideas are fragmented. Because of the fragmented nature of the syllabus content and the vagueness with which it is presented, prospective teachers might not make the connection between learning about these problems and factors and planning for science teaching. The situational nature of pedagogical content knowledge requires that prospective teachers be guided to construct this knowledge within context. As well, it appears that the situational nature of pedagogical content knowledge affected lecturers' ability to provide instructions for prospective teachers to understand how to successfully incorporate it into lessons.

The data showed that prospective teachers such as Vicky and Shernette tried without success to use lesson plans that were developed as part of their *Science Education Course* activities during the practicum. Reflecting on this experience, Vicky suggested that it was not because her plan was not well written, but that her knowledge of factors such as the children were not considered initially when she had written the lesson plans. She concluded that although she knew what she wanted to teach, in order to visualize how a lesson might develop, she had to be familiar with the context of the classroom. Vicky was the only prospective teacher who matriculated from college with a pass in a science subject in the Grade 11 exam and who should be fairly knowledgeable about the concept of measurement, which she had difficulty teaching to Grade 6 children.

Helping Prospective Teachers Connect the Two Different Contexts in Which Pedagogical Content Knowledge Develops

The college course does not seem to provide prospective teachers with adequate opportunity to construct a sense of pedagogical content knowledge as it would be experienced in the practice of teaching. Consequently, when prospective teachers without prior teaching experience are given a class of 60 children to teach during the practicum, they become overwhelmed and, according to Paul, "crumble" under the pressures of the classroom constraints. Teachers, lecturers, and examiners expect prospective teachers to transfer knowledge learned in college to classrooms. Little consideration is given to the differences between the learning context in college and the teaching context in the school classroom. Haigh (1998) suggested that prospective teachers often enter classrooms in survival mode and can be assisted by mentors to progress to a reflective practitioner stage. Such consideration for assisting prospective teachers with the transition from learning to teach in college to learning to teach in classrooms would benefit Jamaican prospective primary teachers.

Hutchinson and Marlin (1999) showed that field-based courses in preservice teacher education raised awareness of taken-for-granted assumptions and equity issues and created expectations regarding teaching among prospective teachers. The findings of Hutchinson and Marlin support the findings of this research, as in this research teachers in classrooms seemed to develop professional identity and pedagogical content knowledge through their struggles and exploration of the children, subject matter, and milieu. As suggested in the expressed views of the teachers in this research, time and experience in classrooms yield more thoughtful involvement of teachers in planning and teaching. Prospective teachers in the Jamaican teacher education program do not have extended periods of field experiences and are therefore not involved in the nuances of classroom life. I feel that pedagogical content knowledge of teachers is constructed and reconstructed each time they think about teaching and teach a different concept to a group of children. Therefore, prospective teachers require extended periods of practice to experience the rhythm and color of classroom life and hence construct an understanding of incorporating pedagogical content knowledge into planning and teaching.

Purpose of Teaching Science

In the syllabus the stated purpose of teaching science is to help pupils develop skills and knowledge necessary to function in society. The purposes of teaching science, as indicated by participants, are to *develop good citizens* and to *develop skills and attitudes related to the practice of science*. Participants referred to the purpose of developing good citizens as involving development of scientific literacy/science for living and development of awareness of and a caring attitude toward the environment. Interestingly, in the conversations, lecturers and JBTE appointees referred to the development of scientific literacy among children, whereas teachers focussed on the environmental awareness and preservation. *Scientific literacy,* according to the lecturers and the JBTE appointees, includes having knowledge of simple science concepts, an understanding of how science relates to everyday life, an awareness of the importance of science for progress, the ability to make informed decisions regarding issues related to science, and an understanding of the nature of science. Whereas the lecturers, JBTE appointees, and teachers had such varied and comprehensive views of the purposes of science, it is of major concern that none of the prospective teachers mentioned any aspect of the purpose of developing good citizens. Prospective teachers, like other participants, identified the purpose of science as developing skills and attitudes.

According to Science Education Standards for the United States of America (National Research Council, 1996) the goals of school science are to educate students who are able to

- experience the richness and excitement of knowing about and understanding the natural world;
- use appropriate scientific processes and principles in making decisions;
- engage intelligently in public discourse and debate about matters of scientific and technological concern; and
- increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their career (p. 13)

The document further explained that these four goals define a scientifically literate person. Similarly, the Council of Ministers of Education, Canada (1997), in its *Common Framework of Science Learning Outcomes*, outlined a vision for scientific literacy for Canada. A section of this vision reads: "Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem solving, and decision-making abilities, to become lifelong learners, and to maintain a sense of wonder about the world around them" (p. 4).

Eisenhart et al. (1996) argued that scientific literacy includes consideration of socially responsible science and broader involvement of more diverse people in science. On the other hand, Longbottom and Butler (1998) believed that scientific ways of thinking can make significant contributions to democracy. For them, teaching science to children should help them understand the limits of scientific knowledge, come to see scientific knowledge as the best available explanation, and acquire many of the critical and creative attributes of scientists. From his perspective on multicultural science education, Hodson (1993) concluded that science education should be personalized, because students are exploring and developing their own understandings of science in response to experiences provided by the teacher. This implies that science teachers should consider the diversity among children in classrooms. Martin, Kass, and Brouwer (1990) argued for authentic science and explain that this would mean that a teacher of authentic science would seek to develop children's experiential bases by referring to as many relevant aspects of science as would be appropriate to children at a given stage of their lives.

Based on the range of propositions regarding the purpose of teaching science which is provided by the literature, the views of the participants regarding the purpose of teaching science in primary school were fairly comprehensive and congruent with views expressed by other educators. However, missing from the views of the participants in this research is the aspect of cultural diversity among children and awareness of the need for students to develop personal understandings in science. Because of the lack of reference by participants to these two elements of science education, it could be argued that an underlying intent of their expressed purposes for teaching science is to have children learning *from science* (Fensham; as cited in Ostman, 1994; Osborne, 2000) rather than *about science*. Martin et al. (1990) suggested that instead of explaining scientific concepts such as refraction to children, one should provide them with a situation from which they can learn about the concept as it relates to their personal lives. When participants referred to applying science knowledge to their everyday living or science for living, an underlying meaning could be, *What can science do for us?* In an excerpt from a conversation with Valerie in Chapter 4, she explicitly stated that children should be considering science for progress, indicating that humans can use science for the purpose they wish and, in most cases, to benefit human advancement. As well, such an orientation to primary school science would filter directly into school science objectives that would require children to recognize and explain human relationships with nature. Ostman suggested that when he examined the text within science textbooks, he identified five different prescriptions for a nature/human relationship: the exploitation of nature focus, the nature as a precondition focus, the human beings as a threat focus, the survival of Homo sapiens focus, and the preservation of nature focus (p. 145).

Aspects of Ostman's (1994) nature/human relationships were evident among participants. As shown in Chapter 4, teachers explained that they used materials from the environment in teaching, but at the same time they tried to help children develop an awareness of how humans affect the ecological balances when they slash and burn for farming. Primary school teachers in this study seem to be providing possibilities for children to start recognizing the moral responsibility of humans for preserving the environment and are also indicating to the children that human beings are threats to the environment. On the other hand, by collecting and bringing material from the environment to a science lesson, according to Ostman's discussion, teachers provide the message that human beings *use* nature to achieve personal ends. Nature in that sense becomes a subordinate to humans, which in turn has underlying implications for the kinds of citizens that schools produce through science teaching.

The idea that science should be taught so that children develop skills and attitudes was very strong throughout the data. This idea seems to be a direct result of the *Science Education Syllabus*, which suggests that in thinking about science, prospective teachers think in terms of process, product, and attitude. The emphasis in the syllabus on the process approach to science teaching and science as process, product, and attitude sends the message to prospective teachers that the use of science processes are central to problem solving both in school science and in everyday life. According to Roberts' (1998) companion meanings, the scientific skill development emphasis that can be found in science curricula bears the message that by using the right skills, knowledge will develop. Teachers are advocates of the range of process skills in teaching and learning science but support the use of hands-on activities more as the source for developing these skills and less for developing knowledge. In conducting this research, I have seen that teachers may choose to focus on the process skills during hands-on activities because there are usually few opportunities to find enough materials for children to do science activities. However, although I admire teachers' patience and determination to teach science through activities, I am wary of the emphasis they place on the teaching of process skills and the de-emphasis on the learning of scientific knowledge.

Science Education Courses inevitably provide messages about the nature of science even if one is not explicitly stated. I discern that the message suggests a scientific skill development emphasis. Although this is important for science teaching, it seems that overemphasis of this message could lead prospective teachers to think that science processes can be successfully detached from the content and context in which they are used. I have shown in Chapter 4 that teachers and lecturers seem to be emphasizing the need for children to acquire process skills, and at the same time they seem to be de-emphasizing the need to acquire scientific knowledge through the use of these skills. Millar and Driver (1987) claimed that it is the context and content that gives meaning to the processes of science, and therefore the processes of science should not be divorced from content and context.

The participants did not indicate the importance of acquiring scientific knowledge, but they did indicate that, along with science processes, attitudes were important to children's science education development. There are two main reasons that the participants suggested (in Chapter 4) for supporting the development of attitudes among children. The first reason is to prepare primary school children for secondary school science, and the second is to help them acquire attitudes characteristic of the practice of science, such as curiosity. Longbottom and Butler (1998) indicated that one of the three aims that they would suggest for science education is that children acquire many of the critical and creative attributes of scientist so that they are armed with the skills to consider evidence and take part in reasoned debates.

The purposes of teaching science which were expressed by participants seem to suggest that science in primary schools is being taught so that children can learn from science rather than about science. Some of the messages implied in their purposes of teaching science include the ideas that human beings use nature, that humans can control and should protect nature, and that the development of science processes and attitudes is a significant aspect of teaching and learning in primary science. Although participants were advocates of inquiry approaches to teaching science in primary schools, I am suspicious of the messages about the purposes of learning science that children might be getting from the science lessons. The significant finding that other aspects of the purpose of teaching science, such as a view of personalizing the learning of science, were not mentioned indicates an implication for lecturers' professional support.

Participants' Reflections on the *Science Education Course*

Participants' reflections on the *Science Education Course* revealed that lecturers were considered to be the mainstay of the *Science Education Course*. Consequently, absence of professional support for lecturers is a key area of concern in this research. By engaging in the interviews for this research, participants had the opportunity to devote some thoughtful time to the examination of their contributions to and experiences with the *Science Education Course*. Loughran (1997) discussed the work of Schon and Dewey and maintained "that considering one's actions, reframing problematic situations, mulling over the flow of suggestions, and reasoning through the implications of alternative views and testing hypotheses are the cornerstones of reflection" (p. 63). Reflecting orally on the course, participants have helped me to recognize and focus on important aspects of the course. One such issue concerns professional development opportunities for lecturers.

Supporting Lecturers Professionally

As participants reflected on their experiences in the *Science Education Course*, there was no mention of professional support for lecturers. This was more evident in the reflections of Peter and Ann, who had the least experience with teaching science education to prospective primary teachers. Peter indicated that most of what he knew about teaching primary science was grounded in what he had learned as a secondary science teacher and through graduate courses. Ann also brought experience from secondary science teaching and graduate courses and used it as a starting point for her teaching. Both lecturers intimated that, initially, their concern was about their own survival, which forced them to slavishly complete the syllabus on time for the exam. At the end of his first year, Peter was relieved when he completed the course, and his students did well on the exam.

There is a paucity of research that examines the professional lives and development of college lecturers who prepare teachers to teach science. However, through the reflections of the participants, I learned that the professional lives of these Jamaican college lecturers were being jeopardized. The analysis of the expressed views of participants indicated that there was little or no opportunity provided for college lecturers to achieve professional growth, reassess their roles as teacher educators, engage in collegial reflection about their achievements and concerns, or examine trends and issues relating to teaching and learning how to teach. Invargson and Loughran (1997) observed that science teachers who do not associate with circumstances and other professionals in science and teaching related fields experience weak profession identities. With the limited circumstances available to lecturers for engaging in professional development activities, Invargson and Loughran's observations might hold true for Jamaican college lecturers.

Like teachers, lecturers seem to grow professionally through stages, starting with trying to survive in teaching and eventually achieving a stage characterized by their ability to master teaching. To engage in any discussion about the professional development of Jamaican college lecturers, one must consider demographic factors that influence teaching, such as educational background, teaching experiences, and experiences with adult teaching and learning. Cohen and Ball (1990) claimed that studies in teacher learning suggest that teachers interpret new ideas and practices through their existing beliefs and habits of practice. All lecturers in this research were from different educational backgrounds and had different types and duration of experience in teaching children and adults. As well, the findings indicate that lecturers' educational background and teaching experiences influenced their choice of instructional methods and their general approach to the syllabus implementation.

Syllabus implementation. Goodlad (1990) considered a common exam and a syllabus to be mandates predetermined by the state. With the diversity in educational background and experiences that lecturers have, I expected that the personal knowledge of each lecturer would be central in informing how the syllabus is used. I expected that implementing the syllabus would be a question of the lecturers' thinking and doing. Therefore, although the syllabus content may remain constant, the personal differences of lecturers should be reflected in their decisions about instructional approaches. From Connelly and Clandinin's (1988) standpoint, it is the personal-practical knowledge of teachers that determines all matters of significance relative to the planned conduct of the classroom. The findings of this study implied that lecturers' classroom experiences did not seem to be largely influenced by themselves and their preferences, but by other stakeholders' influences, such as the JBTE. For example, Donna indicated that she was careful to teach by the syllabus and that all lecturers had the common exam as the focal point for what and how to arrange their classroom experience. This finding is congruent with arguments advanced by Connelly and Clandinin and the findings of Bramford (1998) which suggest that teachers' classroom decisions about what is worthwhile or worthless are advanced by the teacher in conjunction with others' opinions.

Lecturers used the course syllabus as a guide to the content and activities that were supposed to be completed before the exam. With this view of curriculum, implementing the curriculum becomes a means to a predetermined end and fits the curriculum orientation, which Eisner and Vallance (1974) labeled the *technological* approach. However, in keeping with the constructivist theoretical framework of this study, I have to consider that the syllabus and the college context can evoke idiosyncratic interpretations from each individual lecturer. Because of the common exam and the process of its construction (as explained in Chapter 6, questions are chosen from any submitted by lecturers), the individuality of lecturers' interpretation of the syllabus can have dire consequences. This happened, for example, when the exam questions included discovery learning, and some lecturers had not included this topic in their courses because it was not suggested in the syllabus. In addition to course variations in content, one can also expect that variations in course assignments and activities can affect both students' learning and their performance on a common exam.

Approaches to instruction. Lecturers', prospective teachers', and teachers' reflections on the *Science Education Course* revealed that lecturers employed several different instructional approaches and techniques during the course. Central among these were demonstrations, modeling, lecturing, student projects, small and large group discussions, and micro teaching. Of these, prospective teachers and teachers suggested that they did not benefit from lectures. Conversely, teachers and prospective teachers indicated that the most useful were those activities which allowed them to engage in teaching practices such as planning and teaching lessons or viewing demonstrations involving teaching.

Missing from the discussions regarding these teaching approaches and techniques, however, is a most fundamental characteristic of teaching and learning: reflection. Neither teachers nor prospective teachers mentioned that reflection was an integral part of these useful activities. However, when I asked these participants to reflect on their experiences and observations, new meaning about teaching and learning were uncovered by themselves as they reflected and by myself as I listened to them. For example, in one conversation with Donna, a college lecturer, about the scope of the *Science Education Course*, she indicated that she could not be flexible with the course content because of the common exam. During the conversation Donna recognized that she was actually contributing more to the course content than was suggested by the syllabus. She then rationalized her actions, explaining that even though she was adding a little to the course, it was risky; and so most often she preferred not to add to the content of the course.

I found myself thinking differently about participants' beliefs regarding the purpose of the *Science Education Course* after reflecting on their views regarding the course and on Loughran's (1997) suggestion that reflection is a central part of the teacher education program only if the expectations for teaching and learning are beyond the prescriptive approach. Earlier in my discussion about participants' expectations and views about the course, I indicated that they seemed to feel that the purpose of the course was to learn how to teach by being provided with a list of prescribed strategies. From Loughran's point of view, if prospective teachers, teachers, and lecturers believe in a list of principles and prescriptions for teaching and learning how to teach, reflection will not form a part of their repertoire of activities.

The professional and educational diversity that was identified among lecturers and the reflections of participants regarding the instructional strategies and personal contributions that selected lecturers made to the course imply that professional support to lecturers would be beneficial. As shown in this discussion, some of the main areas where this collegial professional support was most required were in syllabus interpretation and instructional strategies.

Possibilities for Further Development of the *Science Education Course*

By examining the syllabus and the participants' perspectives, along with my knowledge of the current trends in science education and teacher education, I am able to suggest possibilities for further development of the *Science Education Course*. I will consider three key areas: a theoretical orientation, the syllabus content, and teaching/learning experiences.

Throughout the conversations regarding the *Science Education Course,* I recognized that participants had three key ideas about the purpose of the *Science Education Course* for prospective teachers:

- to understand what is science and the purpose of teaching science,
- to learn how to teach science, and
- to start developing as a science teacher.

I feel that although these three ideas may seem inadequate to span the range of needs implied in the study of participants' views, the ideas will be considered as a starting point for answering the question, *What knowledge for teaching science would a revised Science Education Course provide for prospective teachers?*

Current Limitations of the Jamaican Teacher Education Context

To consider the knowledge that prospective teachers would acquire through a revised *Science Education Course*, some preliminary limitations should be considered. The first is the time allotted for the course. As lecturers reflected on the course, they indicated that more time would be required if they were to complete the course syllabus adequately. Consequently, they contemplated requesting more time from the JBTE and then speculated about the effects that increased time in one course would have on the other courses. Therefore, I feel that whatever further developments are being considered for the syllabus, the suggestion for possibilities must be limited to a course duration of 45 hours.

A second limitation which became apparent from the data and from my knowledge of the Jamaican teacher education system is that this is the only science course in which prospective teachers have the opportunity to learn about science education and methods of teaching science. The additional science course, which is currently taken by all prospective primary teachers, provides them with content knowledge. Conversations with the director of the JBTE and Donna, a lecturer, suggested that during the rationalization of teacher education in 1989, there was an observed need among prospective teachers for content knowledge in science. These persons suggested that the content courses for all subject disciplines (e.g., social studies, science, and religious education) were added to the teacher education program to ensure that prospective teachers would be knowledgeable in the subject disciplines. It is important to note that these content knowledge courses occupy twice the number of hours that the education (methods) courses do.

Another limitation concerns the availability of resources such as video cameras, VCRs, and funding to allow for school visits and teacher demonstrations. Again from my knowledge of the constraints associated with the Jamaican education system in general, I have to be cognizant of the constraints that might serve to annul any suggestions for possibilities of further development of the *Science Education Syllabus*.

The fourth consideration is that whatever suggestions are offered for a syllabus and a course will be of political importance. Winch (1996) and Orpwood (1988) argued that because different interest groups are concerned with any curriculum content, and although negotiation may be needed to determine changes, those concerned are not always pacified. Tensions within a deliberation are healthy, and it is difficult to achieve consensus. However, it is hoped that the ideas I will advance here will generate useful discussions during the deliberations.

Another limitation is the understanding that each person who uses a syllabus will interpret the syllabus content differently. Persons will also have different ideas about the instructional activities that would be appropriate to the syllabus content and the students. I have shown earlier that this can create problems when a common exam is involved. This limitation is important to consider, because a syllabus that considers the diversity of human thinking and background will have to be fluid in order to accommodate these differences.

The limitations considered here by no means exhaust the possible list, but I think that these are the key considerations at this time. These limitations are significant to the circumstances that exist in teacher education in Jamaica and to the possibilities for any further development of the syllabus and the course. As I contemplate the possibilities for further development to the *Science Education Course*, I am cognizant of these and other issues.

Possibilities for Further Development

Ideas regarding the possibilities for further development of the *Science Education Course* are being constructed as I go through this research. Although these ideas are still evolving, I will discuss those that have inspired me through the literature, my experiences as a scholar, and the findings from the research to think about possibilities for a *Science Education Course*. The first of my suggestions for possibilities for further development of the *Science Education Syllabus* is to establish a theoretical orientation which will offer a view of the purpose of a syllabus, a view of the nature of knowledge, and a view of learning. My suggestion for a theoretical orientation for the *Science Education Course* is the social constructivist idea that knowledge is created and legitimized by means of social interchange. Driver (1988) and Driver et al. (1994) have shown that (a) knowledge develops within a community in which each member is actively involved in building up knowledge from within; (b) social interactions between and among individuals in community and cultural settings are central to the building up of knowledge, with language being the means of social interaction; and (c) the functional and adaptive nature of cognition allows individuals to bring coherence to their individual experiences.

A view of the purpose of a syllabus. From a constructivist standpoint the syllabus would not be seen as a body of knowledge and skills, but rather as a program of activities through which knowledge and skills develop. Driver and Oldham (1986) maintained that this idea of a curriculum changes the role of the teacher from being a passive transmitter of knowledge to a more active role of being a part of the curriculum development process. The findings of this research show that the lecturers in the course provide prospective teachers with knowledge and skills suggested in the syllabus and that lecturers, coming from varying backgrounds, are interpreting the syllabus content differently. Some lecturers were also concerned about the inflexibility of the syllabus to new ideas which they brought to the course. Developing a syllabus with a basic theoretical orientation through which lecturers act as curriculum planners within each college will permit the flexibility and independent thought that they suggested were missing from the *Science Education Course*.

A view of the development of knowledge. From a social constructivist perspective, knowledge is not thought of as separate from the individual, nor from the activities or the community in which this knowledge is generated (Driver et al., 1994; Richardson, 1997). From this standpoint, the knowledge constructed by individuals in one context is also influenced by the knowledge which is brought to the present context from the past. This research has shown that the present *Science Education Syllabus* does not require lecturers to elicit prospective teachers' prior knowledge and ideas, but that lecturers do attempt to do this. When constructivist learning theory is considered for teacher education, linking of students' prior knowledge to present activities is important (Richardson, 1999). Tasks and activities would therefore be tailored to help students examine their beliefs and premises.

A view of learning. A conceptual change perspective on learning could be a consideration for the *Science Education Course*. Several models of a conceptual change approach to teaching and learning have been advanced and used in science teaching with children and in science teacher education (e.g., Appleton 1992; Renner, Karpus, Nussbaum, & Novick, Erickson; as cited in Cosgrove & Osborne 1985). Posner, Strike, Hewson, and Gertzog (1982) argued that conceptual change teaching involves a process through which the learners' basic assumptions about the world, knowledge, and knowing are changed. Fundamental aspects of the process include eliciting beliefs, rendering them implausible by providing anomalies, and presenting plausible alternatives which could appear more fruitful to the learners than their original beliefs. Several *Science Education*

Courses for prospective primary teachers have claimed some success with the use of conceptual change instruction (e.g., Gustafson & Rowell, 1995; Marion et al., 1999). Although neither Jamaican teacher educators nor the *Science Education Syllabus* has expressed any awareness of or support for this framework for instruction in teacher education, I am optimistic about a conceptual change view of learning to science teaching.

Structure and substance of the syllabus. As indicated above, participants' views about science teaching and the college course suggested some purposes that they envisioned a *Science Education Course* serving. These purposes will be incorporated as far as possible into my suggestions for the substance and structure of a *Science Education Course*. I am a bit wary of the label *Science Education Course* because I have concerns about the present *Science Education Course.* The course seems to reflect methods of teaching science as its main emphasis. In a *Science Education Course* I feel the emphasis would be on the epistemology and ontology of science rather than on the methods of teaching science; therefore, students would learn more about science: its philosophy, history, and structure. Because I do not aim to provide these to prospective teachers in 45 hours, I would prefer to label the course *Science Methods.*

The main goal of this course would be to assist prospective teachers in constructing knowledge about teaching science in primary schools. Implicit in the idea of constructing knowledge about science teaching are four main considerations: knowledge about learners and learning, knowledge about science, knowledge about primary schools and classrooms, and knowledge about teaching. This I feel would form the key topics for the content of the course.

Instructional strategies and experiences would play a key role in what prospective teachers learn from the course about teaching science based on the goals and content considered here. Evidence from the research suggests that success results from providing *Science Education Courses* that include reflective practices coupled with interactive, challenging, and meaningful learning experiences for prospective teachers (Loughran & Russell, 1997; Marion et al., 1999; Richardson, 1999). As well, the findings from this research indicate that prospective teachers and teachers recall that they experienced more meaningful learning when the instructional activities challenged their ability to act like teachers in the context of teaching science. Although I am suggesting that instructional strategies should be interactive and challenging, I am also suggesting that lecturers be allowed autonomy to develop and use strategies they feel are appropriate. This has implications for lecturers' professional support. Autonomy does not indicate isolation, and therefore collegiality would be fundamental to lecturers' professional support in this social constructivist atmosphere of teacher education.

Like instructional decisions, decisions concerning evaluation and assessment of student performance would have to be in keeping with the teaching/learning model used and the goals of the course. Because a common exam seems to be one major factor influencing lecturers' instructional styles, as suggested by the findings, the most appropriate form of summative evaluation would be one developed in the college by the lecturers who instruct the course. This has implications for the role of the JBTE and the college.

Summary

My ideas about the knowledge which a revised *Science Education Course* should provide for prospective teachers to teach science is still evolving. However, based on the limitations of the *Science Education Course* which is currently being provided by the colleges in Jamaica, the literature reviewed, and my experience as a scholar, I have suggested that a social constructivist framework for a *Science Education Course* is plausible. In a revised course, prospective teachers would be guided to construct knowledge about learners and learning, science, primary schools and classrooms, and teaching. I have also suggested that a conceptual teaching sequence could be considered and that instructional strategies should be tailored to include reflective practice coupled with interactive, challenging, and meaningful learning activities.

Implications

For the Joint Board of Teacher Education

1. The results of the research show that aspects of the syllabus are vague and provide little information, especially for new lecturers, about the required content. Because of the common exam, lecturers may need to be provided with more detailed content information to allow them to adequately support their students.

2. The results of the research indicate that because of the lack of autonomy regarding course content and evaluation of students, teaching to the test results. Allowing autonomy on the part of lecturers might benefit students' learning about teaching.

3. The findings of the research show that professional support for lecturers might be helpful in assisting them to interpret the syllabus. Professional development days, particularly for dealing with issues of instructional strategies and current trends in science education, may be necessary.

4. The findings show that the *Science Education Course* provides limited knowledge and skills for prospective teachers to be adequately prepared to teach science in Jamaican primary schools. A review of the syllabus, with the goal of providing prospective teachers with a *Science Education Course* which assists them in constructing knowledge about teaching science in primary schools, might be useful and appropriate. I have provided my evolving ideas above.

For the Primary Science Teacher Education Course

1. There is a notable absence of the efforts of the cooperating teacher in the education of the prospective teacher, even though prospective teachers are accommodated in their classrooms each year. The *Science Education Course* would be

enhanced by the involvement of primary school teachers in assisting with the development of pedagogical knowledge during teaching practice.

2. The findings show that although the *Science Education Course* may have provided teachers with the terminology associated with various approaches to teaching science, teachers' personal-practical knowledge and pedagogical content knowledge which are developed through experience are more meaningful in selecting and evaluating techniques and activities for teaching. The teacher education course could therefore consider more experience-based learning as a means of allowing prospective teachers to construct pedagogical content knowledge.

3. The *Science Education Course* might be enhanced by reducing the number of main ideas which are supposed to be presented to prospective teachers during the 45-hour course. I have provided an outline of four key ideas that might be useful for supporting the learning of prospective teachers in the course.

For Lecturers

1. Lecturers may wish to examine their own beliefs and knowledge about science teaching and learning, because the findings show that their professional and experiential background influences how they instruct the science course.

2. The findings indicate that lecturers are considered most significant to the learning-to-teach process. Lecturers might therefore wish to reflect on their own practices as teacher educators, and the Science Board of Studies might wish to foster collegial reflection by lecturers about their role in the teacher-preparation process.

3. Lecturers may wish to consider more involvement in primary school science teaching by teaching some lessons. This would help them construct their own knowledge of teaching science in primary schools, which would in turn benefit the course and prospective teachers.

4. Lecturers' collaborative relationships with primary school teachers and scientists would strengthen the role of the professional community. This could also be reciprocal, because all parties in this relationship would gain worthwhile knowledge about the others' professions.

My Final Reflection

> As human beings we have only two projects: to take responsibility for our own continuing growth, and to contribute to solving the problems in our communities. (Rorty, 1982; as cited in Ellis, 1998b, p. 9)

I refer to this quotation because it speaks to the possible outcomes which should be expected from an interpretive inquiry such as this. As indicated earlier in this chapter, I started this research with a practical concern arising from experiences in my own professional life. I brought preunderstandings with me to this research, and there have been sources of deliberation throughout the research. For example, when I entered the research I believed that the *Science Education Course* was not adequately contributing to the development of the pedagogical content knowledge of prospective teachers. This belief was quickly confirmed by the data because my initial examination of the data was dominated by my preunderstandings of prospective teachers' limited pedagogical content knowledge which I observed on the practicum. After reflecting on the literature concerning the development of prospective teachers and the development of pedagogical content knowledge, I came to a very interesting realization. Experienced prospective teachers who had limited content knowledge were more at ease with incorporating pedagogical content knowledge into their science lessons than inexperienced prospective teachers were. Even more interesting was the finding that lecturers were perplexed by their own inability to provide prospective teachers with clear directives on how to achieve pedagogical content knowledge in their lessons. At this point I concluded that prospective teachers without experience in teaching in primary schools were unable to successfully incorporate pedagogical content knowledge into their plans because they had no firsthand knowledge of classroom contexts as teachers. As discussed earlier, pedagogical content knowledge seems to be constructed and reconstructed with each lesson, because it is so context dependent. This is one finding of my research which can be used to inform instruction for prospective teachers.

Packer and Addison (1989; as cited in Ellis, 1998a) outlined three possible outcomes that should be expected from interpretive inquiry: Ideas for helpful action are identified, new questions and concerns are generated, and the researcher experiences change by doing the research. As well Packer and Addison suggested that it is only through understanding that we are able to take helpful actions. In this section I show that helpful actions have been suggested, that I have developed new questions and concerns, and that some inadequacies of my preunderstandings have been transformed.

As I indicated earlier, the intent of the research was not to prove theory or make predictions, but to advance possibilities for dealing with a practical concern. Ellis (1998a) and Packer and Addison (1989a) therefore guided me in determining the value of my interpretive inquiry. Packer and Addison suggested that, in general, there are four criteria for evaluating interpretive accounts: coherence, relationship to external evidence, consensus, and practical implications. Above all, I have considered the value of my interpretive inquiry with regard to Ellis' (1998a) six questions which were generated to represent the key elements of the discussion by Packer and Addison about the four criteria for evaluating interpretive inquiry. These are:

1. Is it plausible or convincing?
2. Does it fit with other materials we know?
3. Does it have the power to change practice?
4. Has the researcher's understanding been transformed?
5. Has a solution been uncovered? (p. 30)

As I reflect on my research journey and on the findings, I remember my initial interest in becoming a teacher educator. I had mixed feelings about leaving classroom teaching; I had been a primary school teacher for three years and a secondary school teacher for four years prior to pursuing a Bachelor of Education degree in integrated science education. I return to the beginning at the end of this part of my journey because this is where my understandings about the *Science Education Course* started to develop.

As I completed the Bachelor of Education degree (BEd) and was in the process of seeking a job, I spoke with one of my lecturers whom I considered to be a mentor and a confidant about my intention to seek a job in a teachers' college in Jamaica. He looked at me for a while, and then very thoughtfully, almost as if to reprimand, said, "You know, Lena, if I were you I wouldn't do that. I would much prefer to see you back in the school classroom than in the teachers' college. You are really an excellent teacher, but I don't know how you would fare in the teachers' colleges." I was disappointed with his response, so I just mumbled "Okay" and turned to leave. He almost shouted, "Lena! Best of luck in your search, but don't apply to teach the methods course." I stopped to listen, and he continued: "I think that people who are teaching the methods course in college should be more knowledgeable about that aspect of teaching than you are right now. I really don't think the BEd adequately prepares you for that. If you take a job to teach science methods, you will see why I said that." This conversation has haunted me ever since. When I thought about writing this reflection to end this part of my research journey, I reflected on the four years I spent in the teachers' college as a lecturer, on my research findings, and on this haunting conversation with Mr. W., because I have just started to learn to be a college lecturer.

I include this synopsis of my own experiences because it is part of what has led me to this research journey. Looking back at my understandings about educating teachers to teach science, then, I feel that this is an appropriate starting point for the reflection which will follow. Ellis (1998a) pointed out that "a particular signature of interpretive inquiry is self-conscious reflection" (p. 32). I intend to use this section as a place to reflect on the understandings I developed through this research.

The most startling discovery I made in this research is how complex it is to teach others how to teach. Without the insight I have gained from this research, the process of teaching others how to teach is misconstrued as easier than teaching in high schools. My experience with instructing the *Science for Living* course in Jamaican teachers' college does not involve teaching teachers how to teach. The rationale of the *Science for Living Course* is to develop and support prospective teachers' content knowledge of science. This research has therefore been particularly informative and revealing about teaching others how to teach as opposed to teaching the same persons about science. With the insights I have gained from this research, I now believe that I will be more attentive to the role of the *Science for Living* course in preparing the prospective teachers to enter the *Science Education Course*. The complexity of supporting others in developing the knowledge of pedagogy is challenging because of a number of factors.

The first of these concerns the learners' characteristics. I know that there will be numerous and varied learner characteristics, but by learning about the learners themselves, I feel that there is a chance for me to develop a more sound instructional plan. Both the students and I should consider their knowledge of science, teaching experiences, cultural/traditional beliefs, and beliefs about teaching and learning. Awareness of these should inform personal goals planning and development of instructional strategies.

Another factor which I would consider is the syllabus. From the research findings I have come to understand that lecturers' beliefs about the role of the syllabus and their experiences with the syllabus influenced their use of it. I feel that by carefully taking the syllabus apart and reorganizing it to develop less fragmented course content, I would enhance the flow and coherence of the substance of the course. Additionally, for sections of the course which seem inadequate, such as how children learn, I would attempt to incorporate these into sections of the syllabus where they could best fit. For example, how children learn could be a theme that spans several topics in the syllabus. Some of these topics include the approaches to teaching and lesson planning.

From this research I have come to understand that the instructional approaches and techniques that were used by lecturers which were most beneficial were small and large group discussions, writing unit and lesson plans, micro teaching and micro-teaching demonstrations, modeling of teaching, and the use of supplementary reading materials. Whereas I came to understand that through these activities and instructional strategies prospective teachers were able to reflect on their understandings about teaching and learning science, there was no indication that lecturers explicitly encouraged or required reflection in the course. As a lecturer I would consider prospective teachers' reflection to be an integral part of the teaching/learning process and would therefore encourage the writing of reflective journals. I am interested in Loughran's (1997) suggestion that lecturers should take the initiative and write reflective notes which, if prospective teachers desire, they could read. This exercise, Loughran argued, will not only be beneficial for learning but will also develop a trusting environment in which prospective teachers will be willing to take risks. I also feel that another significant use of reflective journals could be to allow the lecturer to learn about the initial, changing, and developing views of prospective teachers as they progress through the course. As well, I would encourage reflective journals not only for the course but also for the practicum.

Another discovery which I made in this research is that cooperating teachers do not consider that they are involved in the development of the prospective teachers who come to their classrooms. This realization is disturbing; therefore, as a lecturer and a practicum supervisor for selected prospective teachers, I intend to encourage the involvement of cooperating teachers in the professional development of the prospective teachers who are teaching their classes. I envision that this would be a cooperative effort with the terms and conditions developed by the prospective teacher, the teacher, and myself.

Through this research I have also realized that successful planning and teaching science in primary schools start with a knowledge of the classroom constraints and students' characteristics, and the selection of teaching activities and content comes after. As a college lecturer I intend to consider this when assisting prospective teachers to plan for teaching. I now understand that prospective teachers should acquaint themselves with the classroom context and with more sound use of textbooks for teaching so that they will be able to develop lessons compatible with the classroom context. On the other hand, I do not intend to shield prospective teachers from the realities of primary school classrooms by providing teaching/learning materials and equipment. The purpose of the practicum is learn about teaching in primary schools, and prospective teachers should be supported and encouraged to deal with the real issues that characterize Jamaican primary science teaching.

During the study I was preoccupied with how participants defined certain terms, such as *discovery learning* and *process skills*. By the end of the research I had developed a new understanding of the meaning of these terms as they related to classroom teaching. I came to understand that the meaning of these and other terms was embedded in their personal-practical knowledge and the pedagogical content knowledge which was constantly being constructed and reconstructed with each lesson. This was the business of teaching science and not the consideration of naming approaches into which the teaching neatly fitted. This is a very significant issue which has implications for how we encourage prospective teachers to plan for their teaching.

This study has raised my awareness regarding the need for professional support for lecturers. I discovered through the study of participants' perspectives that college lecturers require continued renewal and strengthening of their professional roles as science teacher educators, role models, and leaders. Professional support for lecturers can be achieved in several different ways:

1. By building and fostering relationships with other professional communities such as scientists and primary school teachers, lecturers have the chance to learn about the practice and culture within these groups.

2. Professional development activities and sustained reading/discussion groups among themselves will help lecturers keep abreast with trends and issues in science, science teaching, and teacher education.

This interpretive inquiry has generated learning for the participants in the research and for myself as the researcher. By having to reflect on their teaching and on the *Science Education Course*, some teachers have come to understanding more about what they learned through the *Science Education Course*. Some teachers have expressed their interest in having me in their classrooms after the research to have collegial discussions about their planning and instructions. This is also true of lecturers. As well, by conducting the second interviews, I was able to make known some views of teachers and prospective teachers to lecturers and JBTE appointees. These views were sometimes enlightening, and some caused concern. For example, most lecturers were concerned that teachers felt that they had not acquired much from the *Science Education Course*. The research was therefore a learning experience for most participants involved.

As expressed earlier, this research is one part of fulfilling my own personal professional development. The knowledge I developed about the existing *Science Education Course* through this research has equipped me with worthwhile information which I can consider in my professional life as a lecturer and which is useful for considering further development of the *Science Education Course* for prospective primary science teachers. The findings from this research may also be used by other lecturers when they consider their instructional strategies and by the JBTE when they consider professional development sessions for science education lecturers. As I said earlier, my ideas for a *Science Education Course* are evolving. I am constantly reflecting on the question of what knowledge prospective teachers might need to equip them to teach science in primary schools, and as I reflect, my understanding is enriched.

Recommendations for Further Research

As suggested earlier in this research, one consideration on which the value of interpretive inquiry rests is whether new questions and concerns develop as a result of the research. This is an important characteristic of the generative nature of interpretive inquiry (Ellis, 1998a; Packer & Addison, 1989a, 1989b). As I reflect on the findings regarding the *Science Education Course* which is provided for prospective primary teachers to teach science, I have developed new questions and concerns. In this section I present suggestions for research which should address these questions and concerns:

1. Lecturers have suggested that they often disregard their beliefs and philosophies when teaching the *Science Education Course*. Why is it that some lecturers abandon their beliefs in favor of those implied by the syllabus? Does this influence lecturers' images of themselves? Is this tendency to abandon their beliefs a consequence of their educational background? When they abandon these beliefs, do they adopt the beliefs of the syllabus, or is it a tentative shift to facilitate the completion of the syllabus? These are some of the question that I have based on my discovery that some lecturers tend to abandon their beliefs, whereas others do not.

2. Lecturers are preparing prospective teachers to teach science in primary schools. However, no lecturer in the study had taught science in primary school as a trained teacher. I feel that action research to study how a partnership between schools and colleges would enhance the professional lives of teachers, lecturers, and prospective teachers is warranted.

3. The expressed views of teachers suggest that they feel that they are not a part of the process of prospective teachers' professional growth even though they accommodate the prospective teachers for the practicum. Through action research the development and

implementation of a mentorship program for prospective teachers could be initiated and a study of the influence of this program on the development of prospective teachers' pedagogical content knowledge for teaching science could be undertaken.

4. Prospective teachers enter college from varying cultural/traditional backgrounds. An investigation into how the cultural diversity of Jamaican prospective teachers influences their learning to teach science would be an asset to teacher education.

5. I feel that research regarding the practice of teaching science in primary school needs to be done to help develop a clearer understanding of how teachers really teach science. It concerns me that there is a paucity of research regarding science teaching in Jamaican primary schools. The scope of this research did not allow me to develop an understanding of how primary school teachers went about the teaching of science. Research that provides a picture of teachers' practices in teaching primary science could be of significant benefit to teacher education, both inservice and preservice.

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APPENDIX A

SAMPLE OF A MARK SCHEME FOR THE

SCIENCE EDUCATION COURSE EXAM

JOINT BOARD OF TEACHER EDUCATION

In association with

University of the West Indies Faculty of Education

TEACHERS' COLLEGE EXAMINATIONS - JUNE 1992

COMMON PAPER

YEAR 1
PRIMARY

TIME: 2 1/2 HOURS

SCIENCE EDUCATION

MARK SCHEME

---

1. Award 5 marks for discussions centred around any FOUR of the following:

   a) Helps children to understand scientific language/symbols and signs/terminology; to be able to interpret phenomena in their environment; to become scientifically literate.

   b) Helps children to develop manual and intellectual skills, eg. observation, manipulation of equipment, experimenting etc.

   c) Helps children to develop powers of critical thinking and promotes their intellectual development.

   d) Promotes the development of creative and enquiring minds.

   e) Breaks down barriers related to the teaching/learning of science and helps children to develop positive attitudes to science, and to see it as a useful tool in their daily lives.

   f) Helps children to develop good attitudes eg. perserverance, resourcefulness etc. which help to prepare them to be good citizens.

   g) Promotes environmental awareness and commitment - children have the opportunity of learning to conserve resources - light, water, soil etc.

APPENDIX B

LETTERS OF REQUEST AND CONSENT FORM

Letter to Permanent Secretary, Ministry of Education, Youth, and Culture

May 26, 1998

Department of Elementary Education
551 Education Building South
Faculty of Education
University of Alberta
Edmonton, Alberta
T6G 2G5

The Permanent Secretary
Ministry of Education Youth and Culture
2 Heroes Circle
Kingston 4
Jamaica, West Indies

Dear

My name is Lena Swire-Walton. I am currently on special leave from my position as lecturer in the Faculty of Education at the College of Agriculture Science and Education, in order to complete my doctoral studies at the University of Alberta. I will be conducting my doctoral dissertation research in Jamaica. This research involves interviewing internal stakeholders - teachers' college students, primary school teachers' college lecturers, university professors and Joint Board of Teacher Education officers about science education for prospective primary teachers - and analyzing education policy documents. I am therefore seeking the permission and approval from your office to conduct the research.

The purposes of the study are; to describe (a) what stakeholders view as the knowledge for teaching science which is provided for prospective primary teachers, through the *Science Education* course in teachers colleges, (b) what stakeholders view as the knowledge for teaching science which might be required by prospective primary teachers to teach science, and (c) the messages about the knowledge for teaching science which are purported by science syllabi and policy documents. The study will also propose a framework for a knowledge base for prospective primary science teacher education. Data will be collected between July and December 1998.

The Joint Board of Teacher Education and heads of institutions and faculties that are targeted for involvement in the study will be invited to participate, by letter and in person. After I have obtained consent from the heads of relevant institutions and faculties I will invite members of each institution to participate in the research individually, by letter and in person. All activities related to, and resulting from my research will adhere to the requirements of the Ethical Guidelines of the University of Alberta. While all the information gathered will be confidential, and the identity of participants will remain anonymous, upon completion of the study I will be happy to provide you with a copy of the thesis.

I intend to be in Jamaica by June 30. Please let me know by fax (403 492 0762) what further procedures I may need to undertake before proceeding with the research. I may also be contacted in Jamaica by phone at 996 1611. I will be willing to respond to any question or query that you may have about my research.

Your consideration of my request is appreciated and I look forward to your response.

Sincerely,

Lena Swire-Walton

Letter to Joint Board of Teacher Education

May 26, 1998

Department of Elementary Education
551 Education Building South
Faculty of Education
University of Alberta
Edmonton, Alberta
T6G 2G5

The Director
Joint Board of Teacher Education
University of the West Indies
Mona
Jamaica, West Indies

Dear

My name is Lena Swire-Walton. I am currently on special leave from my position as lecturer in the Faculty of Education at the College of Agriculture Science and Education, in order to complete my doctoral studies at the University of Alberta. I will be conducting my doctoral dissertation research in Jamaica. The research involves interviewing teachers' college students, college lecturers and Joint Board of Teacher Education appointees from areas related to primary science teacher education, and analyzing teacher education policy documents. I am therefore seeking the permission and approval from your office to conduct the research.

The purposes of the study are; to describe (a) what stakeholders view as the knowledge for teaching science which is provided for prospective primary teachers, through the *Science Education* course in teachers colleges, (b) what stakeholders view as the knowledge for teaching science which might be required for prospective primary teachers to teach science, and (c) the messages about the knowledge for teaching science which are purported by science syllabi and policy documents. The study will also propose a framework for a knowledge base for prospective primary science teacher education. Data will be collected between July and December 1998.

I am seeking your permission to interview appointees to the Joint Board of Teacher Education who are involved in primary science education. Upon receiving permission from you I will contact the relevant persons who will be asked to volunteer to participate in the research. I am willing to brief you about my study at a time convenient to you.

The heads of teachers colleges and teacher education departments that are targeted for involvement in the study will be invited to participate, by letter and in person. After I have obtained consent from the heads of relevant institutions and departments I will invite prospective participants of each institution to participate in the research, individually, by letter and in person. All activities related to, and resulting from my research will adhere to the requirements of the Ethical Guidelines of the University of Alberta. While all the information gathered will be confidential, and the identity of participants will remain anonymous, upon completion of the study I will be happy to provide you with a copy of the thesis.

I intend to be in Jamaica by June 30. Please let me know by fax (403 492 0762) what further procedures I may need to undertake before proceeding with the research. I may also be contacted in Jamaica by phone at 996 1611. I will be willing to respond to any question or query that you may have about my research.

Your consideration of my request is appreciated and I look forward to your response.

Sincerely,

Lena Swire-Walton

Letter to Heads of Teachers' Colleges and Teacher Education Departments, and Dean of School of Education of the University From Which Participants Will Be Drawn

Date

Department of Elementary Education
551 Education Building South
Faculty of Education
University of Alberta
Edmonton, Alberta
T6G 2G5

The principal/ Head of teacher education department
Name of institution
Address

Dear

My name is Lena Swire-Walton. I am currently on special leave from my position as lecturer in the Faculty of Education at the College of Agriculture Science and Education, in order to complete my doctoral studies at the University of Alberta. I will be conducting my doctoral dissertation research in Jamaica. The research involves interviewing internal stakeholders: university professors, teachers' college lecturers and teachers' college students, about science education for prospective primary teachers. I am seeking your permission and approval to conduct the research in your institution/department.

The purposes of the study are; to describe (a) what stakeholders view as the knowledge for teaching science which is provided for prospective primary teachers, through the *Science Education* course in teachers colleges, (b) what stakeholders view as the knowledge for teaching science which might be required for prospective primary teachers to teach science, (c) the messages about the knowledge for teaching science which are purported by science syllabi and policy documents. The study will also propose a framework for a knowledge base for prospective primary science teacher education. Data will be collected between July and December 1998.

I intend to be in Jamaica by June 30. I am willing to discuss my proposed research with you, at a time convenient to you, when I arrive in Jamaica. After I have obtained consent from you I will invite individual prospective participants from your institution to participate in the research, by letter and in person. All activities related to, and resulting from my research will adhere to the requirements of the Ethical Guidelines of the

University of Alberta. All the information gathered will be confidential, and the identity of participants will remain anonymous.

I may also be contacted by phone at 996 1611. I will be willing to respond to any question or query that you may have about my research.

Your consideration of my request is appreciated and I look forward to your response.

Sincerely,

Lena Swire-Walton

Letter to Prospective Participants

Date

Department of Elementary Education
551 Education Building South
Faculty of Education
University of Alberta
Edmonton, Alberta
T6G 2G5

Dear

My name is Lena Swire-Walton. I am currently on special leave from my position as lecturer in the Faculty of Education at the College of Agriculture Science and Education, in order to complete my doctoral studies at the University of Alberta. I am inviting you to participate in a study, which I am conducting.

The purposes of the study are; to describe (a) what stakeholders view as the knowledge for teaching science which is provided for prospective primary teachers, through the *Science Education* course in teachers colleges, (b) what stakeholders view as the knowledge for teaching science which might be required for prospective primary teachers to teach science, (c) the messages about the knowledge for teaching science which are purported by science syllabi and policy documents. The study will also propose a framework for a knowledge base for prospective primary science teacher education.

You are being invited to participate because you have taken the *Primary Science Education Course* in a teachers' college or are involved in primary science and primary science education at the primary school, and teachers' college levels. Interviews will be conducted between September and December 1998. Your participation in this research means that you will be interviewed at least twice, at times convenient to you within this four-month period. With your consent I will be audio-taping all interviews. Each interview will be approximately one hour. At the beginning of the September I will arrange a meeting with you. At that meeting any concerns or questions you may have about me and the research will be addressed. After the interviews you will also be asked to scrutinize and comment on the interview transcripts and sections of the research finding when they are compiled.

With your permission the interviews will be audio taped and all tapes will be destroyed after five years. All your responses will be treated with strict confidence and all activities related to, and resulting from my research will adhere to the requirements of the Ethical Guidelines of the University of Alberta. You may turn off the tape recorder at anytime during the interviews and you are also free to withdraw from the research at any time, without penalty.

A consent form is attached to this letter. If you will participate in the research please complete the form and return it in the self addressed envelope, which is provided. If you have any questions about the research before you sign the consent form you may contact me by phone, at 9961611, at any time.

Your consideration of my request is appreciated and I look forward to your response.

Yours sincerely,

Lena Swire-Walton

Consent Form

I, ______________________ consent to participate in the study that will be conducted
Print your name here
by Lena Swire-Walton. By filling in this form I am giving my consent to participate in the research under the following conditions,

1. I will allow the interview to be tape-recorded.

2. I agree to allow Lena Swire-Walton to share the information from the interviews with scholars and educators through publications and conferences. However, I understand that my privacy will be protected by not using my name or other information that might identify me.

3. I understand that I can withdraw from the research at any time without penalty and that any records of my participation will be destroyed at that time if I wish.

4. I understand that all tape-recorded interviews will be kept by Lena Swire-Walton for five years after data collection and then destroyed.

____
Signature

____
Address of institution

____
Date

____
Contact telephone number

<u>THANK YOU FOR PARTICIPATING IN THIS RESEARCH.</u>

APPENDIX C

QUESTIONS FOR SEMISTRUCTURED INTERVIEWS

College Lecturers

Part 1. Background Information

1. How long have you been a teachers college lecturer?

2. Have you ever taught in a primary school? For how long and which grades?

3. Could you tell me about your qualification and the post secondary institutions that you attended?

4. What are your general interests?

5. Tell me a little bit about any involvement that you have in science outside of teaching?

6. If you were looking at science lesson in a primary classroom what would you look for in an exemplary lesson?

Part 2. Perspectives about Science Education for Prospective Teachers

1. Tell me a little about your views regarding the importance of science teaching in primary school. Why is science teaching important? What is the some important aspects of science that primary school children should learn?

2. What part do you play in the preparation of teachers to teach primary science? What do you feel is your role? How does the science education course influence your role?

3. What factors influence the way you teach science to prospective teachers? How does the primary school curriculum, the science education course, the prospective teachers, the society, research, examinations, your professional education, the JBTE, your views about science influence your teaching? May I see some of these documents that you have mentioned? What influence do each of these have on your teaching and why?

4. What are your views about science and science teaching? What is science? What should science teaching be? Could you describe a good science lesson?

5. What views of science and science teaching emanate from the *Science Education Syllabus*? What indicators do you have about these?

6. How does the science education course support your views of science? If no how do you balance between your views of science and science teaching and each of these other influential factors when you teach science education?

7. How are your views about science teaching displayed in your own teaching? Does the science education support your views? If your views of science teaching are different from those in the *Science Education Syllabus* how do you deal with the differences in your teaching? If the views of the *Science Education Syllabus* are the same as yours what accounts for this similarity?

8. What views of science teaching do prospective teachers usually arrive with to your course? Why is this so? How do you usually find this out? What indicators do you have?

9. What do you do when you find out the views that prospective teachers have at the beginning of the science education course? Are these reflected in how you teach and what you teach?

10. How do you use the course syllabus? Do you follow sequentially, use every suggested activity, inject some areas that are relevant for science teaching but not stated in the syllabus?

11. How do students benefit from the science education course?

12. Tell me about the essential parts of this science education course that gives primary teachers a good foundation about science teaching.

13. What kinds of feedback do you get from prospective teachers about the science education course? Are these usually written? Could I see these?

14. Tell me about an occasion in your experiences with prospective teachers when you felt really satisfied and or really disappointed about students' preparation for teaching science in primary schools? This occasion could be related to a student an incident, a meeting, a teaching practice lesson or one of your science education lessons where you felt satisfied or disappointed about the foundation that the science education course provided for prospective teachers.

Teachers

Part 1. Background Information

1. How long have you been teaching at primary school?

2. When did you graduate from college?

3. What sort of professional development have you engaged in since then?

4. Have you been involved in any Professional development in science? Where and by whom?

5. What are your general interests?

Part 2. Perspectives of Science Education for Prospective Teachers

1. Tell me a little about how your interest in primary science teaching? Is it a subject you enjoy teaching? Are you comfortable teaching science? What about science and science teaching appeal to you?

2. I would like you to reconstruct one of your best science lessons? What is it about this lesson that causes it to stand out in your mind?

3. What influences the way you teach science? Your teacher education, state mandates, your own views about science, the primary curriculum, a person you know, books? How do any of the things you named influence your teaching?

4. What parts of the science education course that you did in college are most beneficial to you now? In what ways are they beneficial? Tell me about an occasion when you realized that having had this course you had a foundation to work from?

5. What does science mean to you? Where or how did you develop this meaning of science?

6. What are your views about science teaching? How does this view influence how you teach?

7. What view of science and science teaching do you see in the primary science curriculum?

8. Are your views different from those you see in the primary science curriculum? How do you balance these views when you teach science?

9. How do you feel about the preparation you experienced in college for teaching science?

10. What essentials about science teaching do you think is important for prospective teachers to have as a foundation for primary science teaching?

11. How are these provided by the science education course? What aspects of the course provide these essentials you named? Is it in the course outline or is it mostly from the lecturer that these essentials are gained?

12. What are some satisfactions and frustrations you wish to share about your preparation to teach science in primary school?

Prospective Teachers

Perspectives on Science Education for Prospective Teachers

1. At what level are you now in your program?

2. Have you taught in primary school before coming to college? How long?

3. What other experiences do you have working with children?

4. What expectations did you have about learning to teach science when you entered college?

5. How did the science program help you to realize your expectations? Tell me a little about some of the experiences you had in the program?

6. Say a little about the role your lecturer played in helping you to meet your expectations.

7. What does science mean to you? Why is this so?

8. How do you think science should be taught in schools?

9. What aspects of the science education course have prepared you to teach this way? Give me some examples?

10. What essentials for science teaching do you think are important for primary science teachers to have as a foundation for teaching science?

11. In what ways has the science education course prepared you with that foundation for teaching science? Share some examples with me.

12. What aspects of science and science teaching would have been most helpful to prepare you for the last teaching practice exercise? Tell me about some of your experiences that have led you to this view?

13. What other experiences and concerns with regard to the science education course and your teaching of science you would like to share?

Members of JBTE, Professors of UWI

Part 1. Background Information

1. What is your present position and what is your role in this position? What would a typical day be like for you?

2. How long have you been in this position?

3. Have you taught in Jamaican primary school? For how long?

4. Have you taught in teachers' college? For how long and which courses have you taught?

5. Did you attend teachers' college in Jamaica? Which program did you pursue?

6. What are your academic interests? And your general interests?

7. What do you think about the present status of science education in primary schools?

Part 2. Perspectives on Science Education for Prospective Teachers

1. Tell me about any involvement you have had with science education at the teachers' college level? Have you been involved at the curriculum writing level, as a presenter at professional development sessions, external examiner?

2. What does science teaching mean to you?

3. What are your views about how science should be taught at primary school level?

4. What do you think we should be trying to achieve in primary science education at the college level with regard to how science is taught in primary schools? What do teachers need to know in order to teach this kind of science?

5. How does the science education course contribute to the preparation of prospective teachers to teach primary science? What are some examples to support your views?

6. What do you think teacher educators need to do in order to prepare the best kind of teacher for teaching primary science?

7. If you were a lecturer how would you approach the teaching of the syllabus? How would you use the syllabus? As guide or as a mandate? How would you arrange your lessons based on this?

8. What are some sources of information about science teaching that you use for informing how you view science and science teaching? May I see these?

9. What views of science teaching does the *Science Education Syllabus* promote?

10. Do you think teacher educators share the same views about science teaching as is in the *Science Education Syllabus*? How do you suppose science education lecturers deal with this discrepancy of views?

11. Tell me about the essential aspects of science teaching that you think prospective teachers should have as a foundation for teaching primary science? Why should they know about these? How do each of these contribute to good science teaching?

12. Tell me about any occasion regarding science teaching that stands out in your mind as something you will never forget? It may be about a prospective primary science teachers or science education lecturers or primary science teachers, or yourself? What is it about that occasion that makes it so memorable

13. How do you keep in touch with the changes in knowledge in science education? How you share these with teacher educators at the teachers colleges?

14. Are there any other satisfactions or concerns you would like to share with regard to your views about the science education that is provided for prospective primary teachers?

APPENDIX D

SAMPLE OF SYNOPSES OF FIRST INTERVIEWS

Kay's Synopsis

Science and the Primary School

Science is a part of everyday life; it is a way of finding out things that benefit humans. Teachers in the primary schools do not have professional development in science teaching; it is rare. Not like math and language arts.
Lack of materials for teaching science is a major problem for teachers in the primary school. Science therefore becomes boring for children when teachers have to rely on chalk and talk and textbooks as the main teaching tools.
The science content in the primary school is pretty simple and so teachers should have no problem with the content. The discovery method is used for teaching science as children learn best by doing. When teaching science we have to allow children to find things out for themselves. The textbook instead of the syllabus is most often used for decision-making when planning for teaching science. The textbook is very comprehensive and therefore overrides the use of the syllabus.
In the primary school the children, their needs and moods, influences what and how the teacher teaches for science on any particular day.

Science and Teacher Education

The science methods syllabus is of some benefit to prospective teachers as they prepare for the classroom. It helps them to develop and hone knowledge and skills about lesson planning, and organizing lessons in the classroom.
The syllabus and course also prepares the prospective teacher to select among different methods and strategies that are available to them for teaching science and about the topics and arrangement of the primary science curriculum. It also provides an awareness of how children learn.
Micro-teaching is a very important aspect of the course. The lecturer of the science methods course is a major influence on the interest and attitudes that prospective teachers develop through the course.

Foundations for Teacher Education

Prospective teachers need to know how to keep children interested in classroom science; they need to know children's background.
Teachers should be competent at explaining scientific concepts. This science teacher characteristic is enhanced if teachers have a wide repertoire of teaching/learning methods and strategies available to them. Additionally teachers should know how to achieve congruence between content and the different methods.
Teachers learn most of what they know from teaching and being in the classroom and secondary to this is professional development. Knowing how to teach science is somewhat different from the other subjects.

Monica's Synopsis

Science and the Primary School

Science is life, it is a body of information about the world and the universe. Science provides explanations. Primary school science should be student centered. It should be taught using a hands-on minds-on approach while fostering enjoyment. Science at this level should be channeled towards helping children to sort things out for themselves, it should help them to develop skills that will fit them for life. Science at primary school should assist children in explaining away myths that are associated with scientific phenomena that they come across in their daily lives. A good science program should assist children in organizing their own learning. The teacher's role at this level is to help children to organize the knowledge they already have and to socialize children's they work in groups to solve problems.

Science and Teacher Education

The science methods syllabus for prospective primary school teachers suggests that science teaching involve developing skills – a skills approach to teaching. It points to science as being organized and that teacher does not have all the knowledge so resource persons are or should be included in teaching science in primary schools. Teacher educators (lecturers) demonstrate how to teach in addition to providing opportunities for leaning how to teach through micro teaching. During the course activities for teaching different aspects of the primary school science curriculum are emphasized and the lecturer provides student with new information, about areas related to science teaching, not be included on the syllabus. On the other hand too much of this new information cannot be used as the course syllabus influences what is taught and the lecturers role in achieving the goals of the course. While everyday life experiences and the needs of the society and the country do influence how and what they do in this course, ultimately the lecturer teaches the course so students can be successful in the examination. This factor is a deterrent to the provision a multiplicity of novel experiences for students to use as they venture into the classroom. The science methods syllabus can be completed without any practical application of teaching science is done in the course. It is very theoretical.

Foundations for Teaching Science

Our primary school teachers need to develop confidence in teaching science. This lack of confidence might be a result of the limited content knowledge which they posses. The content and the methods course should not be separated form each other as one compliments the other they should therefore be taught as a single course. The prospective teacher would therefore be given the chance to learn to teach science while learning about science – while doing the content. Teachers need to be able to organize lessons and organize themselves to conduct science lessons. Our teachers do not know the benefits of socialization in science teaching and learning. The nature of science and the approaches to teaching science as well as the spiral curriculum are integral to adequate preparation for teaching science but these must be approached practically

Valerie's Synopsis

Science and the Primary School

Teachers in primary schools do not have adequate background in science content, neither do they understand what science is or the philosophies underlying science. Primary teachers see science as a body of knowledge and work toward disseminating this knowledge in the classroom. They have not embraced the skills approach to teaching science. If teachers themselves do not understand what is science they will not be able effective in teaching science so that it will be of benefit to the children at that age. There is a lack of equipment in the classrooms and this greatly impedes the teaching of meaningful science in primary schools.
Children should be exposed to interactive science teaching rather than rote learning. Children should be allowed to explore different scientific concepts; become involved in and have fun with doing science. They should be encouraged to develop good attitudes toward science and openness in discussing scientific issues. Children should be guided to become scientifically literate.

Science and Teacher Education

Science teaching is not "ordinary." Being a science educator is an awesome task. Teachers of science have to willing to extend themselves and the teacher education program should help prospective teachers hone this attitude. In the BEd. Program the science education courses focus on

1. Developing content along with skills and attitude.
2. The nature of science.
3. Doing and planning investigations
4. Assessment

The content of the course is taught through the use of case studies, field trips and an overall use of the constructivist approach. Science content is used to reinforce methods of teaching.

Foundations for Teaching Science

1. Assessment in the science classroom.
2. The nature of science
3. Theories of how children learn – a variety.
4. Using content to teach methods – a close interaction between content and methodology.
5. Have prospective teachers involved in science activities – get their hands wet.
6. Development and fostering in prospective teachers good attitudes toward science and curiosity and interest in science.
7. Understanding of the use of the surrounding as resources for teaching science.
8. Content.
9. Modeling of teaching methods.

Additionally the course requires more flexibility on the part of the JBTE and lecturers as there is individuality among lecturers.
Teaching science involves thinking, spontaneously and reflectively. An experienced teacher has certain distinct characteristics that separate her/him from the novice teacher.

APPENDIX E

SAMPLE OF GROUPS OF TOPICAL POINTS FROM ONE INTERVIEW

Topical Groups

Life in the church does not conflict with my interest in science
I do not see my faith as something that is not scientific, they complement each other.

<u>I am a bit concerned about science education in Jamaica</u>

First I think it is a good thing for them to be introducing science in a big way in primary schools.
The thrust of the whole NAP program
There is now assessment in science as a part of the package
It is more likely now that science will get some more attention
I am a bit concerned from two angles

I find that it (science) is a good thing to introduce it but I am not sure it is going to be a good thing in the context of the present drawbacks
The two things need to come together if it is going to be effective
The responsibility is on the government and the policy-makers to put things together

I had an experience where I had a tutor who was I think one of the greatest that Jamaica had ever produced
She was a very controversial person so you either liked her philosophy or you did not like her philosophy there was no in between with her
She opened my eyes for me to see that the whole business of teaching science is not just something that we should do
Perhaps too it stems form how they themselves were taught science
For me it (science teaching)is an obligation
It (science) is not an ordinary thing
It (science) is something that you fit into every area of life
Teaching science is an extremely important thing
First it is an obligation because I think that I am good at it
I think that I have a responsibility to help people to be good at it
I always see it (science) as an extremely challenging thing
I remember coming across one morning and I was walking across there and suddenly it just dawned on me that I am a science educator
There were not many science educators in Jamaica
I just had this awesome sense of responsibility
If you get it wrong you will be affecting generations and generations
maybe it is not so with language
Perhaps because there are so many of those people but I looked around in my mind and I am thinking now where are these people?
There are not many in the colleges
It (being a science educator in Jamaica)is an awesome sense of responsibility
I just felt this burden.
There are not many (science educators) probably one in each college.

Science at primary school should be as interactive as possible
We do not really need to give primary school children this whole lot of notes and everything that sometimes is viewed as science
Children need to explore science
Need to understand how things work
How they don't work
They (children) need to get their hands wet and dirty
They (children) need to have fun doing science
At the same time build a sense of recognizing that science is important for their daily living
Having scientific literacy
This is the business of helping children to become aware of the importance of science for progress
Yet without the rigid structure of the content, the content
We need really to develop interest (in children)
Develop some attitudes, good attitudes toward science and an openness in discussing scientific issues
Science is really helping children to come to grips with their curiosity and to extend this curiosity to it fullest.
Would be an advocate for teaching to develop attitudes and skills rather than the content of science at that (primary) level

Traditionally teachers of the primary level are afraid of teaching science
They (primary teachers) need to have the content I am not sure how much content there is but they should have.
They are afraid because they believe that they do not have adequate background in science content
If they are not free enough of the content, free in that you do not even have to think about it then you will never be free with the methodology
You still are going to be knocking your head about what am I going to teach how
Once you know your stuff then you can become very creative
Many of the prospective teachers who come in do not have a strong science background, they come in with this weakness

Another area of concern is that many schools are not really equipped in terms of equipment and furniture to teach science
Teachers do have a tendency to use textbooks when they don't have things at their disposal
People are going to be frustrated unless we really are go-getter regardless of
Unless you have come to a point where you are willing to go all out
Many teachers are not like that (go-getters)
How long can they last when doing that sort of thing
Many people cant be like that
It is not a matter of not wanting to be like that, they can't
They are constrained by all kinds of factors, economic, time
All kinds of things

They really can't be the persons who are going to always be gathering little bottles and other things at all times
They wont and that is the real difficulty that primary school teachers have
Do not believe that it is going to work the whole business of the process approach, the attitudes the interest it will not work in the current context
It (teaching science in primary schools) is frustrating.
The only problem is that because we only have a room(at the university)
We don't have much equipment in the room
We should have got the equipment but some projects and funding and the works
Am still hoping that we do get something
Most of the stuff that we use now I take them from my home
Or buy them
Or I get them to bring stuff
We are still at that level
Which is not really a bad thing because the truth is that they may have to do this same thing as well

Not sure about the program in the colleges how much of this kind of thing is done

Unfortunate that teachers are not better prepared to teach science
I too do not believe that the teachers who have been coming here have a real good sense of science
What it (science) really is
What it (science) involves
Those (the teachers doing the BEd program) who come here have not done a lot of science content
They have done a little
They (BEd students) don't really understand the philosophies the whole business of what science is all about and is supposed to do
The truth is they have a picture of science that there is a body of knowledge that need to be disseminated

They have not really embraced the whole business of the skills approach to science
They don't understand it (the skills approach) they don't know it
It is difficult if you don't really understand what science is supposed to be saying, doing for you to really understand what the children's needs are
You are only seeing one angle of it you are only seeing that children need to know about the leaf structure and the various parts but not seeing that the real reason for teaching children this is so that they will understand why the leaf is so important
You are not looking at teaching above the level of comprehension
So they really don't know what they (the teachers) need
It has to do with their background, their training
But the truth is the people who are in the science lectures here really have a very poor background in science because of the qualification level
They (the BEd students) have sometimes no pass in any science subject and that also creates a big problem.

When I was teaching the first course I realized that it was very difficult to move with people because much of the content they lack
I couldn't stop to teach them the concepts involved in sinking and floating before we get down to an investigation on sinking and floating
It (the lack of knowledge) was creating a problem
Last year I introduced a new course which is really a content course
We do the content, not in the traditional way we do it by using an inquiry approach
I use the constructivist approach
Start off by finding out what they believe
We go through the whole process
They write down what they understand about the topic like sinking and floating and then I take them through, using questioning problem solving approach
And they do the various topics
Now there will be a national assessment and people are constrained by these things

When I came here (to the university) I inherited a course
They looked at the process skills in science
Essentially that course I think was written in order to help teachers to implement the whole business of the skills approach in science
I think it came out of the whole movement of the process skills for teaching science
It was done in a very isolated kind of way

I don't think that you can teach skills in an isolated kind of way
I think you have to teach skills in an integrated way alongside the content
You are teaching your content through your skills

The first year I did the course I was a bit timid
I was new and so I was trying to follow everything by the rule
You don't know how much out of the norm you can go
So I really just kind of went through the skills and we also looked at the different planning structures

This particular course has to do with as I said the process skills
I had to look at the structure of science
I put in something about what science is
Added dimension on how children learn
We now look at the nature of science in a short way
That (the nature of science) in itself is a whole course
I have introduced at least two three hours of lecture on the nature of science
We look at the structure of how the learner learns
The child comes to you what does the child have
The final part is where we look at teaching these children given the background of what science really is and given the kind of persons you have before you
What do we now take into consideration in order to teach
Since you are going to be teaching children to draw or to observe what must you do? children do not just observe

They observe the bottle and then what you see and what I see might be different
We are coming from different backgrounds
How do you help children to see what you want them to see
You go into the whole business of questioning
The kinds of things that you want them to do
I look at the skills
We looked at an integrated curriculum and as opposed to the basic curriculum
How do you plan for the science in all of this
After that I thought we were doing too much talking about it (teaching science)
We were still looking at it from a very theoretical perspective
I didn't like that so after that year I now use more case studies in my approach to teaching the various skills
I use case studies sometimes I make them up
I usually make them up or I pull them from text-books or I use various situations now that I am into research
I now sometimes use some of the real stuff which I am pulling in to show and we talk about it now
We couldn't up to last year do much more than that
I do have them do a lot of activity
With at least one set of activities where they actually do some investigation
That primary education course is still very limited
I have introduced a new course
In the investigations where they actually start from scratch with a problem and then they go through
I actually do investigations and use case studies much for the rest of the syllabus
I have also done field trips with them
In that course I am just really trying to make it a little bit more alive than just reading from the textbook saying observing is so and so when you observe you do this
I kind of move it away and kind of introduce other approaches
The other course is a bit different
The unfortunate thing and the difficulty with that approach is that they don't cover much of the content
This is the first year I am doing it and I mean we covered about three areas
I do believe that they have learnt about sinking and floating and about forces and about energy
I specifically selected topics from the primary school syllabus
I thought these topics were difficult for the teachers
I didn't cover all the topics that I wanted to but I did cover some of it
The other thing I do in that course also is that because of my bias toward assessment
Because we don't have an assessment course in primary science I do some of the assessment in this first course
I have had to add that as well
I thought that with the new assessment programs coming on stream and teachers not knowing, somewhere we have to fill some gaps
I introduced that in the first course and so I looked at assessment and primarily pencil and paper assessment

But in this course I introduced concept mapping in a big way
I teach them how to use concept maps
I teach them how to develop concept maps
How to do concept maps as one of the assessment
They do a concept map which is graded so that course is new and exciting
I liked it
First year (which is this year) it was good I think
We have done too many things
But I think that they (the BEd students) have appreciated it (the content of the new course)
I don't know what I will do next year
Don't like to do the same thing too many times

Children do not really come to the classroom with empty minds
They (children) come in with some ideas some explanations of how the world works
They come in with some things
First of all you need to understand where they are coming from
I always say to the students you know children are here (holding out her right hand) and the information that you want them to acquire is right here (holding out her left hand) and you are going to be the bridge so it is important that you first ascertain where they are before you try to get them to where you want them to be
If you use the metaphor of the journey and someone says to you look I am coming to your house and I am lost then the first thing you have to find out is where they are
So we start there and then you recognize that we have to understand what is happening here
Know how to pitch what you want to put there for it to become meaningful
That is really the stance that I take that is how I do it
I am not sure that I agree with that position that this approach is not child centered as it focuses on what teacher want child to know
One of the reasons why we are teachers, we have the edge of experience
And I think that where as children will come and children will give you new and novel things
The fact is that there are many things that children will not know
We need to help them to get to the point where yes this is what we want you to have

You do you have a responsibility to the students
But you also have a responsibility to your boss and to the parents
So I think you have to do what, you know.
They (the colleges) should move away from Piaget alone
Pick up on some of what Bruner has to say
When we do Piaget we sometimes end up with the thinking that children cant learn this material now
That is not necessarily true
Maybe the reason why they cant learn it now is because of the way they (the teachers) are packaging it
That is the reason why I am not really very fond of Piaget

If this is not his intention this is how he comes across to many of the teachers
I said to my teachers the other day have you ever tried using graphs or tables in your assessment
The response was they cant handle it, it is too abstract
Haven't really done any kind of analysis
I have a feeling that this is really coming from Piaget
When you get locked in this whole business of early concrete and so on
You tend to begin to see things in this kind of rigid way
You are not recognizing that there are many ways that you can help a child to overcome depending on how you package it (the content)
Move away from Piaget.

Because of this breadth of coverage of content in college in that short time I don't see How much depth they could cover
What is critical is that teachers get a chance to do what they are learning about
So it is not enough for them to hear it nor even enough for them to even do it in the odd times
It is important that they (teachers) do it (science) themselves
So pretty much in the same way that you have the children in the higher grades do their practical work
This is an important part of the development and training of the primary school teacher
That is the only way they are going to recognize that there is really very little problems that you can have if you hold the echinoderm or if you touch something in the science lab
They (the teachers) are so fearful of touching
A simple activity such as sinking and floating where you can have pans of water and lots of things it was just amazing how they had never done this
These (BEd students) are people who have been teaching for years
We got them (the BEd) to float the potato and to sink it and we got them to use different media, brine and water,
They were so excited I was almost tearful
I said to myself these are people who are teaching
Most of them are teaching for at least 10 to 15 years
They have never done this
Everything that we do in class they go home and do it with their own children at home
I am saying that in the training it has got to be more than just telling them about it, the odd chance that they may, some of them will, the odd chance that they may, they may end up doing it wrong anyway
You have to model it you have to show them
You have to teach it that way
I think in the delivery the whole approach to teaching must reflect the approach that you want them to use
When you are going to be telling them about things that they have never done before they are going to be even more timid
Given their weak background in science they need to do, DO SOME SCIENCE.
You know their should be planned field trips
They should be looking at projects that they can do

Mounting exhibitions,
This business of science exhibition should not be for only those that are interested it should be built into the whole structure of the college program so when they go into the schools to teach they know how to set up an investigation they know how to take children through the investigation
So the college course should not be so theoretical
I think opportunities are there for them to do that
Until we build it into the curriculum things will not be better
Development of an attitude of curiosity and interest
That will only come when teachers begin to get involved in doing the things that we can do in science

Following a curriculum then you are constrained by the curriculum
It's ok if you are in a program where to a certain extent you are free
Have to recognize it
I think that people are afraid that they will not cover everything but we cant cover everything.
It could be because of the constraints of JBTE that lecturers are not launching out into different avenues
We are a real exam driven society so it could be.
I have found that being here (at the university) I can be flexible
I make the decision as to what I do
Perhaps that is a problem because it is easier for me having got over the first year of "am I doing things right"
Not wanting to take any chances
If my understanding is correct it is the board of studies that govern things and these are the same persons who lecture in the colleges
But people do not all think alike
So things will be different among all these persons
You still need some level of moderation
But you need to have flexibility and freedom to do what you want to do
At the same time there must be some kind of moderation to say ok now let us look at what you have done this year and what it is worth
The truth is you meet once per term so unless you are proactive and is on the phone with your colleagues you are pretty much on your own so it does create a problem.

They (prospective teachers) need to learn about assessment
I find that they do not for the most part understand how to set good questions
Even the pencil and paper which I have no problem with should be good pencil and paper tests
I find that sometimes teachers have some real nice ideas
Sometimes it is not the setting of the item but how do you weigh this item what is it worth?
When you give a certain kind of item how do you judge it against another type
These are the problems that teachers face so they generally stick to the true false multiple choice type

I think in the training and of course as I have been reading I have found that we do so much assessment as we teach
This is perhaps one area in which we are least trained
Most of my reading is telling me that this is one area that teachers find most
And it is the area that we are least trained in
I have been talking to my teachers they really have a lot of problems
Like I said it is one thing to assess a regular pencil ad paper objective type item but anytime it moves from that and you go to even an essay or a drawing at first when you say to them so how do you assess the item and then there are pauses and the inadvertently you get the answer that says you just give it a grade
The whole business of structuring things and looking for criteria

I am not in a position to say that it is not done I believe that it is done
I think that what happens is that teachers do not get a chance to really assimilate everything

More interaction where the students are engaged in doing science
Not divorce the content from the methods
I think that is part of the problem

Quite frankly I think too much is being expected of the colleges
I do not think that they cover enough within the time allotted
Maybe the time is too short
There might be need for some merging of some foundation courses
In three years they should be able to cover a significant amount of work
We (university lecturers) are not seeing that kind of person coming here (to the university).
The teachers college is not the place for you to be teaching the background of science content
That should be done at the secondary school when they come they should have a basic background
Don't think that the college should be the place to teach them all of the science from basic up
At the college you should be building on their basic understanding
Maybe that is a part of the problem
When you really begin to understand that this thing is not really something out of the norm there is something real here, they will be able to better appreciate that
Building of the attitude
There is the whole attaching of this thing to something real outside of the classroom so whether there is going to be at that level of the health clinic or it is going to be at the level of the market something for you to show how you can get science
You can see the science in our daily living
Develop that kind of interest so that they will begin to see it
The methods is there the content is there and if they come with a background I would like to see the development of some interest and attitude

Go beyond saying science is for the bright I cant do it I am not bright and that kind of thing.

I subscribe to journals
Just about anything I can find, and that I think is interesting
I need to do is get a strong affiliation with an international body
Working with the ASTJ also helps
Also just by taking with other people
Make it my duty to know and keep in touch with the other people in science education
One incident that perhaps motivated me toward teaching

We were doing respiration and we had a practice teacher

Her supervisor was in the room and she was going through the whole business that the number of Alveoli increased the surface area of the respiratory surface and the capacity of the lung

Could not understand it

She kept repeating it in different ways and I still could not understand

It was not making sense and the class was getting restless

Everyone thought I was being difficult.

As a student I was willing to accept it

At that time her supervisor got up came to the front of the room and said this is a piece of cloth I bought yesterday look at it describe it.

What is the area, and we got involved made some guesses, then she told us what it was then she said I took this out of my bag let us look at the bag how big do you think it is and we guessed and talked, then she folded the fabric and put it in her bag and I will never forget how I felt, I will never forget it and always use this to teach

Recognize that there is an aspect of teaching that is not just being able to know but is to be able to think on your feet

Use what you have.

I just saw how a teacher could make things so clear

Because of how you chose to explain

I realized that it was more to teaching than just teaching

That there was teaching which entailed how to think on your feet now perhaps this other person did not have that understanding

Might have been due to her experience I don't know

I am just thinking back it could have been the fact of nerves

The assessor could have been a little bit more distant from the situation but the truth is she did solve my problem

I understood perfectly what they were talking about

She (the supervisor) was so calm and classic

I have learnt so much from that experience

Perhaps one of the things that teachers need to know and be able to do more than anything is to think on your feet

To pull out all the stops to help children understand

To take the children from where they are to where you want them to be

profound experience.

Common Issues Emerging Across Interviews

Prospective teachers doing science

Teaching Science for living in the primary school
Developing attitudes and skills in primary school science
The impact of community, resources and school infrastructure on science teaching
Use of textbooks in teaching and learning
Improvised materials and teaching aids
Content knowledge of teachers
Insightful science teaching
Interactive science teaching
Methods and approaches
Flexibility in science teacher education
Showing pre-service teachers how to teach (Modeling)
Practicing how to teach
Use of primary school curriculum
Relationship of children's previous knowledge and experiences to science teaching
Assessing and evaluating
Learning theories
Science content coverage in college

Children doing science

Characteristics of the science teacher
Value of the college course
Structure of the college course
How the college science methods course is "taught"
Evaluation and reflection
Use of time
Doing less content to achieve more
Developing into a teacher
Old fashion teaching
Skills approach

APPENDIX F

PAUL'S STORY

I: Tell me about an experience or an incident that had made an impact on you that stands out in your mind as significant, whether in a good way or a bad way.

N: Well, I don't know what to say. [pause, pause, pause] When I was teaching Grade Three in the second year of my teaching, I had to teach mainly physical sciences concepts; you know, force, push, pull, levers, and so on. I am not a physics person, so I had to do much research. Anyway, I decided to get the children really involved in what I was teaching because I knew that was the only way that they would understand; you know, you can't see force, but you experience it. Oh, to say here that I think teachers need to learn how to integrate the content they learn with the best method for teaching and also that they should learn how to teach reading with science. Well, the group I had was a very slow Grade Three. The children could not read or write, but they were very responsive, and I liked that. I got them involved in everything I did, and they liked that. So for forces I asked them to bring discarded materials from home, and they brought so much. Then I provided things like tape and paste and strings. I allowed them to just make things that they use as toys or in the home for some purpose, and they went to town on that, so that was one whole class. And then for the whole week they kept bringing different things that they made at home to me, gigs and trucks, and even the girls made trucks and brooms. Then I asked them to say what they would use each one for, so each student had to tell in one sentence what they would use the thing that they made to do. I then asked them to demonstrate to the class how the thing worked, and so they showed the class. After that I asked them to say what was common about how they got these things to work for them. And there and then, pushes and pulls came out. I was filled with goose pimples when the children used the words and could demonstrate why they had arrived at that conclusion. Then we moved on to force, and here again they could demonstrate how they understood the whole business of push and pull being force, and they would use the words like, for example, you force it to move, and we talked about reasons why we had to force things to move. This experience might not sound like much to be proud of, but if you knew my students, you would feel the same way.

APPENDIX G

JESSICA'S STORY

J: Well yes, I did science in the first year of college and the second year. Well for the second year that one really did help me because I am teaching but I really did not know how to put across the science to the children in the classroom so it has helped in that way. I remember one day I was doing a science lesson and the education officer came into my class, not that I had chosen to teach science at the time but that was the lesson I was doing when she walked into my class. After I did the lesson she commented that it was very good but what she had commented on was my use of space I had everybody like in one corner and she said I should have used up more space, I did not quite remember what the topic of the lesson was but I think we were doing transparent things. I remember there was one child in the class who was looking at the transparent bottle and she said it was not transparent when everybody else thought that it was. The education officer was sitting there and she too could not understand why the child was saying that it was not transparent. Anyhow she come over and took the bottle and sent the child outside to put some water in the bottle and when the child came back she asked the child if she could see through it and the child said no and she got a pen and put it behind the bottle and then she said can you see the pen and the child said yes. There and then you could see that the lesson, understanding the lesson was extended to that child and it is all about knowing how to put across the science knowing how to explain.

APPENDIX H

VICKY'S STORY

I: What other experiences or concerns do you have about the science education course of science teaching?
V: to me my science classes on teaching practice were good. I taught measurement. At first I thought what will I teach these grade six children about measurement that they do not already know? So I decided that for the first topic which was measurement on length or distances I would just let them revise the use of the measuring instruments by measuring the parts of their bodies, desks and so on. It was a shock to me when I found out that the children could not use the ruler properly (I: What do you mean) alright, although some of the rulers were not graduated from the edge some of them started measuring from the very end of the ruler because they were copying children who had rulers that were calibrated from the end. When I saw that I decided that I would group the children and allow those that could measure to do the measurements that I had planned using a variety of measuring instruments while I give the others some small group attention. Miss Walton my class became chaotic because the children who I thought could measure could not conclude that they should use the tape measure and string to measure the length of circular objects because I did not tell them to use the tape measure for this one and the ruler for this one they could not think for themselves that the ruler was not the best instrument to measure the distance around things like the circular covering for the fan. You can imagine that I had to be going from one group to the next and so I became confused and what I had planned to be a beautiful lesson on measuring length became a disaster.
I: How do you now reflect on that experience?
V: Well I think that maybe I should have found out before planning whether the children could actually measure. If I had more experience with the children I would have been able to plan better and this lesson would have been much better. I have also learnt that simply having a good plan for teaching is not all but having a good plan that is planned for the differences among children is what is important. The teacher has to know the children in order to teach them so that they will learn something. And another thing is that as a science teacher if you don't know what to look for, you know like the things that children are going to find difficult or the things that children will make mistakes with then you will not be able to plan for these.
I: thank you for allowing me this interview and I wish you all that is good in your teaching career.

APPENDIX I

SOPHIA'S STORY

I: Tell me about an occasion regarding science teaching that stands out in your mind as significant. I have had several of those (laugh, laugh)
Well tell me a little story about one of these.
M: oh sure. I don't know I guess this one stands out because I guess it's the bright light of how constructivism could be approached. I am not a total constructivist I am an eclectic person I will use methods to suit my own purposes the way I should see them however my first experience of constructivism came at the institute of education in 1988 – 89 where our tutor for days, would seem to us to come to class almost unprepared because he wanted to start where we were at. You know but yet he was taking us to a point and at the end of the class we would see that point and we would have the feeling that there was professional growth within ourselves. It was when the light shone on me just feeling myself, a professional growth through a process, through a course process that I thought was the greatest experience. And that course was using reading and writing in science teaching. He wasn't only talking about it he wasn't only looking at the researches in it but we were experiencing using reading and writing in the teaching of science. so it didn't even have to do with the lad and all those process skills and all those things but for me that was such a bright light because some how in all my experience before I had never seen primary people using drama using literature using children's book using all these things that brings joy to students in science or to bring joy to me on science. That was my first experience and one of my most significant experiences in learning in science.